THE COASTAL STORM AWARENESS PROGRAM

FINAL REPORT

NOVEMBER 2015

Sea Grant
Connecticut

Sea Grant
New York

Sea Grant
NJ Sea Grant Consortium

Cover illustration: track of Superstorm Sandy, 22-29 October 2012

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Introduction

This final report is submitted by the New Jersey Sea Grant Consortium (NJSG), New York Sea Grant (NYSG) and Connecticut Sea Grant (CTSG) to the National Sea Grant Office (NSGO) and the Grants Management Division (GMD) of NOAA on the Coastal Storm Awareness Program (CSAP) in fulfilment of Award Nos. NA13OAR4830227, NA130AR4830229 and NA13OAR4830228, respectively. CSAP was an integrated program of research, communications and extension activities that focused on improving the communication of and public response to coastal storm warnings in New Jersey, New York and Connecticut. CSAP used as a test bed the actual experiences and actions of coastal communities, residents and emergency response personnel during Superstorm Sandy. Lessons from Sandy secured through CSAP regarding the effectiveness of coastal storm warning products, their distribution and their reception by a vulnerable public can help the region and the nation better prepare itself for the next major coastal storm.

Coastal Storm Awareness Program Origins and Background

Superstorm Sandy slammed into the New York Metropolitan area in the early evening of 29 October 2012 causing widespread loss of life and damage. Sandy made landfall near Brigantine, New Jersey, just to the northeast of Atlantic City, New Jersey. The storm was unusual in several ways. At landfall, it was huge, roughly 1,000 km in diameter. Its direction of approach to the mainland in the Tri-State Area was from the southeast while most extra-tropical storms approach from directly south. Lastly, as it neared the coast, the tropical cyclone Sandy merged with an intense low pressure system and strengthened very substantially.

Most of the damage from Sandy in coastal areas was caused by both the arrival of the storm during high tide of a spring tide (upon which the storm surge was superimposed) and the speed at which the storm made landfall (approximately 28 miles per hour) which helped push the water ashore. Severe storm-related flooding occurred in much of coastal New Jersey, the south shore of Long Island (especially western Long Island and New York City) and western parts of Long Island Sound. By the time the storm dissipated over western Pennsylvania on 31 October 2012, it had claimed the lives of 147 people in the Caribbean and the United States. Many areas, including New York City, experienced historic flooding with great damage to infrastructure. Some coastal communities in New Jersey were without power for months. Storm recovery in the hardest-hit areas of coastal New York and New Jersey is still far from complete. Total U.S. damage estimates from Sandy exceed $50 billion.

Sandy was a historic storm. The degree of devastation it produced seemed to surprise many, weather and disaster experts and laypersons alike. The storm and its aftermath triggered a nationwide reassessment of coastal storm preparedness in the United States, pursued nowhere more extensively and thoroughly than in the heavily impacted states of New Jersey, New York and Connecticut. NOAA's National Weather Service conducted an assessment in the months following the storm to document and evaluate the agency's performance and effectiveness before and during the event, focusing on three areas: NWS's forecast, watch and warning

tools; the usefulness of the agency web site as a tool for communicating storm information to the public and the agency's issuance of storm surge products. This assessment found that NWS forecasts of the track, timing and impact of Sandy had been accurate. However, the report found a number of shortcomings in the agency's efforts to disseminate storm information to the general public, especially projections on the timing and height of storm surge. The sad reality is that most of the storm-related deaths in the Tri-State Area were the result of individuals who made bad decisions despite having good information, not evacuating from high-risk areas when they should have, or deciding to leave when conditions had deteriorated to the point where it was safer to stay. Significant improvements were clearly needed in storm hazards communication, the understanding of how best to reach citizens living in the path of a severe coastal storm with storm information, how citizens interpret and process this information and what other factors are at play in their deciding to heed warnings to leave or not.

Since Sandy, the NWS has worked to generate much improved storm surge prediction products that will depict anticipated increases in water level and flooding in ways and terms that the general public can better understand.   The need to improve understanding of how to reach and inform coastal dwellers of impending storm risks became the focus of the CSAP Program.

On 29 January 2013, President Barak Obama signed into law the Disaster Relief Appropriations Act of 2013, better known as the Sandy Supplemental legislation. The Act provided $50.8 billion to improve and streamline federal disaster assistance provided to Sandy victims and to expand federal programs related to storm preparedness. Of the latter funds, NOAA received approximately $326 million for a wide variety of purposes. Two million dollars of NOAA's allotment was earmarked to support the proposal from the NSGO, "Social Science in Support of Effective Risk Communication and Decision-making in the Face of Coastal Storms," drawn from the deficiencies highlighted in the NWS assessment report. The FY 2013 budget sequester subsequently reduced this allotment to $1.832 million.

Having received word that its proposal was to be funded, in late spring 2013 the NSGO requested the Sea Grant programs in New Jersey, New York and Connecticut to prepare a formal proposal for the expenditure of these funds on a targeted research and extension program consistent with the proposal's focus. The program was to be a one-time effort of two year's duration, with substantial reporting and oversight requirements and no possibility of a time extension. The program would focus squarely on the Sandy experience in the Tri-State Area but it was expected that its design and conduct would be such as to make it complementary to other, ongoing Sea Grant/NOAA programs and projects in coastal storms prediction and preparedness.

Coastal Storm Awareness Program Development

The Connecticut, New York and New Jersey Sea Grant Programs submitted an informal CSAP program proposal to the NOAA National Sea Grant Office (NSGO) on 19 June 2013 (see Appendix I). The proposed project, titled the Coastal Storm Awareness Program (CSAP), would

create a linked program of competitively selected research projects, extension and outreach activities and public information efforts. Conducted in partnership with the NOAA National Weather Service (NOAA NWS) and other federal, state and local government agencies, the goal of CSAP was to save lives and promote public safety by creating tools that more effectively inform people of the true severity of the danger from coastal storm hazards and increase the likelihood that residents who should remove themselves out of harm's way actually do so or take other actions that prevent them from becoming storm casualties.

Approval to formally submit the proposal in response to the FFO (NOAA Sea Grant Sandy Response – Social Science, #NOAA-OAR-SG-2013-2003808) was received in early July 2013. The proposal was submitted through Grants.gov on 31 July 2013. Identical awards in the amount of $610,666.67 were made to each of the three state Sea Grant programs in late September 2013. Of the total amount awarded ($1,832,000), $1,479,580 (81%) was earmarked for extramural research and the balance for program administration, extension and communications.

The specific research projects funded, the extension activities undertaken and the communication activities used to inform the public of the program were collectively decided upon by the CSAP Management Team, comprised of the directors of the three state Sea Grant programs, advised by their senior staff.

The integrated research, extension and communications CSAP effort on an important and high visibility issue was conducted on the accelerated timetable stipulated by NOAA (two years with no possibility of extension).

To meet these demanding circumstances, the CSAP team employed a modified version of the historic Sea Grant approach to fulfilling its mission:

1) A directed research component involving social scientists and research institutions in fields like risk assessment, risk communication, risk visualization technologies and basic human behavioral studies;

2) An extension component integrating professionals and agencies in the coastal hazard management, prediction, warning and response community with the research process, to help guide funded projects and to augment the nature and utility of the tools and information produced to facilitate rapid adoption and;

3) An integrated, real-time public communications effort to inform the public of the program and its accomplishments.

Financial and progress reports were completed on a quarterly basis and submitted to NSGO and GMD. Research project PIs submitted semi-annual reports to the Sea Grant program directly funding their work.

Three Framing Questions

The CSAP program was developed to enhance understanding of how the risks from impending coastal storms, and other high impact weather, are assessed, perceived, communicated, and

acted upon (or not), for the purpose of improving the delivery of coastal storm information to protect people and save lives and property. Three framing questions served as the foundation and focus of the program:

1. *How do coastal residents receive storm warning reports?* (i.e., what sources and venues of information and warnings are used and, importantly, trusted?)

2. *What primary factors influence coastal residents in deciding whether to heed storm warnings?* (i.e., what factors are at play when individuals decide to act or not based on the information provided?)

3. *How can coastal storm warnings be made more informative or impactful?* (i.e., what is the nature of storm hazard information and warnings that communities and residents are currently receiving and how can it be improved to make it, in their view, more actionable?)

The results of the CSAP research are here presented and summarized according to these three framing questions. These results can be integrated with those of other NOAA projects and activities that relate to improving communication and response efforts aimed at impending high impact weather and coastal storm hazards.

Program Steering Committee

To be successful, the CSAP had to be known by, and connected to, the coastal storm hazard management and response community in the Tri-State Area. This community, and the mainline media outlets that purvey coastal storm information, were the principal audiences of the CSAP program, although bringing the results of the research to the general public was also an important challenge. The contributions of the emergency management and media communities in shaping the program, including the selection of funded research projects and the provision of input and advice to the funded investigators and Sea Grant staff, was critically important. The principal mechanism to build and sustain this connection was the Program Steering Committee (PSC), with members drawn from the NOAA National Weather Service, the state and local emergency hazard response community in the Sandy-affected area, as well as representatives of public communications media.

In July 2013, the three state Sea Grant Programs invited professionals from these fields to participate on the PSC and help guide the development and course of the CSAP program. The progress, research findings and developments of the CSAP research projects were shared with the PSC members to improve the chance that CSAP could achieve its desired outcomes. The responsibilities of the PSC members were to:

- review the draft CSAP Request for Proposals to ensure that the identified research priorities were consistent with perceived "on-the-ground" needs;

- serve on the Technical Review Panel to review and rate submitted proposals (a sub-set of the PSC served in this capacity);

- serve as links between specific CSAP-funded projects and the program's target audiences;

- meet with the funded investigators and Sea Grant staff at the two "all hands" meetings to discuss and provide feedback on the research projects' progress and outcomes, in order to increase the likelihood that the results and products yield real benefit in influencing future communication about, and response to, coastal storms in the Sandy-affected area and elsewhere;

- discuss implications and "take away" messages of the projects' results, review and assist planned extension and communications efforts, and provide peer review of research products and this summative report; and

- assist researchers and Sea Grant staff in identifying and connecting with key audiences to both collect data and disseminate the final results in appropriate formats and venues.

The members of the Program Steering Committee were:

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Coordination with the National Sea Grant Office (NSGO) and NOAA

The three Sea Grant Programs coordinated all CSAP efforts with the NSGO through Dr. Joshua Brown, who oversees resilience-related activities for NOAA's National Sea Grant College Program. Brown provides oversight to a range of Sea Grant network activities including the Coastal Communities Climate Adaptation Initiative and NOAA Sea Grant's responses to the Deepwater Horizon Oil Spill, Hurricane Sandy and other coastal disasters. He served on NOAA's Post-Sandy Service Assessment team, and was a co-author of the final report.

Coordination of CSAP activities with other coastal hazard risk and risk assessment work being done by NOAA was a priority. The CSAP Management Team sought to be in contact with selected NOAA officials and scientists active in this work before the CSAP program officially started for the purpose of building complementarity and avoiding duplication of effort. The overall program management activity of the CSAP Management Team and part of the extension work were to foster and maintain the mutual sharing of information between CSAP, its investigators and other workers within NOAA, including any similarly-directed research being funded elsewhere in the national Sea Grant network. To that end, Brown assembled a NOAA CSAP advisory group to ensure that the proposals funded by CSAP were consistent with the goals/objectives of the CSAP program (see Proposal Solicitation below) and to review their degree of overlap or complementarity with other ongoing NOAA work in the coastal hazards area.

In January 2015, Joshua Brown alerted NJSG, NYSG and CTSG that staff from NOAA's Grants Management Division (GMD) wanted to arrange a series of periodic conversations with each Sea Grant program to review the financial oversight/grants management measures and practices that the program was using to administer CSAP research funds. GMD was seeking assurance that these measures and practices provided a sufficient level of oversight to ensure that progress on funded projects was on time, that the validity of expenses submitted by contracted institutions could be ascertained and that the pace of budget draw-downs indicated that the contracted funds would be completely expended by the end of the contract period. Each of the three Sea Grant programs and their respective institutional grant management offices participated in individual monthly conference calls with Joshua Brown and one or more representatives of GMD from February 2015 through to the end of the award periods.

Additionally, GMD personnel conducted an on-site review of each Sea Grant program, as part of their oversight of all NOAA Sandy Supplemental funding. The purpose of the site visits was to review how each program and its grants office were managing and tracking the funding, with particular attention to the sub-awards with the ten research institutions. The site reviews were held on March 17, 2015 in New York, on May 22, 2015 in Connecticut, and on June 11, 2015 in New Jersey. The site visit in New York included representatives from NOAA GMD, NSGO, NYSG, as well as Stony Brook University's Offices of Sponsored Programs and Grants Management. The latter offices, part of the Research Foundation (RF) for State University of New York, administers all sponsored and externally contracted research funds for Stony Brook University, including New York Sea Grant. The site visit in Connecticut included NOAA GMD and CTSG staff, and the University of Connecticut Sponsored Program Services staff from Pre-award, Post-award, and the Finance Office. In New Jersey, GMD met with NJSG administrative and fiscal

staff. At all reviews, GMD staff were given a complete and thorough overview of the routine project accounting and billing procedures used by each institution. All specific concerns and questions were fully satisfied by the answers provided.

Finally, Joshua Brown participated in both of the "all hands" CSAP meetings involving funded PI's, the PSC and Sea Grant administrative, extension and communications staff.   During the May 2015 meeting, he facilitated a webinar to enable interested NOAA personnel, who were unable to attend the meeting in person, to hear the research presentations. The Director of the National Sea Grant Office also attended the May 2015 "all hands" meeting.

Proposal Solicitation

The CSAP Call for Research Proposals (Call) described the program's overall purpose and identified specific research priorities related to social science, water level visualization technologies and models, natural hazards assessment, risk communication and social network analysis (see Appendix II). Drafted by the CSAP Management Team, the Call was reviewed by the NSGO and by Joshua Brown's NOAA CSAP advisory group comprised of staff from other NOAA units involved in coastal hazards-related programs and activities. Members of the CSAP PSC reviewed the stated objectives and program priorities for relevance to real world needs, particularly for the areas hardest hit by Sandy.

The compressed timetable of CSAP prohibited the use of a pre-proposal step; the Call solicited full proposals. Prospective principal investigators (PIs) were required to first submit a Letter of Intent (LOI) to give Sea Grant program managers an advance notice in estimating the number of proposals anticipated and to begin lining up qualified technical reviewers.

The Call was released on 10 October 2013. Letters of Intent were due by 28 October 2013 and full proposals by 22 November 2013. The Call was given the broadest feasible distribution. It was sent to the NJSG, NYSG and CTSG programs' standard RFP distribution lists, and all other Sea Grant programs in the network were asked to forward the Call to their RFP distribution lists and any social science researchers known to their programs. The Call was sent to the National Association of Marine Laboratories membership for distribution among the research staff of those 140+ institutions.

On 13 October 2013, the NSGO and the New Jersey, New York and Connecticut Sea Grant programs announced "***Sea Grant's $1.8M Coastal Storm Awareness Program***" with a press release (http://www.seagrant.sunysb.edu/articles/r/2356). Collectively, the release was sent to approximately 250 media outlets including many large circulation dailies in the Tri-State Area (e.g., in New Jersey- *The Star Ledger, Asbury Park Press, Press of Atlantic City* and *Greater Media News Group;* in New York- the *New York Times, Wall Street Journal* and *Newsday*; in Connecticut- the *Hartford Courant*, *Connecticut Post, The Day, Connecticut Mirror, New Haven Register* and *The Hour*)*.* Releases were sent to weeklies, metro area TV networks, radio networks, online news services, and hyper-local media outlets. The Call announcement was forwarded via dozens of environmental and social science LISTSERVs, and directly sent via email to member institutions, academic and agency partners to approximately 700 contacts. The

news release was picked up by the *Newsday* in New York, by *The SandPaper* in southern coastal New Jersey and by *The Hour* in Connecticut, all of which ran related stories. Additionally, the CSAP Call was posted on the NSGO web site and the release and related RFP detailing how the three Sea Grant programs would administer the grants were launched on the websites of all three programs and featured on their social media, Facebook and Twitter.

On Facebook, a 15 October NYSG post reached over 450 people and was re-posted by the Long Island Sound Study and others. Once cited in that week's "Sea Grant Social Media Week in Review" on Facebook; 250 additional people saw the post. Connecticut and New Jersey Sea Grant's social media efforts garnered approximately 1,000 viewers. After being distributed on Twitter for less than eight hours, the CSAP program announcement was retweeted by Hank Hodde (2013 Sea Grant Knauss Fellow working in the NSGO), Margaret Davidson (NOAA/OCRM) and Heather Smiarowski, (CT marine/ Coast Guard educator with over 3,100 followers). This re-tweeting helped to spread the word about the program, as much of NOAA and all of the National Sea Grant Office staff were not in their respective offices at the time and their web and social media presence were suspended during the federal government shutdown. Peyton Robertson, NOAA's Chair of the Sandy Assessment Team, announced the program via *Federal News*. All CSAP media content is archived at www.nyseagrant.org/csap.

The CSAP solicited research in the social sciences, only. While Sea Grant historically has funded social science work in New Jersey, New York, Connecticut and nationally, much of this has been in the general realm of economics. To meet the objectives of the program, the CSAP RFP distribution campaign needed to bring the solicitation to the attention of prospective researchers in academic departments nationwide involving disciplines that were not often penetrated by Sea Grant RFPs, e.g., communication studies, public health, psychology, social welfare, human behavioral studies, etc.   Conservatively estimated, more than 10,000 researchers and scientists received the Call. The hearty response, and the geographic distribution from which the LOIs heralded from, indicated to Sea Grant program managers that this initial goal had been met.

Proposal Review and Selection

Sixty (60) LOIs were received by the 28 October 2013 deadline. The LOIs were reviewed by New York / New Jersey / Connecticut Sea Grant staff as well as by members of the NOAA CSAP advisory group in terms of their consistency with the goals/objectives of the CSAP program and their degree of overlap and complementarity with other ongoing NOAA work in the coastal hazards area. Based on this review, 18 of the LOIs were "flagged" as questionable, but no action was taken because the Call stated explicitly that the LOIs would not be screened as part of the proposal evaluation process. These flags, however, did highlight a potential concern regarding these 18 proposals that came into play during the review of the full proposals.

Of the 60 LOIs, 44 full proposals were received by the 22 November 2013 deadline. The proposals were lodged on a password-protected secure page on NYSG's web site. On 25 November 2013, the three state program directors met via conference call to make an initial

cut among the 44 proposals submitted, based on both the degree of apparent congruency between a proposal's stated goals and objectives and those of the CSAP program and on the comments from the NOAA advisory group regarding duplication of other NOAA activities in coastal hazards. Thirteen (13) proposals were eliminated from further review and funding consideration because they did not clearly address the goals of the CSAP Call.

The remaining 31 proposals were assessed for technical/scientific merit by staff of the three state programs (directors, research coordinators and extension agents) and a Technical Review Panel. Social and communication scientists from institutions around the nation, two members of the NOAA advisory group and individuals from the CSAP Program Steering Committee comprised the Panel. Effort was made to minimize and manage conflicts of interest, and the standard Sea Grant Conflict of Interest Form was completed by each panelist. The Panel was charged with identifying the proposals that individually were of highest scientific and technical quality, appeared the most likely to produce products and information of use to the coastal storm hazard prediction and response community in coastal areas most impacted by Sandy, and that, collectively, offered the best chance for synergies between projects, producing additional positive outcomes and benefits.

The Technical Review Panel met with senior state Sea Grant program staff and a NSGO representative on two 4-hour conference calls, held 16 & 17 December 2013. Each proposal was assigned to three panelists (1st reviewer, 2nd reviewer, 3rd reviewer). As a proposal came up for discussion, any panelist with a conflict of interest with the proposal under consideration left the call. Then, the assigned 1st reviewer gave a brief summary of the proposal, its personnel, objectives, methods, etc., and then assessed the proposal's strengths and weaknesses. This was followed by evaluations of strengths and weaknesses by the 2nd and 3rd reviewers assigned to that proposal. After discussion, the three assigned reviewers provided their numerical scores for the proposal (number of points out of a possible 100).   Review Panel scores were compiled in an Excel spreadsheet. Mean sums, variances and standard deviations were calculated for the scores of each proposal, which were then ranked accordingly. At the conclusion of the review, panelists submitted completed score sheets for their assigned proposals, which were shared with senior state Sea Grant program staff. Those individuals then met on 18 December 2013 to decide which proposals would be recommended for funding.

Discussions with the NSGO in late December 2013 led to a decision to fund ten (10) of the submitted proposals. All PIs were advised on 24 December 2013 of the fate of their submissions. Technical Review Panel comments on the proposals were sent to all PIs in early January 2014.

Awards and Award Conditions

Each state Sea Grant program funded and administered three or four of the selected research proposals and a portion of the collaborative administration, extension and communication activities identified and authorized by the CSAP Management Team. In order to fund the 10th

project, sub-award agreements were put in place to transfer funds from NYSG and NJSG to CTSG, which was given the responsibility to manage a fourth research project.

As stipulated in Section IV. F. of the posted Federal Funding Opportunity announcement for these monies, indirect costs on all proposals funded by the state programs through CSAP were limited to 20% of the requested funds in those budget categories on which indirect costs are normally levied.   The matching funds requirement that routinely adheres to Sea Grant awards was waived for the CSAP program. Other than the reduced indirect cost rate and waived matching funds requirement, the normal financial terms and conditions associated with each state program's research grants/contracts were applied to the CSAP-funded awards.

In January 2014, Sea Grant program staff worked with their grants offices, the PIs and the grants offices of the PIs' institutions to draft and issue sub-award funding agreements with the respective institutions. PIs were notified that they must seek Institutional Review Board (IRB) approval through their own institution before starting any human subject research and that a copy of the IRB letter had to be provided to the relevant Sea Grant program. The project PIs were also provided with a list of all funded projects and key contact information. Each PI received a Letter of Award and each sub-award included an attachment of the award conditions, procedures and policies, including a timetable for progress reports and meetings, requirements related to acknowledgment of funding for all reports and publications, and the stipulation that no-cost extensions were permitted under this award.

The 16-month research projects began on 1 January 2014 with an initial end-date of 30 April 2015. This end-date was later extended to June 15, 2015 to facilitate participation in the second "all hands" meeting, which was scheduled for late May 2015 following the end of the spring academic semester. The concluding three months of the program (June – August 2015) were devoted to assembling informational products describing the research results and collectively planning and starting to implement an outreach strategy by which the results will be shared with the coastal hazards management and response community in the Sandy-affected area.

The PIs of the ten funded projects submitted Institutional Review Board approval letters to their relevant Sea Grant Program. The IRB letters were submitted to and approved by NOAA. This allowed PIs to begin any human subject research.   The PIs provided their first progress reports to their respective Sea Grant Programs by April 21, 2014.

In addition to ongoing communications efforts related to administering CSAP, Sea Grant extension staff from each of the programs provided assistance to the researchers upon their request. They provided introductions to and contact information for key individuals in coastal communities with whom the researchers could work to schedule and hold focus group meetings, interview members of target audiences, or gather other information to their research. The bulk of the extension work commenced after the final project reports were submitted, and will continue beyond the award end-date.

May 2014 "All Hands" Initial Meeting

Sea Grant personnel from the three state programs, project team members from all ten research projects, Program Steering Committee members and a representative from the National Sea Grant Office attended the first "all hands" CSAP meeting at the CUNY Graduate Center in New York City on 13 May 2014 (Appendix III). The PIs from each research project gave 20-minute presentations to discuss their ongoing CSAP research, including their rationale, methodology, initial results and implications. This discourse generated substantial discussion among all attendees leading to new ideas, sharing of data and possible future collaborations. An internal CSAP website (www.nyseagrant.org/csap) hosted by New York Sea Grant was created for the project PIs, providing them with a list of all funded projects, access to progress reports and key contact information.

As a result of the May 2014 meeting, a discussion board for the PIs, Program Steering Committee, and Sea Grant personnel was established through the Sea Grant Association Basecamp account to encourage and stimulate ongoing dialogue. The Basecamp site served as a place to post items of interest including documents, reports and conference notices and to facilitate collaboration among the PIs.

May 2015 "All Hands" Wrap-up Meeting

On 26 & 27 May 2015, the second and final "all hands" meeting was held at the New Jersey Institute of Technology in Newark, New Jersey (Appendix IV). Forty-six participants, including representatives from each of the 10 research projects, Sea Grant staff from Connecticut, New York, New Jersey and the NSGO, and seven Program Steering Committee members, were able to attend. On the 26th, the PIs from each of the research projects were allotted 30 minutes to present their results and field questions. The presentations were shared via a National Sea Grant-initiated webinar to all interested NOAA personnel who were unable to attend the meeting in person.

Prior to the meeting, each PI was asked to highlight the top five findings or results from their project. These findings were then "binned" according to the three framing questions, and circulated. From the individual presentations and ensuing discussion, additional thoughts/questions/points were added to the document, to help inform the discussion on the 27th. The Sea Grant communicators conducted short video interviews with each PI and Tweeted an extensive series of comments on the project results and discussion throughout the meeting.

On the 27th, the "top findings" document, amended with notes from the presentations, was re-circulated and the overall discussion broken into three topics. The first topic, "What synergies are evident among the project results?" focused on any commonality or complementarity in the findings that were evident to either the PIs, the PSC members or Sea Grant staff. The second topic, "What do stakeholders (emergency managers or National Weather Service) need and want from this research-generated information?" was directed to the six Program Steering Committee members who were able to remain for the second day. The third topic focused on the next steps to be taken to finalize and summarize the work and begin to disseminate it in a

coordinated manner to the relevant audiences. The discussion was fruitful and the findings and results are summarized below, in relation to the three framing questions.

The Funded CSAP Research Projects

The funded projects (along with a brief summary for each) were:

Best Practices in Coastal Storm Risk Communication (R/CSAP-1-NJ)

Principal Investigators: *Cara Cuite, Karen O'Neill, William Hallman, David Robinson, Steven Decker, Christopher Obropta*
Lead Institution: Rutgers, The State University of New Jersey

Brief Summary: In an effort to understand how to improve public response to coastal storm risk communications, researchers engaged in a range of activities that culminated in a website designed for emergency managers (EMs). First, in interviews with EMs, who are frequently on the front lines of communicating with the public about coastal storms, researchers sought to understand the communications topics EMs would like to see addressed in the website, and their specific needs and questions about how to best communicate with the public. An Internet-based survey was then conducted to test messages of the sort that EMs often use. Among a large number of message variables tested, some findings stand out. **Researchers found that using the word "voluntary" in evacuation notices may result in less evacuation than other similar messages. While "mandatory" is most effective, it is not always feasible, however, using "evacuation advisories" is more effective than saying "voluntary."** In addition, **while localizing evacuation messages to town level has been shown to be important, drilling down to street level notices may not significantly improve evacuation rates**. Targeting "flood-prone areas" and "flood zones" helps to motivate those who believe they live in flood zones to evacuate, and could reduce shadow evacuation among those who do not, but risks leaving behind the sizable proportion of the population who are not sure if they live in a flood zone. The findings of this study, as well as the existing risk communication literature, are being compiled into a website under development that will provide coastal storm risk communications guidance.

They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to NWS Coastal Flooding Forecasts (R/CSAP-2-NJ)

Principal Investigators: *Rachel Hogan Carr, Burrell Montz, Gary Szatkowski, Lisa Auermuller, Susan Frankel, Elizabeth Goldman*
Lead Institution: Nurture Nature Center, Easton, PA

Brief Summary: National Weather Service's (NWS) suite of coastal flood forecast and warning products are a critical source of information for residents in determining their flood risk and which actions to take to prevent loss of life and property. To assess how coastal residents understand and interpret NWS coastal flood products, and the best mechanism for delivery, Nurture Nature Center, together with East Carolina University, Jacques Cousteau National Estuarine Research Reserve (New Jersey), and RMC Research, investigated how the public responds to and interprets the NWS's coastal flood and storm surge forecast and warning products and tools. The study involved a series of focus groups, surveys and interviews that solicited feedback from coastal community residents (Ocean and Monmouth Counties in New Jersey), emergency personnel and broadcast meteorologists about the ways in which they use these products. Participants in focus groups were exposed to a seven-day Superstorm Sandy scenario illustrated with NWS products, focusing in particular on the use of emergency briefing packages. Modified versions of the products were shown in a second round of focus groups and surveys to test improvements for clarity and to examine factors in how framing and conveying extreme weather messages can facilitate public understanding and motivate action. Participants gave feedback about how the timing, the verbal

and graphic clarity of the information conveyed, and the inclusion of uncertainty information affected their understanding of and response to the storm (actual or anticipated).

Findings support the use of NWS emergency briefing packages as a preferred method for disseminating storm and flood risk information. However, necessary changes to improve visual clarity, provide more succinct information, and localize messages must be employed for risk communication to be effective. The study offers specific recommended design changes to NWS coastal flood forecast products, as well as best practice recommendations for the use of briefings. Results also provide detailed analysis of the sources that participants rely upon for receiving and sharing information, as well as the timing they prefer for receiving information. **Findings suggest that NOAA is an authoritative source of weather information, but also that residents expect and want to receive weather warnings from local municipal and emergency management audiences.**

Further, while residents prefer storm information five to four days prior to the storm landfall date, Emergency Managers prefer information seven days prior in order to have time to reach out into the community. Specific product design recommendations from this study are intended to be easily implemented by NWS to improve public response to its products. Study results also provide recommendations and findings that will be of benefit to the emergency management community, and which will improve risk communication and community resiliency in the face of coastal storm threats.

Adolescent and Family Decision Making In Time of Disaster (R/CSAP-3-NJ)

Principal Investigators: *Cristina Hoven, George Musa, Lawrence Amsel*
Lead Institution: Columbia University

Brief Summary: While there has been considerable attention paid to the most effective ways of engaging adults as individuals in disaster preparedness and actual disaster responses, including evacuation, the role of adolescents and the role of the family as a decision-making group around disaster preparedness and evacuation has not received sufficient attention. This study, carried out by the Child Psychiatric Epidemiology Group (CPEG) - Columbia University/New York State Psychiatric Institute (CPEG), under the direction of Drs. Christina Hoven, Lawrence Amsel and George Musa, studied Superstorm Sandy-exposed families using an innovative study design that combined intense individual family discussion groups with behavioral-decision making tasks, to gain a multidimensional understanding of how adolescent decision-making interacts with family decision-making at times of disaster preparedness and evacuation. These results, in the hands of our emergency response and educational partners, could be instrumental in creating educational programs that empower youth and improve family engagement around disaster preparedness and evacuation, potentially saving lives.

Findings include:
1. Adolescent involvement in evacuation decision-making was significantly higher in families who did evacuate than in those who did not evacuate. Adolescent females generally played a greater role in decision-making than adolescent males.

2. Families that evacuated were more likely to have discussed the evacuation within the family, and were more likely to have had disagreements about evacuation than were families that did not evacuate.

3. Families that evacuated were more likely to have been "advised or mandated" to evacuate, and more often accessed web-based information about the storm, than families who did not evacuate.

4. 60% of evacuating families (27 % of non-evacuating families) had received a mandatory evacuation order during Sandy. However, there was no difference between evacuating and non-evacuating families in stating they would follow a mandatory evacuation order in the future.

The ultimate aim of this research is to increase our understanding of the various intricacies of family decision-making processes and to examine the roles that adolescents play in those processes. This research could benefit public health and public safety by assisting in the development of future strategies for disaster educational programs that are based on a scientific understanding of individual and group decision-making processes and their

coordination. It also holds the promise of empowering adolescents and young adults to have more relevant roles in family decisions. CPEG plans to share the research findings with end-user education partners who will use them to produce curricula and tangible educational materials that will enhance disaster preparedness by including important human-factor aspects of decision and negotiation style into these programs, and, importantly, by helping personalize the education by making learners aware of their individual and family decisional styles, and how this affects their outcomes.

Measuring Public Responses to a Surge of Information: How Individuals Understand, React, and Respond to Storm Surge Media Messages (R/CSAP-4-NY)

Principal Investigator: *Clifford W. Scherer, Laura Rickard, Gina Eosco*
Lead Institution: Cornell University

Brief Summary: Deciding whether an approaching hurricane poses a serious threat to people's safety and to property is a complex process. How information is presented can change perceptions of the seriousness of an approaching storm. Broadcast media generally use maps, radar or a newscaster standing out in the storm to try to convey the seriousness of a storm. Yet, past experience (the last storm or the most serious one in memory), how neighbors and friends are responding (boarding up windows or going about things as usual), how local authorities communicate (knocking on doors with warnings or business as usual) or how broadcast media mention a specific area or ignore it, all influence how individuals respond. **Findings from this research project suggest that how serious storm warnings are communicated can be significantly improved.** For example, **a photo showing how the results of the storm surge and wind may impact a local neighborhood may be more effective than a radar or storm track map. There may develop a false sense of security among those who make storm preparations ahead of time and come to feel that their home and property (and they) are "storm-proof", even in the face of storms that warrant an evacuation. Results of this research project promise to offer a number of significant findings about how to improve storm risk communication.**

Forecasting Evacuation Behaviors of Coastal Communities in Response to Storm Hazard Information (R/CSAP-5-NY)

Principal Investigators: *Ricardo A. Daziano, Linda K. Nozick, Philip L. Liu*
Lead Institution: Cornell University

Brief Summary: A number of Sandy-related human fatalities could have been prevented if residents had evacuated when mandated to; 45% of drowning deaths occurred in Evacuation Zone A, which had been identified as being at risk of flooding from any category of hurricane. This fact illustrates the key motivation behind studying evacuation behavior. Existing research in the field of evacuation behavior has examined what different factors influence evacuation decisions and how they do so. Five of the most important factors include characteristics of the storm, risk perception, housing type, authorities' actions and the hazard level of the area. Socio-demographic factors related to evacuation behavior are gender, age, household size, income, race/ethnicity and level of education. Physical disability, proximity to evacuation routes, previous experience with extreme weather events, the presence of pets and media reports also affect the decision of whether or not to evacuate in the case of an extreme weather event. In the existing literature, however, little attention has been devoted to the problem of how storm information impacts evacuation actions.

In this project, we analyzed data collected in the spring of 2015 among 619 respondents in the tri-state area impacted by Sandy, using a unique instrument. In the online survey, cognitive, emotional and behavioral responses to information about extreme weather events were collected. The instrument was designed to cover a thorough set of dimensions that we identified as critical to evacuation decisions, including pre-awareness, experience, behavioral influence, risk perceptions, affect, evacuation intentions, preventive actions, channel beliefs, source credibility, attribution of responsibility and social networks.

One of the main results obtained in this research is that communities at risk rely on official sources to make evacuation decisions for them. This dependence seems to rely on the fact that, in the Northeast, damaging

hurricanes do occur, but less frequently than in other areas. **In fact, the community expects to be told what to do and when to do so in a very precise, simple and succinct message. Additionally, the media (local media/the Weather Channel) plays a larger role in influencing the respondents' evacuation decisions during Sandy than the local authority, friends, and neighbors did.** Finally, according to the estimated evacuation behavior models, **the main determinant to increase the likelihood of evacuation is a mandatory evacuation order, informed by local media or the Weather Channel. Voluntary evacuation orders are perceived as ambiguous, and they may even reduce the likelihood of evacuation compared to not having any order at all.**

Understanding Responses to Storm Warnings: Learning from Those Who "Rode Out" Hurricane Sandy (R/CSAP-6-NY)

Principal Investigator: *Sharon D. Moran, William Peace, Samuel Ratick, Rebecca Garden*

Lead Institution: SUNY Environmental Science and Forestry

Brief Summary: The project explored the phenomenon of 'staying behind' when an evacuation has been advised in advance of a severe storm. In order to understand people's response to Hurricane Sandy evacuation efforts in their larger context, we used two approaches: scholarly analysis and empirical research. Based on our review of the academic literature and the events themselves, we analyzed the phenomenon two ways. First, we showed how disaster management could benefit from the insights of the disability studies framework, identifying several misconceptions that could be acting as barriers to better understanding to how people behave and why. Second, we determined that shifts in governance practices associated with a more neoliberal form of government are currently re-shaping the incentives associated with on-the-ground practices, complicating disaster readiness programs, and making clear messaging even more important.

The empirical portion of our research used a qualitative approach to capture people's 'lived experience.' Personal narratives about decisions they made were collected from individuals who rode out the storm, despite evacuation warnings. People's memories of the period were accessed through multiple avenues including a survey (online), interviews (phone and face-to-face), published materials, and related statements. Using a semi-structured approach, we asked open-ended questions about their thought processes; the narratives were analyzed using a system of coding to help characterize, analyze and summarize the respondents' thoughts. **The reasons cited (in order) included: nowhere to go; no transportation; no confidence that evacuation is necessary; rejection of shelters as a viable option; desire to protect property from theft and damage; concern for pets; no money for a hotel; lack of accessible transportation and shelters; and concern for neighbors, among others. For people with disabilities (including mobility and sensory), some related facets of accessibility included: the lack of accurate information about whether their needs would be accommodated, accessible communication, absence of coordination, and inattention to implementation of existing plans, among others.** Also, many respondents cited the Hurricane Irene warnings (in the previous year) as shaping their thinking. The analysis of these narratives also revealed some unexpected perspectives: for example, **some respondents voiced a proud self-reliance about their decision to stay, reinforced by information from government sources, and this underscores the need for clarity in messaging concerning evacuations.**

An Audience Segmentation Analysis of Connecticut Coastal Residents to Support Storm Preparedness (R/CSAP-7-CT)

Principal Investigators: *Jennifer R. Marlon, Anthony Leiserowitz*
Lead Institution: Yale University

Brief Summary: Social scientists who conduct post-disaster studies have long understood that people are often surprised by and unprepared for the severity or extent of natural hazards. Such results are found even despite major advances in the technical accuracy and advance warning of storm forecasts. Research also shows that surprise among the public could be reduced with more effective communication, informed by the specific and diverse needs of different audiences. Here we present the results from a representative survey and segmentation

analysis on hurricane attitudes of coastal Connecticut residents. **We find that 70% of coastal residents do not know they live in an evacuation zone, 74% have never seen an evacuation route map, and only 31% believe it would be safer to evacuate than to stay home during a Category 2 hurricane, suggesting that awareness of hurricane risks in general is quite low**. We also identify five distinct audiences that range from the "First Out" (of which 55% evacuated for Superstorm Sandy), who feel the most anxious and are the most likely to leave prior to a storm making landfall, to the "Diehards" (of which only 6% evacuated for Superstorm Sandy), who feel the most prepared and are the most unlikely to respond to official evacuation notices. Three middle segments (the "Constrained", "Optimist", and "Reluctant") are differentiated by their storm expectations and readiness, as well as by different evacuation barriers.** Thus, many people refuse to evacuate under any circumstance. Others are willing to go because they fear they could be trapped in their homes. In-between are those who are constrained from leaving or would do so if officially ordered to leave.

Based on these results, Connecticut coastal residents need basic information about their vulnerability, especially to storm surge. In addition, communications should be tailored to meet the unique needs of these different audiences.

Assessment of Social Media Usage during Severe Weather Events and the Development of a Twitter-based Model for Improved Communication of Storm-related Information (R/CSAP-8-CT)

Principal Investigators: *John F. Edwards, Somya D. Mohanty, Patrick Fitzpatrick*
Lead Institution: Mississippi State University

Brief Summary: The goal of this research project was to better understand the sources, quality and reliability of information received by individuals affected by Hurricane Sandy. To this end, the research team took a threefold approach to exploring the issues: a survey was conducted with individuals from New York, New Jersey, and Connecticut who experienced Hurricane Sandy; social-media posts from Twitter were analyzed to identify the users who were most responsible for contributing to the weather-related topics of discussion; and a novel software application was developed for use by emergency managers to gather time-critical, social media information (photographs and messages) for coordinating disaster relief and assistance.

Responses to the survey helped answer three main questions: 1) how did people obtain weather-related information during Hurricane Sandy; 2) from whom did people obtain this information; and 3) what type of weather-related information did people share via Twitter? Although a broad array of communication media were used during Sandy, **television proved to be the most popular source of weather-related information. However, once people lost power, many shifted to radio and face-to-face conversations, as well as using Twitter and other social media platforms to receive storm-related information.** Of the survey respondents, 58% lost television, 53% lost non-cellular Internet connection, 45% lost landline telephone service (of those who had a landline), and 27% lost cellphone service**. In contrast to non-Twitter users, avid users of social media relied more on information that they received from friends, family, and government agencies. Twitter users possess a more comprehensive communication network than non-Twitter users. It was also found that during Hurricane Sandy, Twitter users more frequently shared storm-related photographs than any other information.**

The analysis of social-media content showed that **Twitter was a highly valuable source of information during the hurricane.** There was a considerable increase in the number of users and the messages that were shared during the peak of the hurricane. A large number of posts contained weather-specific information that was being shared with photographs taken by the users that showed the intensity of the hurricane in real-time, along with images of damage and flooding. **The analysis of social media also revealed a number of key influencers from different domains: 1) Political (GovChristie, MikeBloomberg, NYGoverner, NYCMayorsOffice, CoryBooker), 2) News and Weather (NOAA, NWS, NHC_Atlantic, breakingstorm, wunderground, twc_hurricane, weather_channel, ABCnews), and 3) Relief organizations (Red_Cross, Occupy_Sandy).** These key influencers and their followers participated in Twitter-based discussions related to Hurricane Sandy. The connectivity of the influencers and their followers on Twitter played a vital role in information sharing and dissemination throughout the hurricane.

The final result of this research was the design and development of a novel software application that provides emergency managers and first responders with real-time, exact-location, images chronicling the effects of a weather-related disaster (e.g. damage, flooding). Despite warnings to take shelter or evacuate from an impending disaster site, many people remain in place and share photographs of a given disaster using social media platforms such as Twitter. **SoC-VM, the software application developed as part of this research project, allows emergency managers to have direct access to all images posted on Twitter from a given area in real-time, often hours before first responders can safely enter the disaster zone.** Many of these images are geo-coded, meaning that the exact location (street address) of the damage or flooding can be geographically pinpointed and verified using programs like Google Street View. Such images can help emergency managers better plan and prioritize their rescue and relief efforts.

The PI had consulted with a patent attorney about previous software projects; the consultant indicated that due to the backlog of software patent applications submitted to the US patent office, by the time a patent is obtained for a software application the technology has usually changed and the application already outdated. The cost of running the software is significant and cannot be made freely available. The live connection to the Twitter firehose costs several $1000's per month and running a full laboratory of human coders amounts to several $1000 per day. **The PI and his team would ideally like to provide the software as a service at a cost-recovery basis through their academically-based data collection laboratory, and they are currently seeking a large agency to work with that finds the real-time images valuable enough to contract for this service**. The PI is in communication with the National Weather Service and is scheduled to present on the software at the annual meeting of the American Meteorological Society in January 2016.

Behaviorally Realistic Communications to Improve the Public's Response to and Preparedness for High Impact Storm Events (R/CSAP-9-CT)

Principal Investigators: *Gabrielle Wong-Parodi, Baruch Fischhoff, Ben Strauss*
Lead Institution Carnegie Mellon University

Brief Summary: The risk of coastal flooding is increasing due to more frequent and intense high-impact storm events, rising sea levels and more people living in flood-prone areas. Although taking private mitigation measures can reduce damage and risk, people who live in risk-prone areas rarely take mitigation measures voluntarily. Most research has focused on factors that motivate people to take private mitigation measures, however little has been done to investigate how people view preparation and information needs. Here we investigate the views of New Jersey coastal residents impacted by Superstorm Sandy. **Residents expressed deep attachment to their community and although they see increasing flooding risk due to natural and/or human causes, they expressed reluctance to consider moving even if they were to experience another event like Sandy.** Indeed, they see themselves as responsible for their choice to live in a vulnerable community and described private mitigation measures they deemed appropriate for meeting immediate and long-term risks. While these measures may be appropriate, they recognized that they may not be feasible for all due to heterogeneous social and economic circumstances. Therefore, **residents expressed the need for tailored information about appropriate and effective mitigation measures as well as improved visualizations to better understand the impact of the risk, which should be provided by trusted sources such as local officials.** An experiment assessing the effect of tailored information on motivation to prepare found that providing such information did indeed enhance intentions to prepare, but at the same time was associated with lower perceived chances of there being a Sandy-like event in the future. **Thus, it seems that preparing for high impact events may lead people to feel like their overall risk is reduced. These results suggest tailored information provided by trusted sources may provide useful guidance for the development of behaviorally realistic risk communications.**

Evaluating Evacuation Decision-making Processes among Residents of Long Beach, NY before Superstorm Sandy: Lessons for the Role of Authority and Language in Storm Warnings (R/CSAP-10-CT)

Principal Investigators: *E. Christa Farmer, Elizabeth Ploran, Mary Anne Trasciatti*
Lead Institution: Hofstra University

Brief Summary: Despite coastal storm surge warnings and evacuation orders starting several days before landfall, only 33% of coastal residents in Long Beach, NY left their homes prior to Superstorm Sandy. The resulting damage from the storm caused 90% of residents to evacuate due to damage to their homes, surrounding infrastructure, and threats to personal safety from the aftermath. The current project used personal interviews with residents, both those who did and did not evacuate, to determine the sources of information and influence most critical to personal evacuation decisions. **Preliminary analysis of the interviews indicates that very few people (fewer than 10%) talk about specific authority figures (e.g., the governor, local emergency management officials). Instead, most people describe the role of television media and friends, family, and neighbors in their decision to stay or to evacuate. In addition, many of our interviewees (~45%) describe a comparison to the impact of Hurricane Irene that often negatively impacted their decision to leave, even if that comparison was made using second-hand information from family and neighbors.**

Using the themes identified from the interviews as described above, new potential pre-storm messages were developed and tested for effectiveness in persuading residents to heed evacuation orders in a hypothetical major coastal storm scenario similar to Superstorm Sandy. These messages included commentary from local non-traditional authorities (e.g., a local business owner), standard descriptions of impending storm surge and wind speeds, descriptions of actions taken by police and fire departments, and more traditional messages about mandatory evacuation orders set by the governor and county executive. Several actual messages from local emergency management and media outlets prior to Superstorm Sandy were also included for comparison.

The results suggest that despite the descriptions from the interviews of reliance on media and personal connections, residents do heed some messages coming from traditional authorities (e.g., the governor or county executive), particularly if those messages describe a mandatory evacuation. Residents also understand magnitude differences in technical weather information and will evacuate if the predictions are sufficiently dire (e.g., 6-12 feet of storm surge, 90-100 mph winds). Importantly, however**, messages noting actions taken by authorities (e.g., evacuating their own families or going door-to-door) and the potential loss of water/sewer service (as opposed to electrical outages) may have a high level of influence not previously identified. This last result may indicate an area for potential growth and development in pre-storm messaging.** Interjecting messages about specific evacuation activities and potential post-storm damage may persuade more residents of coastal storm areas to evacuate prior to storm landfall, allowing for more post-storm resources to be diverted to rebuilding infrastructure instead of rescue operations.

Individual final project reports are found in Appendix V (V1 – V10), along with a comprehensive list of issued reports, journal articles and public presentations to date.

Findings and Recommendations

This effort was one of the (rare) examples of a major research project in which a set of social scientists from multiple disciplines all focused on the same specific environmental problem, at the same time, completing a portfolio of results on it. The findings from the ten CSAP-funded research projects are integrated and described below. For each salient finding, the project final report where it is found and further explained is noted. The reader is urged to consult the attached project final reports for more complete information on the finding and the work that produced it.

The findings of the ten research project at times reinforced each other and at times provided somewhat contradictory information. This was probably to be expected. This report's concluding section, "Next Steps," identifies further work that, if undertaken, would paint a fuller, and probably truer picture of the complex arena of public risk perception and storm warning response in the Tri-State Area. As an example, Marlon et al. (2015, Yale) surveyed Connecticut coastal residents and grouped people into five categories based on their perception of risk, among other factors:

The First Out (21%) are typically ready and willing to go, are more likely to know they live in an evacuation zone and are more ethnically diverse (55% evacuated during Sandy).

The Constrained (14%) face barriers such as poor health/disability, pets, lack of money that limit their options; they believe it as safe to stay as is to leave (22% evacuated during Sandy).

The Optimists (16%) underestimate the risks and are the least prepared, can be caught off guard, and have lower income. They are the most likely of all groups to perceive significant barriers to evacuating such as health/disability, lack of money, lack of know-how (17% evacuated during Sandy).

The Reluctant (27%) want to be told to leave before they will leave. They are wealthier and whiter, are more likely to evacuate with official notice from local police/fire, government official or Governor's office, tend to live farther from coast, do not perceive barriers to evacuation, and with evacuation order would leave at levels similar to First Out (13% evacuated during Sandy).

The Diehards (22%) believe it is riskier to leave than to stay, they are older and male, they want to protect property and have a high sense of self-efficacy. Pets are important barriers to leaving for 25% of diehards (only 6% evacuated during Sandy).

Does this categorization hold for coastal residents and communities throughout the Tri-State Area? We don't know, especially in terms of the relative percentage of the coastal population that falls within the several response categories.

Framing Question 1: How do coastal residents receive storm warning reports? (i.e., what sources and venues of information and warnings are used and, importantly, trusted?)

During Superstorm Sandy, the public relied on a broad array of media platforms to keep current with the progress of the storm. Television and the Internet were primary sources of storm information, but social media platforms like Facebook and Twitter also saw strong use. Twitter, a message-centric platform, is easily accessed through mobile devices making it particularly useful during emergencies or disasters (Edwards et al., 2015, MS State).

Issuing storm warnings and related information over a broad array of communication media is important, because during the course of the storm, access to a particular primary source of information may be cut off, largely due to power outages (Edwards et al., 2015, MS State). The public's primary reliance on television for storm-related information prior to Sandy's landfall shifted to a greater reliance on radio and face-to-face conversations after landfall, largely due

to loss of power. While 58% of those surveyed lost television service, only 27% lost cell phone service, highlighting the greater resilience of cell phone systems during disasters.

Residents used Internet websites most heavily for source of flooding information, followed by TV, radio and to lesser extent, Facebook; younger people relied on smartphones (Hogan Carr, 2015; Daziano et al., 2015; Marlon et al., 2015; Edwards et al., 2015; Farmer et al., 2015). Residents were more likely to seek information about impending storms (meteorological data, impacts) than information about preparing for storms (Hogan Carr et al., 2015).

Storms generate a lot of conversation - Twitter captured nearly 14 million "tweets" in the Tri-State Area over a 17-day period before, during and after Sandy. Edwards et al. (2015) coded the Twitter messages by keywords related to weather and looked at prominent Twitter users and the flow of information throughout the Twitter network. The researchers were able to assess changing sentiments throughout the course of the storm. Prior to landfall, people tweeted jokes about the impending, "Frankenstorm", during the storm they tweeted about safety and power outages, and after the storm passed shifted to tweeting about relief and recovery efforts.

Twitter users shared lots of photos of storm damage and personal experiences (Edwards et al., 2015). They also followed eight or more weather-related hashtags, which again emphasizes the importance of issuing storm related warnings on as many platforms as possible to ensure people have access to critical information.

Emergency personnel relied most heavily on Internet websites and smart phone apps, followed by TV and radio (Hogan Carr, 2015). National Weather Service (NWS) storm briefings are critically important to emergency managers, broadcast meteorologists and local officials (Hogan Carr et al., 2015; Cuite et al., 2015). Feedback from Hogan Carr's work also suggests that these NWS briefing materials should be shared more widely, potentially through local officials who could supplement them with community-specific information and instructions.

Framing Question 2: What primary factors influence coastal residents in deciding whether to heed storm warnings? (i.e., what factors are at play when individuals decide to act or not based on the information provided?)

People generally recognize that the chances of high impact storm events are increasing and that the consequences can be dire (e.g., impacts to local economy, way of life, and social fabric of community). However, many still express a strong commitment to staying in their homes and communities. Indeed, if forced to leave their communities (e.g., because it was permanently inundated by water), many would move to a similar beach community (Wong-Parodi, 2015). The projected strength of a storm like Sandy, in terms of projected wind speed and storm surge, has a direct effect on the process of deciding whether to prepare to ride it out or to evacuate if so advised (Marlon et al., 2015; Wong-Parodi, 2015; Farmer et al., 2015). However, several other factors had a strong influence on the decisions people made with respect to Sandy, including the source and format of the warnings, previous experience with coastal storms, and the demographics of different coastal communities.

Marlon et al. (2015) surveyed Connecticut coastal residents and grouped people into five categories based on their perception of risk from coastal storms among other factors:

The First Out (21%) are typically ready and willing to go, are more likely to know they live in an evacuation zone and are more ethnically diverse (55% evacuated during Sandy).

The Constrained (14%) face barriers such as poor health/disability, pets, or lack of money that they believe limit their evacuation options; they believe it as safe to stay as is to leave (22% evacuated during Sandy).

The Optimists (16%) underestimate the risks and are the least prepared, can be caught off guard, and have lower income. They are the most likely of all groups to perceive significant barriers to evacuating such as health/disability, lack of money, lack of know-how (17% evacuated during Sandy).

The Reluctant (27%) want to be told to leave before they will leave. They are wealthier and whiter, are more likely to evacuate with official notice from local police/fire, government official or Governor's office, tend to live farther from coast, do not perceive barriers to evacuation, and with evacuation order would leave at levels similar to First Out (13% evacuated during Sandy).

The Diehards (22%) believe it is riskier to leave than to stay, they are older and male, they want to protect property and have a high sense of self-efficacy. Pets are important barriers to leaving for 25% of diehards (only 6% evacuated during Sandy).

These differences in risk perception and situation need to be kept in mind as storm preparation and warnings are developed and issues.

Factor 1 – Source of the Warnings

The general consensus is that people are most responsive to storm information (including that originating from the NWS) and evacuation orders that are delivered by sources they personally trust, although the CSAP research indicated that what source(s) were most trusted may vary between communities. While the NWS was recognized as the authoritative source of weather information, many people expected and preferred to receive weather information from more local sources (Hogan Carr, 2015).

In the study by Marlon et al. (2015), local firefighters and police are the sources of evacuation information and orders most likely to be listened to by all five categories of people (First Out to Diehards). Results from the work by Farmer et al. (2015) also showed that personal actions taken by local fire departments or police, such as going door-to-door with evacuation orders, or evacuating their own families, have a greater influence on residents than just an evacuation order itself. Hogan Carr (2015), Daziano (2015) and Wong-Parodi (2015) found similar results. Some people also trust county or state officials as sources of storm information. For example, Marlon et al. (2015) found that their Optimists and Reluctants were more likely to follow evacuation orders from state or local officials (after police and firefighters) while the Constrained and the Diehards turned to friends, family or neighbors (after police and firefighters).

On the other hand, some researchers determined that family, friends or neighbors, local TV news or The Weather Channel had a greater influence on evacuation decisions than did government agencies or officials (Edwards et al., 2015; Daziano et al., 2015). Edwards et al. (2015) found that when considering action plans during Hurricane Sandy, most individuals still relied upon traditional sources of information (e.g. family/friends, news stations) and modalities of communication (e.g. television, telephone, face-to-face), instead of newly emerging information sources such as Weather Apps or social media posts. Family and friends do influence decisions and can either support or counter actions suggested by local officials, depending in part on the demographics of those involved in the decision-making (Hogan Carr, 2015; Hoven et al., 2015; Moran et al., 2015; and Wong-Parodi, 2015). Hoven et al. (2015) found that families that evacuated were more likely to have been advised or mandated to evacuate, to have discussed it with family and have had disagreements about evacuation and to have used web-based information about the storms.

Factor 2 – Format/Phrasing of Warnings

The format of warnings also influenced the decisions people made with respect to evacuation during Sandy. The key finding here was that people are more likely to pay attention to evacuation orders that are mandatory, rather than voluntary, even if mandatory orders are difficult for law enforcement to enforce, and sometimes are not even feasible to enact at a local level (Cuite et al., 2015; Daziano et al., 2015). Both research teams confirmed how ineffective and ambiguous the word "voluntary" is – it actually seems to have a reverse effect on people's decisions and actions related to evacuation; i.e., a storm warranting only a "voluntary" evacuation just could not be that bad. Very few people seriously consider evacuating when it is promoted as a voluntary measure. Daziano et al. (2015) found that compliance among those surveyed was likely to be 24 times greater when the phrase "mandatory evacuation" is used; on average, people were 41% less likely to evacuate under "voluntary" evacuation orders. In lieu of using the word "mandatory", the phrases "strongly recommended" or "evacuation advisory" may be effective alternatives (Cuite et al., 2015).

Inclusion of specific local information in a warning was determined to be a good motivator as people are attuned to their own communities (Cuite et al., 2015; Hogan Carr, 2015). Residents rely on local information to determine their coastal flood risk and need to prepare; seeing their specific community, rather than an entire region, named in an NWS or other media storm forecast or order can motivate them to take protective action (Hogan Carr, 2015). Similarly, Hogan Carr found that the "personal plea" from a Mount Holly NJ NWS forecaster included in a Sandy storm briefing was highly effective in motivating residents to take action.

While some of those surveyed felt that community-level information was sufficient and that street-specific details were unnecessary, others, particularly elderly or disabled residents, indicated that street or building-level detail as well as updates on the functioning of major power systems and the accessibility of communication systems, transportation and shelters were important (Hogan Carr, 2015; Moran et al., 2015). Residents with special needs may require more information about the general evacuate environment before coming to a decision to move or not.

Guilt appeals or scare tactics related to the safety of emergency responders and/or the portraying the potentially dire consequences of staying when asked to evacuate can also be good motivators (Cuite et al., 2015), as can be the sharing of actions being taken by local officials and emergency managers with respect to their own families (Farmer et al., 2015). Personally-recorded messages can convey a "tone" or sense of urgency better than robo-messages (general discussion during May 2015 "all hands" meeting), while stating realities such as "the toilet won't work" and "you won't be able to shower" can be effective in helping people understand the ramification of disrupted power and sewer services that may follow the storm (Farmer et al., 2015).

Audience response to warnings appears to have a temporal aspect. Emergency personnel paid attention to NWS storm warnings 6 to 7 days before Sandy made landfall; residents reported starting to pay attention to the storm about 4 or 5 days out (Hogan Carr, 2015).

Evacuation orders or flood warnings targeted to flood zones or evacuation zones are problematic if people don't know if they live in flood or evacuation zones. Cuite et al. (2015) and Marlon et al. (2015) both found that a significant portion of those surveyed did not know or were not sure if they lived in an official evacuation zone or a flood zone. Marlon et al. found that 74% of Connecticut coastal residents surveyed had never seen an evacuation route map. This uncertainty leads to people evacuating unnecessarily in some cases, while others remain at home when they should be leaving. As noted by a PSC member, storm evacuation signs lead to a destination, not just away from the coast. In 2013, New York City's Office of Emergency Management revised its hurricane evacuation zones from A, B and C to 1 through 6 and started a "Know Your Zone" campaign to help familiarize residents with these changes, posting maps of the zones in public areas throughout the City.

The terminology used in storm warnings can influence whether or not the general population understands the risk being conveyed. Hoven et al. (2015) found that few people had any concept of what the term "storm surge" meant; some envisioned a tsunami while others thought it was related to the tide somehow. The NOAA NWS has recently begun to characterize storm surge as "height of the water above ground level." This change will hopefully help people visualize what is meant and reduce this confusion about storm surge in the future.

Factor 3 – Previous Experience with Coastal Storms

Previous experience with coastal storms is a third factor with a strong influence on how people reacted to Sandy storm warnings. Hoven et al. (2015) found that while the most important factor in a decision *to* evacuate during Sandy was concern for the family's safety, the most important factor among those who *did not* evacuate was previous experience. Daziano et al. (2015) found that previous experience with coastal storms and evacuations had a range of influences on decisions taken regarding Sandy. Some results indicate that previous experience with evacuation increases the likelihood of evacuation in the future, while the likelihood of evacuation is 54% lower if the individual had no previous experience (Daziano et al., 2015). However, what people say they will do in the future with respect to evacuation orders does not always match well with their previous behavior relative to evacuation orders. Hoven et al. (2015) documented a shift from what their survey respondents actually did during Sandy (27%

ignored a mandatory evacuation order), to what they predicted doing in the future (83% said they would evacuate under voluntary orders and 100% said they would evacuate under mandatory orders).

On the other hand, previous experience in taking action when the storm (e.g., Tropical Storm Irene) didn't turn out as bad as expected adversely affected decisions with respect to evacuation during Sandy (Moran et al. (2015). Scherer et al. (2015) documented similar examples. Experience with Hurricane Irene warnings and related government/state evacuation orders diminished trust of these orders when they were issued for Sandy.

Farmer et al. (2015) found about 45% of their interviewees cited their experience with Hurricane Irene as an event that negatively impacted their decision to leave in the face of Sandy, even if that comparison was made using second-hand information from family and neighbors. One tragic example is a Staten Island family who evacuated during Irene and returned home to find they had been robbed. They subsequently decided not to evacuate during Sandy and their home was swept away along with two family members. As PSC member Nelson Vaz (NWS, Upton NY) noted during one discussion, "No storm is ever the same as previous ones".

Previous experience can also hinder or color a person's ability to conceptualize just how bad a storm can be (Wong-Parodi, 2015). People can only imagine the worst storm *they* have ever experienced. It is unclear what kind of information can be conveyed that enables someone to think beyond their imagination.

The elderly or persons with a disability or health issue make evacuation decisions that are based on their own previous experiences and their understanding of the pros and cons of staying or leaving. Moran et al. (2015) documented experiences of disabled residents from Sandy-affected areas. Based on previous experience, key factors in some of their decisions to shelter in place were concerns about accessibility to a new location, transportation and lack of real-time information on the status of shelters and which might be able to accommodate their needs. The Americans with Disabilities Act addresses a civil rights issue and community leaders need to reach out to the disabled members of their communities to include them into conversations on local storm preparation. In New York City, a federal class action lawsuit brought in 2011 resulted in decision to upgrade disaster centers to be able to accommodate 120,000 disabled people by September 2017.

Another constraint that forced some people to ignore evacuation orders and shelter in place was a lack of pet-friendly shelters. People do not want to leave their pets behind; this is another area that communities need to address.

Some percentage of the population will never evacuate for a variety of reasons. Some fear prolonged inaccessibility to their homes after the storm and possible loss of possessions to looters; others feel that what they need in a shelter will not be provided or be accessible; and still others believe they are well prepared to stay in their homes. However, it is unclear whether increased storm preparedness at home leads to an increased or decreased likelihood of

following future evacuation advisories (Scherer et al., 2015; Marlon et al., 2015; Farmer et al., 2015). Increased preparation for coastal storms may lead to a lowering of risk perception and a decreased likelihood of evacuation (Scherer et al., 2015; Marlon et al., 2015; Farmer et al., 2015). How will future evacuation behavior be affected by requirements to make homes in vulnerable coastal areas flood compliant? Scherer et al. (2015) documented mixed responses to this question. Their survey results indicated that if people felt their financial risk was minimized by having safer flood-compliant homes, they would be MORE likely to leave, while their focus group participants indicated that if they felt their homes were safer, they would be LESS likely to evacuate during future storms. This is definitely a conundrum that warrants further investigation to more completely elucidate.

Before Sandy, people took a lot of short-term (immediate) measures such as procuring nonperishable goods, water, moving vehicles to higher ground, etc. After Sandy, people reported taking (or intending to take) more long-term measures such as installing flood vents, raising their home on pilings, etc. These types of high-impact events represent a "window of opportunity" to prepare for future events (Wong-Parodi, 2015).

Factor 4 – Demographics of Constituents

Hoven et al. (2015) looked at the role of adolescents in the evacuation decision-making process. They found that families that evacuated were more likely to involve their adolescents in the evacuation decision-making process, and that single-parent households and households with female adolescents were more likely to involve the adolescent in future evacuation decisions.

Ethnicity may also play a role in influencing the decision-making process (Daziano et al., 2015). Whites, particularly males, are less likely to leave (62% lower for males), while Hispanics and African-Americans are more likely to decide to leave (172% and 63% higher, respectively). The likelihood for evacuation increases among older citizens, unless disability or health acts as a constraint (Daziano et al., 2015; Moran et al., 2015; Marlon et al., 2015). Residents living in detached homes are more likely to evacuate than those living in multi-family units (Daziano et al., 2015). Those living in an evacuation zone have a higher probability of evacuating if they clearly know that they live in an evacuation zone; in fact, living in an evacuation zone increased the likelihood of evacuation almost 8 times (Daziano et al., 2015; Marlon et al., 2015).

Framing Question 3: How can coastal storm warnings be made more informative / impactful? (i.e., how the coastal storm warning information received by coastal residents be improved to, in their view, make it more actionable?)

Answering this question is the fundamental purpose of the CSAP Program. All ten of the funded research projects produced recommendations that speak to the issue. The most salient of these recommendations, and others that originated at the discussion of the research findings at the 26-27 May 2015 Wrap-Up meeting, are presented below. The recommendations are in no particular order of importance but, given the centrality of NWS storm warnings and products to the issue of coastal storm preparedness and response on the part of residents and coastal communities, recommendations on improving these products are listed first. The NWS, with its

briefings and related briefing packages is viewed as the authoritative source of storm-related meteorological data and information (Note: the NWS is experimenting with starting to include probabilistic forecasts in addition to the traditional deterministic forecasts used now).

Recommendations on NWS storm-related activities and products:

- NWS should prepare a communications plan containing a schedule for when storm information will be replayed and by whom

- NWS briefing materials should be shared more broadly to include residents as well as the primary target audiences of local officials, emergency managers and the media. This can be done by NWS itself or through rebroadcast of NWS information by media/emergency managers

- Keep briefings short, and include clear, direct summaries

- Put most critical action-oriented information up front and storm details to the back

- Use color, different font sizes, bolding/underlining to emphasize important information

- Add detailed legends as appropriate to clearly explain symbols

- Clarify/simplify the terminology and graphics used; avoid confusing terms (e.g., the difference between "watch" and "warning"; storm surge). *Note: The NWS has a group of people focusing on terminology and their public relations staff are experimenting with using impact-based graphics.*

- Strike a balance between the amount of text and graphics

- Where possible, identify key communities by name

- Provide a visual context of the potential storm impact when possible (e.g., paint water level heights on key landmarks or provide visuals of houses on inundated street)

- Differentiate between impacts to property and to human safety

- Use environmental cues ("calm before the storm") to help people understand storm progression. When there was no rain, no wind, a clear sky and the dire predictions continued, many assumed the predictions were very wrong

Recommendations for local emergency managers, municipal officials, fire, police, etc.:

- Record personal messages rather than robo-messages for any phone alerts in order to convey the tone of urgency

- Communicate storm information using Code Red phone call, reverse 911, first responders going door to door, town websites, Facebook, Twitter

- Use very precise, simple and succinct messages

- People with disabilities are different, not a problem; reach out to involve them in proactive storm response planning

- Determine how to provide critical information in multiple languages and formats to ensure language barriers are avoided and ADA requirements are met; no sector of the population should be left information-isolated

- Seek input from elderly and disabled residents on specific needs related to accessibility to transportation and shelter, and up-to-date communication before, during and after a storm

- Ensure shelters are accessible, pet- and service dog-friendly, and information on their remaining capacity is updated throughout the storm

- Promote understanding among residents where evacuation zones are, what the evacuation routes are, and where they lead

- Discuss projected sewer outages to increase pre-storm evacuations

- Emergency managers may consider their role in communicating storm risk to public as minor, with their primary focus being logistics, interagency communication, and the media, but they may be the most critical link in the warning information chain. Local people trust local sources. Communications should be organized around four emergency management phases – mitigation, preparedness, response and recovery

Communicating the Coastal Storm Awareness Program

Communicating CSAP has been, and will continue to be, an ongoing process. The communications staff of the three state Sea Grant programs were and continue to be involved in advertising the program and helping to bring it to the attention to prospective researchers across the country; promoting the funded research projects while they were underway; and, in collaboration with Sea Grant Extension staff, communicating the results of the individual projects and collective program to audiences such as NWS, emergency managers and the general public.

Announcing the CSAP Program

As described in the report section, "Proposal Solicitation" (page 11 *et seq*.) Sea Grant communicators were very active in promoting the release of the CSAP RFP and in promoting general awareness of the program from its earliest days.

Announcing CSAP Research Projects

A press release was drafted and issued jointly by the Communicators of the three programs in concert with the National Sea Grant Office (Appendix VI), announcing the funded projects. In addition, the Communicators collaborated to draft material summarizing each of the projects comprising the Coastal Storm Awareness Program. Using this content, a three-page fact sheet was developed by the New Jersey Sea Grant Communicator (see Appendix VII) and a tri-fold brochure by the New York Sea Grant Communicator (Appendix VIII). Communications media,

including several large-circulation dailies and university communications' offices, picked up the announcement press release in the three states. News, media hits, project descriptions, Sea Grant staff contact information and archives related to Superstorm Sandy can be found at www.nyseagrant.org/csap.

An internal CSAP website (hosted at NYSG) was created for the project PIs to provide them with a list of all funded projects, access to progress reports and key contact information. As a result of the May 2014 All Hands meeting, a discussion board for the PIs, Program Steering Committee, and Sea Grant personnel was established through the Sea Grant Association Basecamp account to encourage and stimulate ongoing dialogue. This venue has been used to set up a webinar on "Social Media Tracking & Analysis System (SMTAS)" hosted by one of the PIs in August 2015.

Keeping CSAP in the Public Eye

New York Sea Grant Communications Specialist Paul Focazio and CSAP communicator was featured in a National Sea Grant Office online feature for Hurricane Preparedness Week, http://seagrant.noaa.gov/News/FeatureStories/TabId/268/artmid/715/articleid/239/Hurricane-Preparedness-Week-Spotlight-on-New-York-Sea-Grant-Communications-Specialist-Paul-Focazio.aspx.

Ms. Gina Eosco, a Cornell University doctoral student working on Dr. Scherer's CSAP project, gave a very well-received presentation at the biennial national gathering of Sea Grant professionals known as "Sea Grant Week" in Florida Sept 10-11, 2014. An invited speaker, she shared information in the two workshop sessions entitled *Communication about Climate Change*.

During September 2014, Storm Preparedness Month, a social media article entitled: "Researchers on Improving Coastal Storm Awareness" was posted on social media by the three Sea Grant programs and retweeted by NOAA, NOAA Climate, NOAA Research and FEMA's National Hurricane Preparation program.

In October 2014, the second anniversary of Sandy, the Sea Grant communicators promoted CSAP projects through social media. One story highlighted the Hofstra University CSAP project based on a September interview with the interpreter working with Long Beach NY residents who did not evacuate during Sandy.

Peg Van Patten, CTSG Communicator, wrote an article on the Mississippi State University CSAP project on Twitter-based geo-referenced communication for the New York Sea Grant newsletter and also promoted preliminary results on social media via Facebook and Twitter. She also distributed CSAP brochures at the Northeast Risk and Resilience Forum in Stamford, CT, 08 October 2014, which was attended by more than 175 people.

In November 2014, the CSAP-funded Nature Nurture Center held a focus group in Brick Township, NJ to examine NWS messages, to find out what and how individuals were reacting in the days before the storm, and how they might react in the future. Matthew McGrath,

Communications Specialist with NJSG live-tweeted both of the sessions with the hashtag: #CSAP.

Communicating CSAP Results to Date

In late spring 2015, CTSG worked with Yale PI Jen Marlon and a public relations staff person at Yale to preview and help publicize release of the first publication from their project, "Hurricane Perceptions of Coastal Connecticut Residents." This was featured in a video and several news clips, as well as social media. http://environment.yale.edu/climate-communication/

Peg Van Patten also worked with Yale's news office to draft a second press release. That release resulted in an article in The Day newspaper: http://www.theday.com/local/20150326/survey-shows-gaps-in-public-awareness-of-coastal-storm-risk- and a story on the National Sea Grant website: "CT Residents Need Better Preparation and Response for Coastal Storms. New report describes public attitudes and behaviors towards past and future storms along Connecticut coast"

Van Patten also worked with Marlon on an intended second publication, the audience segmentation analysis. She contracted with an illustrator, Chris Cater, to produce cartoon illustrations of the five audience segments the researchers identified: "The First-Out," "The Reluctant" "The Optimists" "the Constrained" and the "Die-Hards." The illustrations have been handed off to the PI for use in this report. Web use rights were obtained.

In July 2015, three PIs collaborated on a very short report of the 26 /27 May 2015 Wrap-Up workshop to highlight the CSAP findings, especially results supported by multiple studies. The article was submitted to EOS, Transactions, American Geophysical Union (http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)2324-9250). During that session, the communications staff recorded short videos with the PIs of the 10 projects. NYSG Communications Manager Barbara Branca interviewed Jamie Rhome, Storm Surge Lead from the NWS's Hurricane Center in Miami. Video footage (taken in New York City the same day as his briefing to Good Morning America) edited with the approved mini-interviews with the PIs form the foundation of a short CSAP "synthesis" video that Branca and NYSG's Paul Focazio are submitting as a companion piece to this final CSAP synthesis report and will make available on YouTube and social media upon approval. Like the findings of this report, the video will link the results to the three framing questions previously discussed.

The ten short videos of each project PI recorded during the May 2015 "all hands" meeting in Newark were edited and close-captioned by CTSG Communications Director Peg Van Patten. The videos were submitted to NOAA National Sea Grant and are being reviewed by staff of NOAA's Office of Congressional Affairs before they are posted.

In addition, the Communicators have drafted a plan for continuing to highlight CSAP results after the award end-date. They will collect copies of any peer-reviewed journal articles produced by the PIs and ensure their submittal to the National Sea Grant Library and will post links where possible, to the papers on the CSAP website.

Through the NOAA National Sea Grant Office, Nancy Balcom (Associate Director of CTSG) was invited by Dr. Alexander E. "Sandy" MacDonald, OAR Chief Science Adviser, to present a summary of the CSAP findings on risk communication of coastal storm hazards during the NOAA Science Days on "Sandy Supplemental: Research and Results to Improve Disaster Assistance and Response" on 27-29 October 2015 in Washington, DC and Silver Spring, MD. Balcom was subsequently asked to present slightly shortened versions of the talk to NOAA leadership, Congressional members, and the media. On October 27 2015, Balcom presented "Communicating Risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy?" relating some of the findings of the Coastal Storm Awareness Program (Appendix IX). More than 100 individuals attended the presentations in person or by webinar. On October 28, NOAA Communications with the American Meteorological Society jointly held a media briefing on three of NOAA's seven Sandy Supplemental Funds projects, including CSAP. There were 10 media representatives in attendance or on the phone, and several follow-up stories resulted (Appendix X). Later that afternoon, the three speakers, including Balcom, gave briefings on their project results for 12-15 members of NOAA leadership, including Dr. Kathleen Sullivan; Craig McLean, OAR; and Louisa Koch, Office of Education. Finally, on October 29th, two briefings on the three projects, including CSAP, were held for both the House and the Senate, drawing about 20 staffers, including Martin Dorgensen, Office of Rep. Paul Tonko (D-NY-20); Daniel Newman, Office of Rep. Matt Cartwright (D-PA-17); Camille Kidd, Office of Rep. Kathleen Rice (D-NY-04); and Jessica Brown, Legislative Correspondent, Office of Elizabeth Esty (D-CT-05) from the House, and Sara Maaiki, Office of Senator Gillibrand (D-NY); Bob Caffary, Office of Senator Richard Blumenthal (D-CT); Matt Thomson, Legislative Correspondent, Office of Senator Cory Booker (D-NJ) and several Fellows and detailees from the Senate Commerce Committee, Oceans Subcommittee.

Extending the Coastal Storm Awareness Program Results

With the CSAP research projects completed, the work to extend and communicate the results was begun in in earnest in August 2015. The extension of the results of the CSAP research projects to key target audiences will primarily be the responsibility of the Sea Grant extension staff, in collaboration with the communications staff and directors.

Extension Planning for CSAP

The following Sea Grant extension staff have primary ongoing extension responsibilities for the CSAP:

Connecticut: Juliana Barrett, Associate Extension Educator; Bruce Hyde, Assistant Extension
                        Educator
New Jersey: Jon Miller, Coastal Processes Specialist; Michael Schwebel, Community
                        Resilience & Climate Adaptation Specialist
New York: Jay Tanski, Coastal Processes & Facilities Specialist

Extension staff from Connecticut, New York and New Jersey spoke via a conference call on 23 July 2015 to begin to plan how to approach the in-depth extension of the CSAP results. A follow-up meeting was held at Stony Brook University's Manhattan campus on 11 August 2015 to develop a plan for moving ahead over time. Eight extension and one communication staff members from the three Sea Grant programs met to discuss the results of the ten research projects and begin to develop a plan for integrating those results into ongoing and new outreach programs. Those attending were Nancy Balcom, Juliana Barrett and Bruce Hyde (CTSG), Jay Tanski, Kathy Bunting-Howarth and Paul Focazio (NYSG) and Jon Miller, Amy Williams and Michael Schwebel (NJSG).

Connecticut Sea Grant extension educators Juliana Barrett and Bruce Hyde have begun to plan how they will incorporate CSAP findings into their ongoing Climate Adaptation Academies and other outreach programs to help communities improve their hazard resilience. A graduate student has been hired for Spring 2016 to work on a means for coastal Connecticut residents to be able to access GIS maps to determine where they live relative to flood and evacuation zones.

As part of the New Jersey Sea Grant extension program, staff with the Stevens Institute (Jon Miller, Amy Williams) participated in conference calls and the NYC meeting on the CSAP program. Information from those meetings was incorporated into community outreach through two meetings on defining and understanding storm surge. One meeting, "Making Sense of Surge", was held in Monmouth County on 17 August 2015 and the other meeting, a "Dune It Right" program with added information on surge, was held in Cape May on 24 August 2015 and attended by 52 people (Appendix XI). Another workshop was held on 23 September 2015. In addition, Stevens Institute staff have been invited to the Coastal Coalition of Atlantic and Cape May Counties as a result of their interactions with the mayor of Cape May, which will allow them more opportunity to work with shore communities on issues of surge and other CSAP initiatives.

Jon Miller and Amy Williams also worked with the education team, Diana Burich and Mindy Voss at NJSG to develop a hands-on lesson plan to teach students about storm surge. After one brainstorming meeting, they will create the lesson plan and hope to test it with some school groups in fall 2015.

Mike Schwebel, NJSG Community Resilience and Climate Adaptation agent based at the Urban Coast Institute at Monmouth University, also participated in conference calls and the in person meeting on 8/11 for the CSAP program in NYC, as well as a previous CSAP meeting at NJIT in Newark in late May 2015. Mike has informally begun to make individuals and communities aware of some of the CSAP research results. More importantly, Mike is doing this through his work with the NOAA RCCI grant (NOAA Network Resiliency grants) received by the State and other partners (Monmouth University UCI), a leveraging or bridging of these two NOAA projects. CSAP information has been used on an informal basis when meeting with towns, regarding alert system discussions and evacuation topics during the RCCI outreach process.

Following up on the May CSAP research meeting, New York Sea Grant (NYSG) worked with the local emergency management PSC representative to identify the CSAP projects most pertinent to New York stakeholders and the best strategy for disseminating the results to these audiences

as they are finalized. Towards this end, NYSG developed a database of 580 municipal chief executives, law enforcement officials, emergency managers, and public works officials at the county, town, village and city level who have direct responsibility for planning, ordering and implementing emergency evacuations. NYSG also participated in the CSAP extension planning conference call and coordinated and hosted the extension meeting in New York City on 11 August 2015. In response to questions and issues identified during the team conference regarding the content and target audiences for CSAP extension programming, NYSG distributed a report they developed as part of a separate, but related, project done in conjunction with the New York State Resiliency Institute for Storms and Emergencies to team members. The report provides an overview of state emergency evacuation procedures, protocols, authorities, and responsibilities and identifies problems associate with evacuation planning and implementation during Sandy as well as opportunities for addressing these problems. Information contained in the report can help the extension team to tailor state-specific CSAP programming.

Next Steps for CSAP

As described above, the research component of CSAP has ended, but the communications and extension work by which CSAP research and its results and recommendations will be communicated to user groups and the general public are in full swing as this report is submitted. These efforts will continue into the foreseeable future.   There are a number of professional organizations whose meetings provide an ideal opportunity to present CSAP findings and recommendations to groups related to CSAP's target audience (e.g., professional journalism conferences, National Weather Association, Natural Hazards Center annual meeting, Emergency Management Institute, etc.).

On their own, the ten CSAP research teams are moving forward to write up their research and its findings as a "special collection" of the journal, *Weather, Climate, and Society*.

The Research Coordinators of the three state Sea grant programs will be tracking impacts and project results from the CSAP-funded research projects for several years to come. These results and impacts will be lodged on the NSGO's PIER system and also entered onto the CSAP public web site, which will be maintained for at least the next several years.

The population in coastal districts of the Tri-State Area is not stable and unchanging. People move in and move out on a regular basis and this will present a continuing education need for those who are concerned about public awareness and understanding of coastal storm hazards and preparedness.

Some members of the PSC have suggested that a logical next step would be for the CSAP program to prepare a CSAP research results-based training course/manual on coastal storm hazard awareness and preparation. There is a plethora of information on this topic available to emergency managers, first responders and the general public. A comprehensive, succinct and geographically-localized effort to convey CSAP research findings in a very comprehensive way might greatly influence the approach and performance of the region when the next Sandy arrives.

All who have thus far taken part in the CSAP program - - Sea Grant staff, funded researchers, PSC members - - feel strongly that the program has been successful. It has produced much new information and many new insights that, if applied, should help those in the Tri-State Area and beyond weather the next major coastal storm with less damage and loss of life. The Sea Grant programs in New Jersey, New York and Connecticut are committed to seeing this happen. However, CSAP has not answered all the pertinent questions. It has not fully dissected and deciphered how coastal residents will likely react to future coastal storms and storm warnings. More remains to be done. Will it be done? The three Sea Grant programs will engage the NSGO, NOAA, NWS and others to identify specific additional research activities that would raise the bar of our understanding and storm readiness, in the Tri-State Area and nationally and to find the funding to support the next generation of CSAP research, to make the region more weather-ready and its citizens and communities safer from the growing threat of large coastal storms, more frequent coastal flooding and sea level rise.

Web Sites / Tools

Tools:

a) Cuite et al., 2015, Rutgers: A website is under development to provide evidence-based recommendations for best practices in coastal storm risk communication into the emergency management phases of mitigation, preparation, response and recovery. A link will be provided when completed.
b) Edwards et al., 2015, Mississippi State: Design and development of a novel software application (SoC-VM) that provides emergency managers and first responders with real-time, exact-location, images chronicling the effects of a weather-related disaster.
c) Hogan Carr et al., 2015, Nurture Nature Center: Final reports and other resources can be located using focusonfloods.org
d) Wong-Parodi, 2015, Carnegie Mellon: An extension of Climate Central's Surging Seas Risk Finder (www.climatecentral.surgingseas.org) is now in preparation. A link to the new pages will be provided when completed.

Publications / Presentations

Balcom, N. (October 27-29, 2015). Communicating Risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy? NOAA Science Days webinar and presentations. Silver Spring MD and Washington DC.

Carr, R. H. (October 1, 2015). They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts. Webinar, National Silver Jackets.

Carr, R. H. (May 13, 2105). Flood Risk and Uncertainty: Assessing National Weather Service's Flood Forecast and Warning Tools. National Weather Service National Hydrology Program Managers Conference, Tuscaloosa, Alabama.

Carr, R. H. (May 8, 2015). They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts. New Jersey Emergency Preparedness Association Annual Meeting, Atlantic City, NJ.

Carr, R. H. (September 30, 2014). From Risk to Resiliency: Insights into Flood Messaging. Pennsylvania Floodplain Managers Association, Annual Meeting.

Carr, R. H. (2015) They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts. *The Buzz*, National Silver Jackets Newsletter, Summer.

Carr, R. H. (2015).How to Improve Public Response to NWS Forecasts. AWARE, National Weather Service newsletter, June.

Carr, R. H., Szatkowski, G. (October 26, 2014). They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts. New Jersey Association of Floodplain Managers, Annual Conference, Atlantic City, NJ.

Cuite, C.L., Decker, S., Robinson, D., Hallman, W., Morss, R., Demuth, J. (January 13, 2016). Experimental Testing of Evacuation Messages in Sandy-affected Areas. Paper to be presented at the American Meteorology Society Meeting, New Orleans, LA.

Cuite, C. L., Shwom, R. Hallman, W. K., Morss, R. & Demuth, J. (December 8, 2015). Experimental tests of coastal storm risk communication. Paper to be presented at the 34th annual meeting of the Society for Risk Analysis, Alexandria, VA.

Cuite, C.L. (November 10, 2015). Communicating about coastal storms. Presented to the quarterly meeting of the New Jersey Emergency Management Association, Bordentown, NJ.

Cuite, C.L., Shwom, R.L., & Robinson, D. (May 7, 2015). Best Practices in Coastal Storm Risk Communication. Presented to the New Jersey Emergency Management Annual Conference, Atlantic City, NJ.

Daziano, R. A. 2014. Behavioral response to extreme-weather hazards: from evacuation decisions to supporting resilience investments. Proceeding of the 1st International Workshop on the Resilience and Safety of Modern Social Systems. National Graduate Institute for Policy Studies, Tokyo, Japan.

Eosco, G., Rickard, L., Scherer, C. W., Haase, D. (December 2015). Emerging issues from discussions with coastal residents about information, evacuation and perceived risks. Society for Risk Analysis.

Hoven, C., Amsel, L., Musa, G., Wicks, J., Doan, T., Ryan, M., Sylk, T., Dougherty, A., Eisenberg, R., Bergman, M., Aurora, M., Samet, D. (2015, May 13). Adolescent and Family Decision-Making In Time of Disaster. Poster session presented at the NJSGC Site Review, West Long Branch, NJ.

Marlon, J., Farmer, E. C., Moran, S. 2015 (forthcoming). Communicating Hurricane Risks: Challenges and Recommendations. *Eos* (Transactions, American Geophysical Union)

Marlon, J. (December 2, 2015). Should I Go or Should I Stay? Hurricane Attitudes of Coastal Connecticut Residents. 2015 Sea Grant Extension Program Leaders and Communicators Conference, Mystic CT.

Marlon, J. (November 11, 2015). Hurricane Perceptions of Coastal Connecticut Residents and Hurricane Attitudes of Coastal Connecticut Residents. Forum sponsored by League of Women Voters of the East Shore and Shoreline Village CT.

Marlon, J. (July 21, 2015). Should I Go or Should I Stay? Hurricane Attitudes of Coastal Connecticut Residents. NOAA North Atlantic Regional Team Connecticut Congressional Roundtable.

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URL: http://environment.yale.edu/climate-communication/article/hurricane-perceptions-of-coastal-ct-residents/

Montz, B. May 27, 2015). They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts. North Carolina Hurricane Workshop.

Motoaki, Y., Daziano, R.A., Schuldt, J.P., Eosco, G.M., Rickard, L.N. & Scherer, C.W. (2015) Response to Hurricane Forecasts: an examination of attributes that trigger risk perceptions and evacuation intentions. Paper accepted for presentation at the Fourth International Choice Modelling Conference, May, Austin, TX.

Rickard, L., Eosco, G., Scherer, C. W. (December 2015). A flood of information: Exploring the influence of visual type on hurricane risk perception. Society for Risk Analysis.

Rickard, L. N., Eosco, G. M., Scherer, C. W. (2014. Do I stay or do I go? Exploring predictors of behavioral decision-making during Hurricane Sandy. Society for Risk Analysis: Denver CO.

Schuldt, J.P., Eosco, G.M., Rickard, L.N., Daziano, R., & Scherer, C.W. (December, 2014). A tale of two storms: Recalling the risk of "Hurricane" versus "Superstorm" Sandy. Poster presented at the annual meeting of the Society for Risk Analysis, Denver, CO.

Semmens, K. (May 13, 2015). They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts poster presentation. NJ Sea Grant Consortium Site Review.

Semmens, K., Hoekstra, S. (January 4-8, 2015). Poster presentation. American Meteorological Society, Annual Meeting, Phoenix, AZ.

Toke, A. & Cuite, C.L. (April 24, 2015). Using Social Media to Analyze Public Perceptions of Risk Communications Practices. Poster presented to the Aresty Undergraduate Research Symposium, New Brunswick, NJ.

Wise, W. (October 2015). Communicating Risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy? Northeast Sea Grant Consortium biennial meeting, Kennebunkport, ME.

Wong-Parodi, G. (May 21, 2015). Preparing for coastal flooding risk in vulnerable communities. Center for Climate and Energy Decision Making, Carnegie Mellon University.

Appendices

    I.   Connecticut, New York and New Jersey Sea Grant proposal to the National Sea Grant Office, July 2013
   II.   CSAP Call for Research Proposals
  III.   Agenda, CSAP "all hands" Initial Meeting, 13 May 2014
  IV.   Agenda, CSAP "all hands" Wrap-Up Meeting, 26-27 May 2015
   V.   Final Research Project Reports (V1-V10)
  VI.   Press release
 VII.   Three-page fact sheet
VIII.   Tri-fold brochure
  IX.   Agendas for NOAA Science Days, Hill Briefings, NOAA Leadership Briefing
   X.   Media Hits from NOAA Science Day presentations
  XI.   Flyers from New Jersey Sea Grant Extension workshops

Appendix I:

Connecticut, New York and New Jersey Sea Grant proposal to the

National Sea Grant Office, July 2013

(Connecticut version provided; all three programs submitted same document with program names changed. Per program budget was reduced to $610,667 at a later date for a total of $1,832.000)

PROPOSAL - TITLE PAGE

PROJECT TITLE:

Program: NOAA Sea Grant Sandy Response - Social Science

Title: The Coastal Storm Awareness Program - Connecticut Sea Grant Component

PROJECT LEADER/S: (Add Attachment if more than 4)

	FirstName	Init	LastName	Co-Project Leader: FirstName	Init	LastName
Project Leader:	Sylvain		De Guise	Nancy		Balcom
Institution:	University of Connecticut			University of Connecticut		
Department:	Connecticut Sea Grant			Connecticut Sea Grant		
Street Address:	1080 Shennecossett Road			1080 Shennecossett Road		
City, State, Zip:	Groton CT 06340			Groton CT 06340		
Phone:	860-405-9138					
Fax:	860-405-9109					
Email:	sylvain.deguise@uconn.edu					
Position/Title:	Director					

	FirstName	Init	LastName	FirstName	Init	LastName
Co-Project Leader/s:	Juliana		Barrett			
Institution:	University of Connecticut					
Department:	Connecticut Sea Grant					
Street Address:	1080 Shennecossett Road					
City, State, Zip:	Groton CT 06340					
Phone:						
Fax:						
Email:						
Position/Title:						

FINANCIAL SUMMARY:

	Proposed Funding Request		
	Year 1	Year 2	Total
Federal Funds:	554,040	61,560	615,600
Matching Funds:	0	0	0

Project Duration: Two Years
(e.g., Two years)

Source of Matching Funds: Not required

Estimated Start/Completion Date: 9/1/2013 - 8/31/2015

REQUIRED SIGNATURE

	(name)	(sign)	
Project Leader:	Nancy Balcom	*Nancy Balcom*	Date: 07/23/13
Institutional Representative:	Antje Harnisch	*[signature]*	Email: preaward@uconn.edu
Address:	Office for Sponsored Programs, 438 Whitney Road Ext., Unit 1133, Storrs, CT 06269-1133		Phone: 860-486-3622

SEA GRANT PROJECT SUMMARY FORM (90-2)

INSTITUTION: Connecticut Sea Grant **ICODE:**
TITLE: Coastal Storm Awareness Program: Connecticut Component
PROJECT NUMBER: R/CSAP-CT-1 **REVISION DATE:** 07/26/2013
PROJECT STATUS: New **INITIATION DATE:** 09/01/2013
 COMPLETION DATE: 08/31/2015

SUB PROGRAM:
PRINCIPAL INVESTIGATOR: Sylvain De Guise
AFFILIATION: University of Connecticut / CTSG **EFFORT:** Year 1: .25 mm Year 2: .25mm

CO-PI: Nancy Balcom **EFFORT:**
AFFILIATION: University of CT / CTSG Year 1: .25mm Year 2: .25mm

FUNDS: $615,600 **STATE MATCHING FUNDS:** $0
(Year 1: $554,040; Year 2: $61,560
LAST YEAR'S SEA GRANT FUNDS: $0 **LAST YEAR'S MATCHING FUNDS:** $0

PASS-THROUGH FUNDS: $0 **LAST YEAR'S PASS-THRU FUNDS:** $0
RELATED PROJECTS:
PARENT PROJECTS:
SEA GRANT STRATEGIC PLAN CLASSIFICATION: Hazard Resilient Coastal Communities (CTSG); Resilient Coastal Communities and Economies (NSGO); 121-- Public Safety, Coastal & Natural Hazards, Severe Storms

OBJECTIVES:
1. To support competitively-selected social science research and related technology transfer to improve the public response to coastal storm hazard information in the areas most affected by Superstorm Sandy.
2. To ensure coastal storm hazard prediction and response personnel are closely involved with this effort throughout its duration so that the projects, results, and products will be most useful for their needs and responsibilities.
3. To inform the public, in real-time, about the program and its accomplishments.

METHODOLOGY:
1. Coordinate all efforts with senior personnel of the New Jersey Sea Grant Consortium and the New York Sea Grant Institute.
2. Develop and utilize a Program Steering Committee (PSC) that includes emergency response managers and others with coastal storm safety information responsibilities, including the media.
3. Develop and nationally distribute an open Request for Proposals for 18-month research projects.
4. Select proposals based on input from a special Proposal Review Panel that includes peers and a subset of PSC members. Decide which SG program will fund and administer which projects.
5. Integrate Sea Grant extension personnel with the projects, the PSC, and other stakeholders, to convey products and feedback.
6. Use Sea Grant communicators to issue press releases and handle electronic and social media information about the effort.

RATIONALE:
Many of the human deaths and injuries that were caused in the coastal areas of New Jersey, New York, and Connecticut by Superstorm Sandy in October 2012 might have been prevented if residents had better understood the risks and heeded emergency warnings. The proposed project, the Coastal Storm Awareness Program (CSAP), aims to improve the coastal storms hazard warning system in the Sandy-affected region and the information it conveys, by better understanding the factors that affect whether recipients of this information decide to act on it. The ultimate goal of CSAP is to save lives and promote public safety by creating tools that will better inform people of the true severity of the danger from coastal storms and increase the likelihood that residents who should remove themselves from harm's way actually do so or take other actions that would prevent them from becoming storm casualties.

Project Title: Coastal Storm Awareness Program: Connecticut Component

Principal Investigator: Sylvain De Guise, CT Sea Grant

(Co-Principal Investigators with separate proposals: William Wise, Interim Director, New York

Sea Grant Institute, Peter Rowe, NJ Sea Grant Consortium;)

Project Description

(1) Introduction/Background/Justification

The National Sea Grant Office (NSGO) has received funding from the National Oceanic and Atmospheric Administration (NOAA) to support targeted social science research and related technology transfer to improve the public response to coastal storm hazard information in the areas most affected by Superstorm Sandy in October 2012. The impetus for making these monies available is the hard reality that many of the human deaths and injuries caused by Superstorm Sandy were likely preventable. Too many coastal residents either failed to fully understand the severity of the storm and the dangerous conditions it would produce, or chose not to evacuate in spite of the serious risks of staying in their homes. The proposed project, the Coastal Storm Awareness Program (CSAP), creates a linked program of competitively selected research projects, extension outreach activities and public information efforts aimed improving the coastal storm hazards warning system in the Sandy-affected region, the information it conveys (what, when, how, and by whom) and the factors that affect whether recipients of this information decide to act on it. The goal of the program is to save lives and promote public safety by creating tools that will better inform people of the true severity of the danger from coastal storm hazards and increase the likelihood that residents who should remove themselves out of harm's way actually do so or take other actions that would prevent them from becoming storm casualties.

CSAP will be jointly administered by the Sea Grant programs in New Jersey, New York and Connecticut. Equal funding will be provided separately to each state program. However, the specific research projects to be funded, the extension activities to be undertaken and the communication activities used to inform the public of the program will be collectively decided by the CSAP Management Team, comprised of the directors of the three state Sea Grant programs, advised by their senior staff.

(2) <u>Work Plan and Milestones</u>

CSAP will involve an integrated research, extension and communications effort on an important and high visibility issue, and will be conducted on the accelerated timetable stipulated by NSGO. To meet these demanding circumstances, CSAP will employ a modified version of the historic Sea Grant approach to fulfilling its mission: 1) a directed research component that draws on the most capable scientists and research institutions in such fields as risk assessment, risk communication, risk visualization technologies and basic human behavioral studies; 2) an extension component that integrates professionals and agencies in the coastal hazard management, prediction, warning and response community into the research process to help guide funded projects and to augment the nature and utility of the tools and information produced which, in turn, will lead to rapid adoption and 3) an integrative, real-time public communications effort to inform the public of the program and its accomplishments.   More details on these three program components follow.

Financial and progress reporting to NSGO will be on a quarterly basis as stipulated.

a. Competitively Funded Research Component

1. Request for Proposals

The Request for Proposals (RFP) will effectively describe the program's overall purpose and, especially, its specific research priorities to social scientists and those involved in such fields as water level visualization technologies and models, natural hazards assessment, risk communication, social network analysis, etc.   The RFP will be drafted by CSAP Management Team, with review by persons in the coastal storm hazards prediction and response community in the Sandy-affected area for the relevance of its stated objectives and program priorities to real-world needs, particularly for the areas hardest hit by Sandy (see Program Steering Committee or PSC, described on page 8). The document will be given a national distribution, supplemented by an effort to bring it to the direct attention of scientists and researchers in the above fields. The nascent directory of social scientists maintained by the NSGO will be particularly useful in this distribution, as will the list of social scientists maintained by NSF's Decision, Risk and Management Science program, which has been kindly offered to the CSAP Management Team.

The compressed timetable of CSAP will prohibit the use of a pre-proposal step and the RFP will solicit full proposals.   A letter-of-intent from prospective PIs will be required,

however. These letters will give program managers a headstart in estimating the volume of proposals to be anticipated and perhaps lining up qualified and appropriate technical reviewers.

A preliminary CSAP Request for Proposals is already being drafted.

2. *Proposal Review*

Review of proposals will be conducted by the CSAP Management Team, aided by a composite Proposal Review Panel, comprised of a subset of the Program Steering Committee members (see below) and a number of invited technical experts.   In recommending proposals for funding under CSAP, the Proposal Review Panel will be charged with identifying those proposals that individually are of highest scientific and technical quality, appear most likely to produce products and information of use to the coastal storm hazard prediction and response community in coastal areas most impacted by Sandy and that, collectively, offer the best chance for synergies between projects that produce additional positive outcomes and benefits. CSAP will not take place in a vacuum. A high degree of complementarity and communication between CSAP and other pertinent NOAA efforts in coastal risk and hazard assessment and communication be developed and sustained. A list of federal employees within NOAA and other agencies already dealing with coastal storm hazard warning and response will be used to link CSAP and its work with that underway in those agencies. This may extend to the direct participation of those agencies in CSAP.

3. *Funded Project Administration*

The three state Sea Grant programs have abundant experience in developing and managing university-based research programs, including both programmatic and financial aspects. The CSAP Management Team will provide NSGO with copies of proposals selected for funding before awards are made. Each of the three state Sea Grant programs will fund a subset of the selected research proposals and a portion of the collaborative administration, extension and communication activities identified and authorized by the CSAP Management Team. Should programming decisions require that funds be transferred between the states, the three programs have the capability to do so.

As stipulated in Section IV. F. of the posted Federal Funding Opportunity announcement for these monies, indirect costs on this proposal, and on all derivative proposals funded by the state programs through CSAP, are limited to 20% of the requested funds in those budget categories on which indirect costs are normally levied.   The matching funds requirement that routinely adheres to Sea Grant awards will be waived for the CSAP

program. Other than the requested reduced indirect cost rate and waived matching funds requirement, the normal financial terms and conditions associated with each state program's research grants/contracts will apply to CSAP-funded awards.

The suite of research projects funded under CSAP will not be orchestrated from the top but will, rather, be assembled from the responses to the RFP. However, it is clear that the urgency of the program's purpose and the widespread interest in it, the expectations under which the program will operate and the condensed program timetable will impose a substantial research administration challenge to the state Sea Grant programs that must be met if CSAP is to fully succeed. This will probably translate into more detailed and more frequent progress reports from funded investigators, mandatory participation for project PIs in periodic program progress meetings and other assemblies related to the program, etc. Research managers in the three state programs will be in very close touch with CSAP funded projects so that the program can take maximum advantage of potential synergies between these projects to produce to their full potential.

4. *Program Timetable*

The program will have a two-year duration that will begin with receipt of federal funding by the state programs. Program announcement and research project solicitation and selection will be done in the initial 3 months. Funded research projects will then run for 18 months. The concluding 3 months of the program will be devoted to assembling informational products describing research results and an intensive effort to bring these to the attention of the coastal hazards management and response community in the Sandy-affected area. The following is the projected timetable for the program:

July-August 2013 (before award) – develop RFP

03 September 2013 - receipt of federal funding; release of RFP

1 October 2013 – letters of intent due

31 October 2013 – proposals due

01 December 2013 – proposal review completed/funding decisions & and awards made, research projects start

31 May 2014 – 1st 6-month progress reports due

30 November 2014 – 2nd 6-month progress reports due

31 May 2015 – Funded projects completed and final reports and products due

31 August 2015 – program ends

This is an ambitious timetable. To meet it will require the concerted action of Sea Grant program managers at the state level and involved NSGO staff. Research awards will be made for 18 months, with no option for additional time. It is likely to be a challenge to keep the researchers on track with this timeframe, but doing so will be essential.

b. Extension & Communications Activities

Extension personnel from the three state Sea Grant programs will be integrated into the research program in order to advise researchers about the communities being studied and to increase the probability of the research findings and products being implemented. Extension and communications professionals from the three Sea Grant programs will also formulate unified plans to, respectively, extend CSAP research to the coastal storm hazard and emergency response community (including public media) and bring the program, its objectives and findings to the attention of the general public. The extension and communications efforts must develop in near synchrony with the research element of CSAP. The conceptual plans for extension and communications plan are described below.

1. Extension Programming

Sea Grant Extension personnel from New York, Connecticut, and New Jersey will be responsible for implementing the outreach portion of the CSAP effort. Given the accelerated timeline of the project and the fact that the expected products and tools resulting from the research effort are not well defined at this time, the traditional Sea Grant outreach model of extending peer-reviewed, published research results to stakeholder audiences will not be possible. Rather, the extension effort will focus on ensuring stakeholder input is integrated into, and helps guide, the research effort from the start. Outreach and extension efforts will be conducted concurrently with the research effort and will require a degree of flexibility as CSAP develops.

The proposed extension effort will include several elements. Senior extension personnel, in conjunction with members of the Program Steering Committee (PSC), will assist in organizing the PSC, reviewing proposals and serve as a liaison with the researchers. They will helping the funded researchers locate and obtain local storm impact related data and provide them with local/regional information, guidance, contacts and advice to help ensure the research results and products meet the needs of target audiences. As these research results, products and tools are developed, extension personnel will work with the CSAP Management Team to help coordinate, facilitate and participate in informational meetings for PSC members.

Outreach efforts will also focus on expanding participation in the developmental process by a wider audience than those serving on PSC. A larger group of stakeholders involved with emergency response and storm hazard warning, including local emergency managers and appropriate coastal community representatives, will be identified and selected in consultation with PSC members to review and provide input on research results and tools as they become available. Content and potential delivery mechanisms (informational meetings, on-line webinars, via e-mail, written materials, etc.) will depend on the specific tools and products developed by the researchers and the preferences of the stakeholders chosen to participate, with an emphasis on getting stakeholder feedback about the tools and products in a timely manner. Extension will compile and synthesize stakeholder input and provide it to the researchers, PSC members and the CSAP Management Team as appropriate. This will help ensure the research results meet the needs of the target audiences and encourage early adoption of resultant tools and products by stakeholders. Extension will also develop summaries of research findings for coastal stakeholders participating in this effort outside the PSC, as appropriate, to ensure they are kept apprised of the progress of the effort to which they contribute time and information.

Tentative Time Line for CSAP Extension Effort

August 2013 (before award): Assist in Identifying Members, Organizing PSC and Holding
                First Meeting

Sept. - Oct 2013: Identify and Recruit Stakeholders to Provide Outside Input

November 2013: Review and Provide Input on Proposals

December 2013: Assist in Organizing and Participating in First PSC/Researcher Meeting

Dec 2013 - Jan 2014: Develop/Disseminate Materials on Funded Projects to Stakeholders

Dec 2013 - May 2015: Assist Researchers as Needed

Jan 2014 - Feb 2014: Solicit, Compile and Synthesize Input from Stakeholders and Research Progress Reports, Summarize and Provide to PSC and Researchers

June 2014: Assist in Organizing and Participate in 2nd PSC/Researcher Meeting

July 2014: Develop/Disseminate Findings and Materials from 2nd PSC/Researcher Meeting to Outside Stakeholders

August 2014: Solicit, Compile and Synthesize Input from Stakeholders and Research Progress Reports, Summarize and Provide to PSC and Researchers

December 2014: Assist in Organizing and Participate in 3rd PSC/Researcher Meeting, Inviting Outside Stakeholder Participation as Appropriate.

Jan 2015 - Feb 2015: Develop and Disseminate Findings and Materials from 3rd PSC/Researcher Meeting to Outside Stakeholders

June 2015: Provide Outside Stakeholders with Research Final Reports.

July-August 2015: Compile and Synthesize Stakeholder Input, Provide Summary to PSC with Recommendations for future Extension and Outreach components.

2. *Communications Effort*

Communications leaders from Connecticut, New York, and New Jersey will support the Coastal Storm Awareness Program (CSAP) by working with the research and extension components to identify key media contacts, assist in packaging messages to target audiences and engage the public.

The messages and information conveyed will be primarily based on research and activities generated from within the research component of the CSAP but could also incorporate initiatives and input from other agencies and stakeholder groups seeking to increase understanding of coastal storm awareness among the area's residents.

The CSAP Multi-State Communications Team (CSAP-MSCT) team will design, produce and distribute publications and other resource materials to appropriate audiences using all available and conventional means and mediums including, print, computer technology, radio, social media, and TV and strive to develop innovative methods of transmitting information.

Specifically, the CSAP-MSCT will collaborate on an initial press release regarding the award and the call for proposals; a statement on the research chosen; a final series of summary press releases focusing on the research conducted; and production assistance related to final products such as documents or websites generated by this effort.

The team will also create a coordinated schedule of social media posts and exchanges and investigate developing a comprehensive media campaign to promote and market project end products and deliverables. Because media campaigns are generally expensive and often cost prohibitive, any such effort will be strictly contingent on securing additional CSAP funding or outside funds and partnerships.

At the conclusion of the CSAP program, a summative document(s) will be prepared by, or with oversight from, the CSAP Management Team that describes the history of the program and the accomplishments of its research, extension and communications elements. It will further describe the principal products stemming from this work, either 1) new and improved tools to accurately convey coastal storm hazard information and/or 2) better understandings of the factors that affect how residents interpret and react to this information, including other factors they often use when making a decision to evacuate a threatened area or not. This latter information may play directly back into more effective storm response planning. These documents may take the form of a review article in a referred scientific journal, a Sea Grant special report, or both. The individual research projects will be encouraged to publish their work in appropriate, peer-reviewed journals, but accepted publication is unlikely to be before the 31 August 2015 end date of CSAP.

(3) <u>Outcomes</u>

Description of the results and outcomes from the CSAP program is not possible at this time, as the specific research projects that will be funded are unknown. What can be said is that these results will be directly focused on the two major CSAP themes: 1) improving the availability and quality of information on coastal storm hazards and the risks they pose to human safety in those coastal areas of New Jersey, New York and Connecticut that are most susceptible to coastal storm impacts and 2) providing a more informed understanding of how this risk information is received, perceived and acted upon by coastal residents in these at-risk areas. This information will be directly useful to the coastal storm hazard management and response communities in the tri-state area. The outcome of CSAP will be an enhanced ability of those in this community to do their jobs well: conveying coastal storm hazard information with maximum accuracy and portraying the risks to human safety of impending storms in ways that will be more understandable and relevant to coastal residents and coastal communities. In combination, these two outcomes should produce the ultimate outcome sought by the program - - better decisions by coastal residents and better planning and management decisions by coastal communities that together reduce the number and severity of human casualties in this region from coastal storms.

(4) <u>Coordination with Other Elements</u>

To be successful, CSAP must be known to the coastal storm hazard management and response community in the tri-state region. That community must be afforded an opportunity to contribute to the shaping of the program, including the selection of funded research projects and the provision of input and advice to funded investigators of these projects. Finally, the progress, research findings and developments of the CSAP research projects must be regularly shared with members of the coastal storm hazard management and response community. The tighter this connection, the greater the chance that CSAP will achieve its desired outcomes. The principal mechanism to build and sustain this connection will be the Program Steering Committee (PSC). The PSC will be comprised of approximately 12-18 persons drawn from the National Weather Service and the emergency hazard response community in the Sandy-affected area, as well as representatives of public communications media, through which many coastal residents receive their information about coastal storm hazards. The PSC will be involved in the review of extension and communications efforts, periodic research program reviews and other landmark events in the CSAP timetables (see above). Additionally, individual PSC members may serve as links between specific CSAP-funded projects and the program's target audience.

The three state Sea Grant programs are already compiling names of potential Program Steering Committee members.   The organizations that will be represented on the Steering Committee will likely include: National Weather Service; state and municipal offices of emergency management in New Jersey, Connecticut and New York; CZM officials and public radio and television stations.

Coordination of CSAP activities with other coastal hazard risk and risk assessment work being done by NOAA is another priority. The CSAP Management Team will be in contact with selected NOAA officials and scientists active in this work before the official start of the program. Building complementarity and avoiding duplication of effort are the objectives. Part of the extension work and the overall program management activity of the CSAP Management Team will be to foster and maintain the mutual sharing of information between CSAP, its investigators and other workers within NOAA, including any similarly-directed research being funded elsewhere in the national Sea Grant network.

Scientific and technical review of research projects will be the job of the Proposal Review Panel. As described above, the Panel will include members drawn from the PSC as well as invited members from the social science research community and experts in natural hazard mapping/visualization. While the Proposal Review Panel will be active

primarily in the early stages of CSAP in the review of proposals, it may also play a role in providing peer review of research products and the above-referenced summative report produced at the end of the CSAP program.

(5) <u>Data/Information Sharing Plan</u>

Connecticut Sea Grant will ensure that each competitively-selected research project to be funded by the *CSAP: Connecticut Component* allocation has its own acceptable data sharing plan as part of its proposal. Each project will be only 18 months in duration and its personnel will be required to implement the project's data sharing plan within two years of the data collection or creation, and provide proof of this to Connecticut Sea Grant.

Since the research projects have not yet been identified, the specifics of their plans cannot be provided at this time. However, it should be noted that the RFP will include the following text:

> New NOAA regulations require that data and information collected and/or created under NOAA (including Sea Grant) grants must be made visible, accessible, and independently understandable to general users, free of charge or at minimal cost, in a timely manner (typically no later than two years after the data are collected or created), except where limited by law, regulation, policy or by security requirements.
>
> The new requirement has two basic parts: (1) environmental and socio-economic data generated by a grant project must be made available after a reasonable period of exclusive use, and (2) the grant proposal must describe the plan to make the data available.
>
> To comply with this new requirement, the principal investigator must include a data management plan in his/her proposal that describes how the project's data and metadata will be made available to others. Deposition of data in standard data archives (e.g., by discipline) or in available university archives is encouraged. This requirement for data archiving is in addition to the expected publication of research results in peer-reviewed journals. The proposed plan will be reviewed for compliance with NOAA requirements

More information about Data Sharing Plan requirements may be obtained from the NOAA Data Sharing Plan procedural directive webpage, available at *https://geo-ide.noaa.gov/wiki/index.php?title=Data_Sharing_for_NOAA_Grants_PD* .

The administration, extension outreach, and communications activities to be conducted by Connecticut Sea Grant under CSAP will not generate environmental data, and therefore do not require a data management plan.

Appendix II:

CSAP Call for Research Proposals

New Jersey, New York, and Connecticut Sea Grant's
Call for Research Proposals
Coastal Storm Awareness Program (CSAP)

Required Letter of Intent Due: 4:30 pm EDT Monday, October 28, 2013
Full Proposals Due: 4:30 pm EST Friday, November 22, 2013

Available funds: nearly $1.5 million
to support about 10 projects over a 16-month time span
January 1, 2014, through April 30, 2015

The objective of this research initiative, Sea Grant's *Coastal Storm Awareness Program* (CSAP), is to better understand the current mechanisms used to disseminate and receive coastal storm hazard information, the information being conveyed (what, when, how, and by whom), the factors that affect whether recipients of this information decide to act on it, and the actions that these recipients take as a result. The goal of the program is to save lives and promote public safety by providing valid social science research and/or technology-based tools that could be used by the National Weather Service, Emergency Managers, the media and coastal communities in order to ensure that informed decisions are made by coastal residents during severe coastal storms. It is anticipated that the application of the funded research's results will increase the likelihood that residents who should remove themselves from harm's way actually do so or take other actions to prevent themselves from becoming storm casualties. Proposals funded under CSAP will focus on the coastal areas of New Jersey, New York and Connecticut impacted by Hurricane Sandy.

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I. BACKGROUND

Hurricane/Post-Tropical Cyclone Sandy made landfall on October 29, 2013, near Brigantine, NJ. From the Caribbean through the Eastern Seaboard of the United States, the storm caused massive devastation of property and shorelines as well as loss of life. According to the National Weather Service (NWS) Assessment, 147 deaths were directly due to the storm. According to the Center for Disease Control, 40 of those were drowning deaths – deaths that might have been prevented if residents had evacuated. The scale of the storm and the populations it affected were very large. Sandy was the second most costly storm event in U.S. history, resulting in approximately $62 billion of economic losses.

The National Sea Grant College Program awarded funds from the Sandy Supplemental Appropriations Legislation to the New Jersey, New York and Connecticut Sea Grant programs for the purpose of funding research related to preventing these types of preventable deaths in the future. These Sea Grant programs will jointly administer and manage the Coastal Storms Awareness Program research competition and work with coastal stakeholders such as the NWS, emergency management agencies, media, and coastal communities through the CSAP Program Steering Committee. This Committee will ensure that research results will meet the needs of the stakeholders and increase the likelihood that results will be implemented at the appropriate local or regional level.

II. RESEARCH TOPICS FOR THIS CALL

The Sea Grant Programs administering this *Coastal Storm Awareness Program* (CSAP) (New Jersey, New York and Connecticut) request proposals that contribute to or build upon prior social science research to better understand how and why people made or will make choices relative to coastal storm warnings or other high-impact weather events expected to affect coastal areas. The research could also develop guidelines, tools, and technologies that will assist those who are responsible for issuing or conveying storm information, and those who direct emergency management efforts in communities to reduce casualties and losses.

CSAP seeks proposals to enhance our understanding of how the risks from impending coastal storms, and other high impact weather, are assessed, perceived, communicated, and acted upon (or not) in order to improve the delivery of information regarding coastal storms so as to protect people and save lives and property. Proposals that incorporate the development of technology for the purposes of risk communication are also encouraged.

In responding to these needs, CSAP proposals may contribute to or build upon prior research to explore:
   A. The nature of storm hazard information and warnings that communities and residents are receiving.
   B. What sources and venues of information and warnings are trusted.
   C. The factors that determine how the public will or will not act on the information provided.
Additional potential proposal topics could address, but are not limited to, the following:
   D. Development of technology-based information appropriate for communicating risks from coastal storms to emergency managers, the media and the public.

E. Identifying cultural and language barriers that exist and effective ways that they can be overcome before and during a weather event.
F. Testing of NOAA products used to convey risks (e.g., regarding wind in tropical cyclones), similar to the testing of surge products which has already been completed and the testing of watch/warning/advisory and the Hurricane Local Statement products which is currently underway.
G. Examining how social media is being used and how communicators can most effectively use this tool during a weather emergency.

NOAA is conducting a number of other activities and projects related to improving communication and response efforts aimed at impending high impact weather and coastal storm hazards. More information on these activities is available here: http://www.nyseagrant.org/csap

Work proposed for funding through CSAP should build upon or complement, but not duplicate, existing research including that conducted by or for NOAA or other relevant agencies, or address an important aspect of coastal storm hazard communication and personal risk response that is not covered by previous work. Letters of Intent (see below) should briefly mention how the proposed work will build upon or complement existing research and studies as well as any specific connections to entities involved in coastal storm communication and response.

Qualifying projects include traditional social science disciplines such as anthropology, communications, economics, sociology, political science, psychology, as well as interdisciplinary research addressing environmental policy, disaster management, data visualization or human dimensions. Technology-based proposals should be embedded within the appropriate disciplinary perspective associated with the potential tool. CSAP encourages multi-disciplinary and multi-investigator research to the extent that it is practical. In addition, projects will be required to engage end-users (such as the NWS, emergency managers, and coastal communities) throughout the course of the project to ensure the relevance, utilization and societal impacts of the research outputs. For this Call, it is expected that Sea Grant Extension professionals located in the Sandy-hit areas and the CSAP Program Steering Committee will be actively engaged in the research, through advising or other appropriate roles, to ensure that final products are useful to end-users.

III. GENERAL INFORMATION ABOUT PROPOSAL SUBMISSION
A. Who is Eligible to Submit:
Eligible groups are listed below:
1. Researchers at universities and colleges.
2. Researchers at other not-for-profit or tribal research institutions.
3. Researchers who are personnel of state or local agencies, or of not-for-profit organizations.
4. Researchers at for-profit institutions or companies (within limits established by the National Sea Grant Office).

Important Notes: Research must target coastal area(s) impacted by Hurricane/Post-Tropical Cyclone Sandy in New Jersey, New York and Connecticut. To help NOAA, emergency managers, media and coastal communities to transition the results of these studies into their

operations, preference will be given to proposals that include a component that can be tested in a NOAA weather facility or other appropriate venues for the research proposed. Federal employees may participate in projects as collaborators, but are *not* eligible to receive funds under this initiative, and their contributions cannot be considered a source of cost-sharing. Students can be involved in the research projects, but cannot serve as Principal, co-Principal, or Associate Investigators. Personnel that have an employment affiliation with the Sea Grant programs in NJ, NY, or CT are not eligible for funding under this Call.

B. Duration of Proposed Work:
In this Call, the research projects will run for a maximum of 16 months during the period January 2, 2014, through April 30, 2015. **There will be no possibility for any type of extension** due to the source of the funds.

C. Budget Size (total of indirect plus direct costs):
The total budget request (direct + indirect costs) for a project may not exceed $150,000 for the 16-month period. Budgets must include travel costs for 2 trips to the NY/NJ area for meetings with the CSAP Program Steering Committee, during month 5 of the project and at the end of the project. Final payments will not be made until final reports are filed. **Indirect cost rates as normally levied on budget categories by the recipient institution are limited to 20% of the requested funds in those categories.**

D. Cost-Share Requirement:
CSAP has *no* cost-share requirement.

E. Data Management and Sharing Plan:
New NOAA regulations require that data and information collected and/or created under NOAA (including Sea Grant) grants must be made visible, accessible, and independently understandable to general users, free of charge or at minimal cost, in a timely manner (typically no later than two years after the data are collected or created), except where limited by law, regulation, policy or by security requirements.

The new requirement has two basic parts: (1) environmental and socio-economic data generated by a grant project must be made available after a reasonable period of exclusive use, and (2) the grant proposal must describe the plan to make the data available.

To comply with this new requirement, the principal investigator must include a data management plan within their proposal that describes how and when the project's data and metadata will be made available to others. Deposition of data in standard data archives (e.g., by discipline) or in available university archives is encouraged. This requirement for data archiving is in addition to the expected publication of research results in peer-reviewed journals. The proposed plan will be reviewed for compliance with NOAA requirements.

F. What and When to Submit:
  1. Letter of Intent
In order for a full proposal to be considered, a Letter of Intent (LOI) must be submitted **by 4:30 pm EDT on Monday October 28, 2013**. It must be submitted electronically through New York

Sea Grant's electronic submission web site: www.NYSGProposal.org . On that site, navigate to "Coastal Storm Awareness Program (CSAP)" and follow all directions for electronic submission.

Be sure to include the following information in the Letter of Intent:
- The names, affiliations and contact information of the personnel expected to be involved;
- A draft title; and
- A brief statement, not to exceed two pages, describing the question or issue you plan to address in a full proposal.

Important notes about LOI submission:
  a) Signatures of principal investigators or campus officials are not required.
  b) Submit it as a single pdf file, with 1" margins all around, and a font equivalent to 12-point New Times Roman.
  c) We recommend submission via a PC at your university office, with a current version of Internet Explorer, Firefox, or Google Chrome web browser installed.
  d) If you have trouble with submission through www.NYSGProposal.org, call NYSG (631-632-9780) to explain the problem. We will try to help, but cannot guarantee that we can solve your problem. In any case, unless the web site (housed on the Stony Brook University server) becomes inoperable, it is *your* responsibility to use equipment that will allow you to meet the deadline.
  e) Submissions received after the deadline of 4:30 pm EDT on October 28, 2013, cannot be accepted and the lead investigator will be notified. Please be sure to watch the time! Even if you are on the website before the deadline, if your file is not submitted by 4:30 pm, it will not be accepted.
  f) A LOI reference number will be provided to the lead author.
  g) The LOI will *not* be used as a screening tool. Since there is no pre-proposal step, the LOI will be helpful to the managers of CSAP to prepare for full proposal review.
  h) No full proposal will be accepted without a Letter of Intent filed prior to the deadline.

   2. **Full Proposal**
Full proposals must be submitted by **4:30 pm EST on Friday November 22, 2014.** Like the LOIs, they must be submitted electronically through New York Sea Grant's electronic submission web site: www.NYSGProposal.org . Navigate to "Coastal Storm Awareness Program (CSAP)" and follow all directions for electronic submission.

The full proposals must follow the Instructions in Section VII, which starts on page 8.

Important notes about full proposal submission:
  a) Only proposals for which a Letter of Intent had been received will be considered. Be sure to indicate in a cover note the LOI reference number that had been provided to the lead author.
  b) Submissions that do not include the required information (see Section VII for Instructions) will lose rating points.
  c) Double-check your proposal file before uploading it at the submission web site to make sure it is PC-readable and that it is your final version. *It must be in the form of a single*

pdf file. You will receive an auto-receipt from the web site confirming your submission, but this is not an indication that your file is readable.

d) We recommend submission via a PC at your university office, with a current version of Internet Explorer, Firefox, or Google Chrome web browser installed.

e) If you have trouble with submission through www.NYSGProposal.org, call NYSG (631-632-9780) to explain the problem. We will try to help, but cannot guarantee that we can solve your problem. In any case, unless the web site (housed on the Stony Brook University server) becomes inoperable, it is *your* responsibility to use equipment that will allow you to meet the deadline.

f) All submissions will be checked in the order they were posted and any that contain a virus or that are unreadable cannot be accepted. The lead investigator will be notified about this by email. However, for submissions that are posted on November 22, NYSG cannot guarantee that this check and notification will take place before the 4:30 pm EST deadline.

g) Submissions received after the deadline of 4:30 pm EST on November 22, 2013, will not be accepted and the lead investigator will be notified. Please be sure to watch the time! Even if you are on the website before the deadline, if your file is not submitted by 4:30 pm EST, it will not be accepted.

IV. THE REVIEW PROCESS

All proposals submitted in response to this CSAP call will be screened by the CSAP Sea Grant programs' managers and appropriate extension staff, aided by a composite Proposal Review Panel, comprised of a subset of the CSAP Program Steering Committee members and a number of invited technical experts. The CSAP Program Steering Committee is comprised of representatives from the NWS, emergency hazard response community, and public communications media in the Sandy-affected areas.

Projects will be selected on the basis of the following criteria:

- **Significance of the specific problem or issue in the context of the CSAP goals and research topics –** the degree to which the proposed project reflects the goals and research topics of the Call, and addresses a significant problem or issue.
- **Scientific or technical merit of the work plan –** the degree to which the research activity uses appropriate hypotheses and methods.
- **Expected products and anticipated impacts –** efficacy, significance and importance of the products (models, methods, tools, and scientific information) and impacts (change in behavior/policies) that are expected to result from this project; usability of the products and documentable impacts.
- **Qualifications of the investigators –** the degree to which investigators are qualified by education, training, and/or experience to execute the proposed activity.
- **Appropriateness of the budget** – the degree to which the requested funding is appropriate and reflects reasonable costs for the proposed research.
- **Data Management/Sharing Plan** – this section will be provided to, but not evaluated by the Proposal Review Panel. Rather, once the top proposals are selected, Sea Grant staff will assess whether the Plan is satisfactory.

V. TIMELINE

October 10, 2013	CSAP Call for Proposals released
October 28, 2013	Deadline for Letter of intent at 4:30 pm EDT
November 22, 2013	Deadline for full proposals at 4:30 pm EST
December 19, 2013	CSAP Sea Grant programs notify successful investigators
January 2, 2014	Research projects' earliest start date
April 30, 2015	Research projects' latest end date
June 1, 2015	Deadline for Final Reports at 4:30 PM EDT

VI. SEA GRANT CONTACTS

New Jersey Sea Grant
Peter Rowe, Associate Director (732-872-1300 x31), prowe@njseagrant.org
New York Sea Grant
William Wise, Interim Director (631-632-6905), william.wise@stonybrook.edu
Connecticut Sea Grant
Sylvain De Guise, Director (860-405-9138), sylvain.deguise@uconn.edu

VII. SPECIFIC INSTRUCTIONS FOR FULL PROPOSAL COMPONENTS (use as a checklist)

Be sure to use the format and provide the information as described below. **Components A-K and all of the information specified within them is required.** Use all-around margins of at least 1" and a font size no less than #12 Times New Roman. Submissions that do not include all of the required information and/or that do not follow the format requirements will lose rating points and/or be truncated.

___ **A. Title Page:** See example and downloadable blank versions of this on NYSG's web page http://www.seagrant.sunysb.edu/articles/t/grants-policies-downloadable-forms-for-proposal-submission. Be sure to include pages for subcontracting institutions (follow examples). Obtain all required signatures and scan all title pages as one PDF document in order to submit electronically.

___ **B. Project Summary Form 90-2:** See example and use downloadable blank versions of this from NYSG's web page http://www.seagrant.sunysb.edu/articles/t/grants-policies-downloadable-forms-for-proposal-submission. The Project Summary Form should very briefly convey all essential elements of the proposed activities. *It may not exceed 1-2 pages in length*.

___ **C. Project Narrative:** Organize your materials for Sections 1-6 as presented below, and follow the examples and guidelines provided. This component (C, with its 6 sections) *may not exceed 12 pages*, including any figures, tables, etc. Pages beyond this limit will be removed.

___   1. PROJECT TITLE:
The title should be brief, specific, and descriptive of the activity.

___   2. PRINCIPAL AND ASSOCIATE INVESTIGATORS:
List principal, co-principal, and associate investigators with department and university/institution affiliations. Students cannot be PIs or AIs, do not list them here.

___   3. INTRODUCTION / BACKGROUND / JUSTIFICATION:
Text in this section should explain why/how the proposed research is important. You should carefully review other significant, related work and demonstrate how your proposed research will build on this base. Finally, be sure to clearly describe how this project will significantly contribute to achieving the goals and addressing the research topics of this Call.

___   4. GENERAL WORK PLAN AND MILESTONES:
Clearly and succinctly state your project hypotheses. Then list the objectives of your project (which should be the same as listed in the 90-2 form). Describe the overall study design and work plan and outline in detail the research methods, techniques, and analytical/statistical methods (as appropriate) that will be used to accomplish the stated objectives. Spell out what you expect to accomplish and in what time frame, identifying specific milestones. Be sure to include:
- the steps and techniques that will be used;
- the experimental design;
- any data sources to be used and how they will be accessed; and
- any facility and equipment requirements and how they will be met.

Reviewers should be able to assess the appropriateness of the proposed work plan and milestones for achieving the stated project objectives.

___   5. OUTCOMES:
One of the National Sea Grant Office's main emphases is that Sea Grant activities, including research, must be able to show documentable accomplishments and impacts. It is very important that the full proposal describe how the project results would be used and by whom. How do you plan to convey the results and what demonstrable impacts would come from this? In other words, this section should detail the significance and importance of the products and impacts that are expected to result from the proposed project. You should also describe the usability of the products (e.g., who will be able to use them, how will they have access, etc.) and how the impacts can be documented (e.g., how will one be able to measure the impacts to accrue from your results). Your statements should be specific and, optimally, should be substantiated by references or attached supportive correspondence.

___   6. COORDINATION:
List the roles and responsibilities of personnel, including students, as related to the project. Letters that verify the collaboration of other investigators or organizations to be involved with the project (if any) must be included in your proposal submission. Also, please note that close coordination of your research with the agency, industry, or other user group that will be its prime beneficiary is a good way to enhance the success of your project. This section should clearly show that you have already investigated these connections and contacts. We recommend that

you contact Sea Grant in the areas in which you will be conducting research about this because they are likely to be involved with the extension of your results, as well. In addition, they should be able to connect you with appropriate members of the CSAP Program Steering Committee. If your work will be carried out in conjunction with a business, industry, government organization or citizen's group, list the name and address of the organization and the main contact person. If the group is providing financial support, data, materials, manpower or guidance, be sure to state this and provide correspondence that verifies the commitment. In this section, you should also describe any linkages that the project would have with other programs or projects: international, federal, state, or local. Describe how this proposal is complementary, not duplicative.

___ D. Data Management/Sharing Plan *(not to exceed 2 pages)*

New NOAA regulations require that data and information collected and/or created under NOAA (including Sea Grant) grants must be made visible, accessible, and independently understandable to general users, free of charge or at minimal cost, in a timely manner (typically no later than two years after the data are collected or created), except where limited by law, regulation, policy or by security requirements. The new requirement has two basic parts: (1) environmental and socio-economic data generated by a grant project must be made available after a reasonable period of exclusive use, and (2) the grant proposal must describe the plan to make the data available.

To comply with this new requirement, your full proposal must include a data management/ sharing plan that describes how the project's data and metadata will be made available to others. Deposition of data in standard data archives (e.g., by discipline) or in available university or NOAA archives is encouraged. This requirement for data archiving is *in addition* to the expected publication of research results in peer-reviewed journals. The proposed plan will be reviewed for compliance with NOAA requirements. If funds are needed for this task, they must be included in the full proposal budget form and text justification.

Per NOAA, "environmental data" are recorded and derived observations and measurements of the physical, chemical, biological, geological, and geophysical properties and conditions of the oceans, atmosphere, space environment, sun, and solid earth, as well as correlative data, such as socio-economic data, related documentation, and metadata. Media, including voice recordings and photographs, may be included.

Per NOAA, "independently understandable" means that the data must be accompanied with documentation, metadata and, if needed, tools to read the data that allow the user to interpret the data properly. If there are concerns by users with data access or understandability, they can be reported to NOAA, who will do an independent check.

There are several acceptable ways to share data, but the CSAP Sea Grant programs strongly prefer that you use either:
  a) Data Archive – a place where data are acquired, manipulated, documented, and distributed. NOAA facilities that archive data and make the data openly available should be considered. Disciplinary databases and university archives are also options.
  b) Data Enclave – a controlled, secure environment in which eligible researchers can perform analyses using data resources.

A typical plan should include a description of the types of environmental data and information created during the course of the project; the tentative date by which data will be shared; the standards to be used for data / metadata format and content; policies addressing data stewardship and preservation; procedures for providing access, sharing, and security (including location); and prior experience in publishing such data.

A few other points:

- If the project will not generate environmental data, it is sufficient (and necessary) to state that in a sentence.
- The CSAP Sea Grant programs do not have the capacity to serve as a repository, but if you need information about potential archives or enclaves, contact the Sea Grant personnel listed in the Call's section VI, above.
- This section of your proposal will be included in the materials read by the Review Panel, but will not be evaluated by them. Sea Grant staff will assess whether the plan seems satisfactory, but NOAA will have the final word on whether the proposed plan meets their minimum requirements.
- It will be the CSAP Sea Grant programs' responsibility to ensure and enforce that you follow the proposed and accepted plan.
- Be sure the Data Management/Sharing Plan does not exceed 2 pages.

___ **E. Literature Cited:** Include the complete citations for each publication referenced within the proposal. If none, state that.

___ **F. Project Timeline:** See example and use downloadable blank versions of the timeline form on the web page http://www.seagrant.sunysb.edu/articles/t/grants-policies-downloadable-forms-for-proposal-submission.

___ **G. Budget Justification:** This must be a written narrative. The dollar figure and justification for each budget category will be closely examined, so PIs must be very careful to explain **all** anticipated expenses. Please remember that matching funds (aka cost share) are ***not*** required under this Call. Also please remember that under this special Call, **indirect cost rates as normally levied on budget categories by the recipient institution are limited to 20% of the requested funds in those categories.**

To assist with your submission, please use New York Sea Grant's generic "fiscal policies" website, which contains guidance information and should answer many questions you may have as you prepare your budget. The website is http://www.seagrant.sunysb.edu/articles/t/grants-policies-forms-policies and includes guidelines regarding allowable budgetary items. See http://www.seagrant.sunysb.edu/articles/t/grants-policies-downloadable-forms-for-proposal-submission for an example budget justification. Note that the special conditions about matching funds and indirect costs are not highlighted in these generic policies, although they do apply to the CSAP Call.

___ **H. Subcontract Scope of Work and Budget Justification:** Include for each subcontracting institution, if any.

___ **I. Budget Forms 90-4:** Be sure to include a budget form for the lead institution and each subcontract. Again, see http://www.seagrant.sunysb.edu/articles/t/grants-policies-downloadable-forms-for-proposal-submission for an example and downloadable blank versions. If you have questions, please use the Sea Grant contacts listed in Section VI.

___ **J. Biosketch:** Include only for all Principal, co-Principal, and Associate Investigators, *not to exceed 2 pages each*. Do not include vitae for students or other personnel.

___ **K. Other Research Support:** For each principal, co-principal, and associate investigator, list all current active support and all applications/proposals pending review or funding. Include source of support, months committed to the project, dates of duration, annual direct costs, project title, any overlap with the present proposal. If none, state that.

___ **L. Letters of Collaboration, Support, and Cost-Share Commitment:** If appropriate, include correspondence regarding expected impacts and benefits, collaborative efforts and/or others' support for the project, and/or letters certifying match commitment (if any). Scan hard copies of such materials or have them sent to you by email so that you can include them **as part of your electronic submission**. Faxes, emails, and hard copies will not be accepted.

Appendix III:

Agenda, CSAP "all hands" Initial Meeting, 13 May 2014

AGENDA

Coastal Storm Awareness Program (CSAP) Meeting
City University of New York Graduate Center
365 Fifth Avenue, NYC
Rooms 9206/9207
13 May 2014

9:00   continental breakfast

9:30   welcome (NJ, NY, CT Sea Grant Directors)
introductions: funded investigators; Program Steering Committee, Sea Grant staff
purpose of meeting (P. Rowe, NJSG)
review agenda (P. Rowe, NJSG)

10:00   program background/development (S. DeGuise, CTSG)

10:20   research team project presentations (20 minutes each)

Hoven / Musa / Amsel, Columbia University
Adolescent and Family Decision Making In Time of Disaster

Daziano / Nozick, Cornell University
Forecasting Evacuation Behaviors of Coastal Communities in Response to Storm Hazard Information

Moran / Peace, SUNY College of Environmental Sciences & Forestry
Understanding Responses to Storm Warnings: Learning from Those Who 'Rode Out' Hurricane Sandy

11:20   break

11:30   research team project presentations (con't)

Wong-Parodi / Strauss / Fischhoff, Carnegie Mellon University
Behaviorally Realistic Communications to Improve the Public's Response to and Preparedness for High Impact Storm Events

Marlon / Leiserowiz, Yale University
An Audience Segmentation Analysis of Coastal Residents of New Jersey, New York and Connecticut

Hogan Carr / Montz / Szatkowski / Auermuller / Frankel / Goldman, Nurture Nature Center
They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to NWS Coastal Flooding Forecasts

12:30   catered lunch

1:30   research team project presentations (con't)

       Cuite / O'Neill / Hallman / Robinson / Decker / Obropta, Rutgers University
       Best Practices in Coastal Storm Risk Communication

       Scherer / Rickard, Cornell University
       Measuring Public Responses to a Surge of Information: How Individuals Understand, React, and Respond to Storm Surge Media Messages

       Farmer / Trasciatti / Ploran, Hofstra University
       Evaluating Evacuation Decision-making Processes Among Residents of Long Beach, NY Before Superstorm Sandy: Lessons for the Role of Authority and Language in Storm Warnings

       Edwards / Mohanty/Fitzpatrick, Mississippi State University
       Assessment of Social Media Usage During Severe Weather Events and the Development of a Twitter-based Model for Improved Communication of Storm-related Information

2:50   break

3:00   open discussion: aiding CSAP research to be maximally successful & impactful
       (PSC and PI's, moderator: C. Schlenk, NYSG)

3:40   extending/communicating CSAP research and its results (J. Tanski, NYSG/P. Van Patten, CTSG)

4:00   looking forward, final thoughts (W.Wise, NYSG)

4:15   end

Appendix IV:

Agenda, CSAP "all hands" Wrap-Up Meeting, 26-27 May 2015

Coastal Storm Awareness Program Project Meeting
Room 205, Kupfrian Hall
New Jersey Institute of Technology, Newark, NJ

Agenda

May 26, 2015

10:00 am   **Welcome and Introductions**
                     Kevin Belfield, Dean, College of Science and Liberal Arts, New Jersey Institute of
                            Technology
                     Nikola Garber, Acting Director, National Sea Grant College Program
                     Peter Rowe, Associate Director, New Jersey Sea Grant Consortium, on behalf of all
                            Sea Grant Programs

10:20 am   **Communicating Results**
                     Barbara Branca, Communications Manager, New York Sea Grant

10:30 am   **Meeting Strategy**
                     William Wise, Director, New York Sea Grant

10:45 am   *Ricardo Daziano / Linda Nozick / Philip Liu / Jonathan Schuldt,* Cornell University
                     Forecasting Evacuation Behaviors of Coastal Communities in Response to
                     Storm Hazard Information

11:15 am   *Christa Farmer / Mary Anne Trasciatti / Elisabeth Ploran,* Hofstra University
                     Evaluating Evacuation Decision-making Processes Among Residents of Long
                     Beach, NY Before Superstorm Sandy: Lessons for the Role of Authority and
                     Language in Storm Warnings

11:45 am   *Clifford Scherer / Laura Rickard,* Cornell University
                     Measuring Public Responses to a Surge of Information: How Individuals
                     Understand, React, and Respond to Storm Surge Media Messages

12:15 pm   Lunch (catered)

1:00 pm   *Jennifer Marlon / Anthony Leiserowitz / Geoff Feinberg,* Yale University
                     An Audience Segmentation Analysis of Coastal Residents of New Jersey, New
                     York and Connecticut

1:30 pm   *Rachel Hogan Carr / Kathryn Semmens / Burrell Montz,* Nurture Nature Center
             **They Had the Facts, Why Didn't They Act? Understanding and Improving
             Public Response to NWS Coastal Flooding Forecasts**

2:00 pm   *John Edwards / Soomya Mohanty / Patrick Fitzpatrick,* Mississippi State University
             **Assessment of Social Media Usage During Severe Weather Events and the
             Development of a Twitter-based Model for Improved Communication of
             Storm-related Information**

2:30 pm   *Cara Cuite / Rachael Shwom / Karen O'Neill / William Hallman / David Robinson /
             Steven Decker / Christopher Obropta,* Rutgers University
             Best Practices in Coastal Storm Risk Communication

3:00 pm   Break

3:15 pm   *Christina Hoven / George Musa / Lawrence Amsel,* Columbia University
             Adolescent and Family Decision Making In Time of Disaster

3:45 pm   *Sharon Moran / William Peace,* SUNY College of Environmental Sciences & Forestry
             **Understanding Responses to Storm Warnings: Learning from Those Who
             'Rode Out' Hurricane Sandy**

4:15 pm   *Gabrielle Wong-Parodi / Ben Strauss /Baruch Fischhoff,* Carnegie Mellon University
             **Behaviorally Realistic Communications to Improve the Public's Response to
             and Preparedness for High Impact Storm Events**

4:45 pm   **Strategies for Day 2 / Housekeeping**

5:10 pm   **Adjourn** (shuttle pick-up ~5:15 pm and 5:30 pm)

Dinner   On your own

May 27, 2015

9:30 am   **Discussion / Strategies / Final Product(s)**
             Syma Ebbin, Research Coordinator and *Nancy Balcom,* Associate Director,
                  Connecticut Sea Grant

12:00 pm   Lunch (catered)

12:45 pm   **Discussion / Strategies / Final Product(s)** *continued*

3:30 pm   **Adjourn**

Appendix V:

Final Research Project Reports

VI: *Best Practices in Coastal Storm Risk Communication (R/CSAP-1-NJ)*
Principal Investigators: *Cara Cuite, Karen O'Neill, William Hallman, David Robinson, Steven Decker, Christopher Obropta*
Lead Institution: Rutgers, The State University of New Jersey

V2: *They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to NWS Coastal Flooding Forecasts (R/CSAP-2-NJ)*
Principal Investigators: *Rachel Hogan Carr, Burrell Montz, Gary Szatkowski, Lisa Auermuller, Susan Frankel, Elizabeth Goldman*
Lead Institution: Nurture Nature Center, Easton, PA

V3: *Adolescent and Family Decision Making In Time of Disaster (R/CSAP-3-NJ)*
Principal Investigators: *Cristina Hoven, George Musa, Lawrence Amsel*
Lead Institution: Columbia University

V4: *Measuring Public Responses to a Surge of Information: How Individuals Understand, React, and Respond to Storm Surge Media Messages (R/CSAP-4-NY)*
Principal Investigator: *Clifford W. Scherer, Laura Rickard, Gina Eosco*
Lead Institution: Cornell University

V5: *Forecasting Evacuation Behaviors of Coastal Communities in Response to Storm Hazard Information (R/CSAP-5-NY)*
Principal Investigators: *Ricardo A. Daziano, Linda K. Nozick, Philip L. Liu*
Lead Institution: Cornell University

V6: *Understanding Responses to Storm Warnings: Learning from Those Who "Rode Out" Hurricane Sandy (R/CSAP-6-NY)*
Principal Investigator: *Sharon D. Moran, William Peace, Samuel Ratick, Rebecca Garden*
Lead Institution: SUNY Environmental Science and Forestry

V7: *An Audience Segmentation Analysis of Connecticut Coastal Residents to Support Storm Preparedness (R/CSAP-7-CT)*
Principal Investigators: *Jennifer R. Marlon, Anthony Leiserowitz*
Lead Institution: Yale University

V8: *Assessment of Social Media Usage during Severe Weather Events and the Development of a Twitter-based Model for Improved Communication of Storm-related Information (R/CSAP-8-CT)*
Principal Investigators: *John F. Edwards, Somya D. Mohanty, Patrick Fitzpatrick*
Lead Institution: Mississippi State University

V9: *Behaviorally Realistic Communications to Improve the Public's Response to and Preparedness for High Impact Storm Events (R/CSAP-9-CT)*
Principal Investigators: *Gabrielle Wong-Parodi, Baruch Fischhoff, Ben Strauss*
Lead Institution Carnegie Mellon University

V10: *Evaluating Evacuation Decision-making Processes among Residents of Long Beach, NY before Superstorm Sandy: Lessons for the Role of Authority and Language in Storm Warnings (R/CSAP-10-CT)*
Principal Investigators: *E. Christa Farmer, Elizabeth Ploran, Mary Anne Trasciatti*
Lead Institution: Hofstra University

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Peter Rowe prowe@njseagrant.org Associate Director, New Jersey Sea Grant Consortium. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Pete Rowe at (732) 872-1300 x 31. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Cara Cuite

Date of Report submission: June 1, 2015

Project #: __ R/CSAP-1-NJ _____

Dates of the project: From [1/2/2014]   to   [5/30/3015].

Project Title:
Best Practices in Coastal Storm Risk Communication

Principal Investigator(s) and Affiliation(s):

1.   Cara L. Cuite, Rutgers University
2.   Rachael Shwom, Rutgers University
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A. PROJECT GOALS AND OBJECTIVES:
1. Determine which risk messages are most effective in encouraging protective actions before, during, and after coastal storms.
2. Develop an empirically-tested, relevant, easily accessible, and usable best practices guide to coastal storm communications that is designed for EMs and other stakeholders interested in communicating about coastal storms.
3. Disseminate results widely, ensuring that we maximize the number of EMs who are aware of, and use these best practices in coastal storm risk communication.
4. Increase the likelihood that residents and visitors will take appropriate protective action during coastal storms.

B. <u>**RESULTS:**</u> **(***Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.***)**
   1. Determine which risk messages are most effective in encouraging protective actions before, during, and after coastal storms.

   In spring of 2015, we conducted an Internet-based survey of 1,716 coastal residents in NJ, CT, and NY. We used multiple sampling techniques, which was necessitated by the zip-code based sampling elements used by our survey vendor, GfK. In NY and NJ, we picked only zip codes that had 40% or more of their landmass in SLOSH Category 2 surge zones. In CT, there is only one zip code that meets that criterion, so we used all zips with more than 1% in the SLOSH category 2 zone. This was done to have representatives from all three states for whom storm risk communications would be relevant. In addition, respondents had to be willing to share their address with the researchers. This strategy resulted in a sample of 203 respondents from the randomly selected KnowledgePanel, and 1,513 respondents from opt-in panels provided by GfK. The demographics of the Internet-based survey are below.

   Table 1. Demographics of Internet-based survey.

State	
CT	26.3
NJ	40.7
NY	33.0
Gender	
Female	56.6
Age	
18-19	5.8
30-44	17.8

45-59	32.8
60+	43.7
Education	
High School or less	11.6
Some college	28.0
Bachelors degree or higher	60.4
Ethnicity	
White, Non-Hispanic	81.6
Black, Non-Hispanic	5.7
Other, Non-Hispanic	5.8
Hispanic	5.5
Multiple Races, Non-Hispanic	1.5

We asked respondents if they believe that they live in a flood zone, and found that 29.7% said yes, 47.4% said no, and 22.5% were not sure. We have very similar data for a question asking whether the respondent believes they live in an evacuation zone. In addition, we have addresses and are waiting for a GIS data file with variables that indicate if they live in storm surge and evacuation zones.

We employed a series of between groups factorial design to test messages. Each respondent saw four hypothetical storm-related scenarios (in a random order), and each scenario included multiple message factors that were being tested. Each respondent was randomly assigned to conditions within each factor. A series of dependent measures were asked after each scenario, with the order of the dependent measures randomized. The dependent measures included a number of behavioral intentions, such as the likelihood of evacuation, other often recommended protective behaviors such as taking out cash and moving cars to high ground, as well as the likelihood of alerting others to the storm. In addition, we asked about perceived risk, perceived message relevance, and the perceived severity of the storm.

The messages we chose to test were based on interviews that we had conducted with EMs (see next section of report), as well as a thorough review of the academic literature. We focused on testing messages that would be realistic for EMs to use. The independent variables we tested include:

– Location-based messages
– Evacuation wording (mandatory, advisories, voluntary)
– Guilt appeals (randomizing the focus on family vs. first responders
– Fear appeals (with Morss and Demuth)
– Storm surge information
– Descriptive information about effects of storm
– Message channel (social media, emergency texts, flyers, face-to-face)

Although not all the results have been analyzed, we focus here on the effects of location-based messages and evacuation wording on one dependent variable—evacuation intentions. Additional analyses are being conducted.

Location-based messages

We tested a series of four location-based message. If a respondent was in the "street" condition, and lived on South Street in Highlands, NJ, they would see the following message.

Forecasters are expecting a strong hurricane to hit <u>Highlands</u> in approximately two days. All residents of <u>Highlands</u> <u>who live on South Street</u> are urged to evacuate their homes. We expect this area to be severely affected by this storm.

For the other conditions, we presented the same text, but the street name did not appear, in it's place appeared "flood-prone areas," "flood zone," or only included the name of the municipality. We found that this variable had a significant main effect of the level of specificity used, with the means of evacuation intentions represented in the table below. Evacuation intentions were measured on a 7 point Likert-type scale, where 1 is "not at all likely" and 7 is "extremely likely."

Table 2. Effect of location-based messages on mean evacuation likelihood.

|	**Mean evacuation likelihood**
Street	4.92a
Municipality	4.74a
Flood zone	4.32b

Flood prone area	4.10b

Note. Means with different letter subscripts are significantly different, $p < .05$.

We had hypothesized that including street names in the evacuation message would significantly increase evacuation intentions. However, while street level messages resulted in the highest evacuation intentions, they were not significantly different from the intentions in the municipality alone. So we conclude from this that, although the technology exists to do so, it may not be worth the expense and effort to tailor the messages to the level of the street. Just including the name of the town or city should result in the same evacuation likelihood.

There was a significant interaction between the location-based message and whether a respondent believed that they lived in a flood zone. Figure 1 shows this interaction, and demonstrates that those who do *not* believe that they live in a flood zone were less likely to say they will evacuate with the flood zone and flood-prone area messages compared to the street or municipality messages. In contrast, the evacuation intentions of those who believe they live in a flood-prone area are not significantly different with these messages than they are in the other two conditions (street or municipality alone).
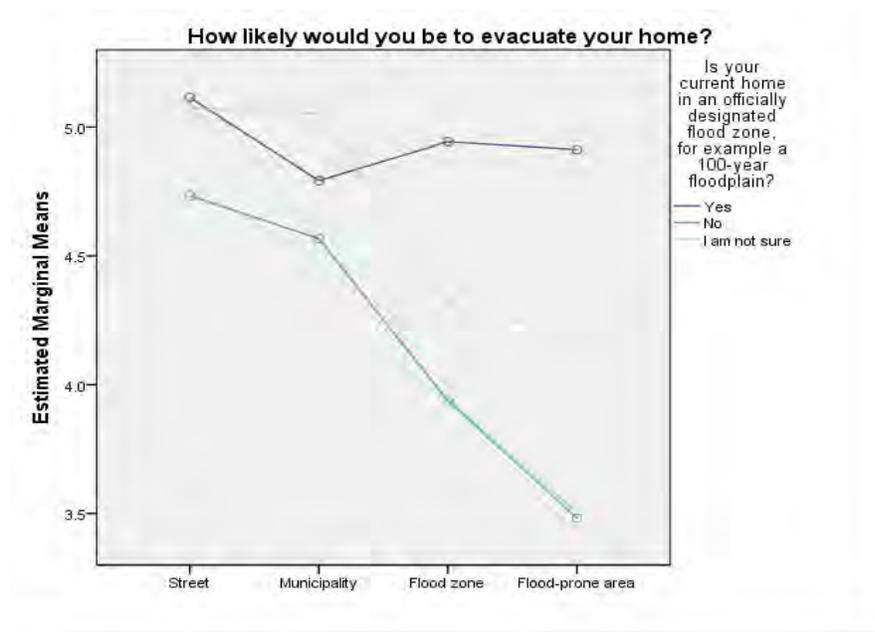
This is important because it demonstrates that using "flood zone" or "flood prone area" can result in more appropriate responses for much of the population, specifically those who know that they are either in or are not in flood zones. (We are waiting for additional data to confirm that those perceptions are in fact correct). However, for those who do not know if they are or not, which is about 1 in 5 respondents, they are significantly less likely to evacuate when they

hear "flood zone" or "flood prone area" messages compared with the other messages, which means that it could be reducing evacuation among those who may need to evacuate.

This speaks to the importance of educating the public about whether or not they live in flood and evacuation zones. New York City is currently engaged in a city-wide outreach effort (http://www.nyc.gov/html/oem/html/get_prepared/know_your_zone/knowyourzone.html), and once we've learned more about the success of that program, it may serve as a model for other municipalities.

Evacuation wording messages

We tested a number of different evacuation wording messages. We know that many EMs do not like to use a "mandatory" order because they feel that they cannot back it up by forcing evacuation, so they often say they are issuing a "voluntary" evacuation order. In addition, we heard a number of other wordings for evacuation that were used to tell people to evacuate. We tested these different messages using the following scenario:

A nor'easter is predicted for NJ. The Highlands Office of Emergency Management has issued a voluntary evacuation order for your area. We expect significant damage from the storm.

Other conditions saw the underline text replaced with one of the following:
- advises residents of your area to evacuate
- has issued an evacuation advisory for your area
- strongly recommends that residents of your area evacuate
- has issued a mandatory evacuation order for your area.

We found that the wording of the evacuation message had a significant effect on evacuation likelihood. Specifically, the "mandatory" wording resulted in significantly higher evacuation intentions than any of the other messages, and that the voluntary wording had significantly worse evacuation intentions than any of the other conditions, see Table 3 below.

Table 3. Effect of evacuation wording on mean evacuation likelihood.

	Mean evacuation likelihood
Mandatory evacuation order	5.11a
Strongly recommends	4.35b
Advises	4.19b

Evacuation advisory	4.16b
Voluntary evacuation order	3.70c

<u>Note</u>. Means with different letter subscripts are significantly different, *p* < .05.

This indicates that to maximize evacuation, an evacuation should be described as "mandatory." Knowing that this is not always possible or desirable for EMs, the clearest advice is for EMs from this component of the study is to avoid using the term "voluntary" when describing evacuations, as that is likely to result in the lowest level of evacuation. "Strongly recommending" and "evacuation advisories" may be the best middle ground.

2. Develop an empirically-tested, relevant, easily accessible, and usable best practices guide to coastal storm communications that is designed for EMs and other stakeholders interested in communicating about coastal storms.

Our team has developed the website www.coastalstormriskcommunication.org (also found at the www.coastalstormriskcommunication.com which redirects people to the .org site). The site organizes our evidence based recommendations for best practices in coastal storm risk communication into the emergency management phases of mitigation, preparation, response and recovery. In addition to recommendations, the site provides links to other resources for emergency managers, and a description of the research literature on which it is based.

This website was developed through work conducted in three phases. First, interviews with EMs about the site, second working with the design company to build the site, and finally, through usability testing of the site with EMs.

Phase 1: Interviews of Emergency Managers
The first step we took to develop this website was to conduct 12 interviews with local EMs. We conducted 3 pilot interviews and then 9 interviews (3 from each of NY, NJ, and CT). Appendix 1 provides the questions we asked of the EMs.

The purpose of these interviews was to investigate:
1) Local EMs' communication practices before, during, and after a storm
2) Identify EMs' beliefs about what are effective communication tactics
3) Identify what questions EMs had about communicating with their public
4) Identify what formats made sense for getting best communication practices to EMs.

Table 4. Characterization of Municipalities represented in interviews

State	
3 pilots in NJ and CT	1 medium city with river flooding in NJ, 1 small wealthy coastal town in NJ, 1 medium size city in CT

3 EM interviews in CT	2 medium diverse coastal cities, 1 high income smaller town
3 EM interviews in NY	2 small coastal towns on Long Island, one coastal town near New York City
3 EM interviews	2 small coastal towns, and 1 larger coastal town

All interviews were recorded and then transcribed. After being transcribed interviews were coded to answer the research questions identified above. Below is a summary of the findings.

What are Local Emergency Managers' Current Risk Communication Practices & Beliefs about their Effectiveness?

EMs use diverse sources of weather information which they report finding useful in making the decisions they need to make.
All EMs feel like they have proper access to weather information though this comes in various forms. All also received information through their county or state offices of emergency management that were pushing out weather forecasts from the National Weather Service. But to find out specifics in their areas or answer questions towns pursued additional sources. Towns that had participated in the "storm ready" program spoke of the call in briefings with local meteorologists via the weather service as being very useful. Others had training in weather forecasts and liked to use the data from the National Weather Service or National Hurricane Service (when appropriate). Others used the regional briefings.

EMs vary in the amount of information they have about their audience.
Towns are very diverse in the information they have on their public and the resources they have to gather information. Small coastal towns often have an advantage because of the size of the population and homogeneity in single family housing. Some towns have made concerted efforts to gather information on their populations. One thing towns did was to conduct campaigns to sign up special needs individuals (often coordinated through social service or medical providers). One town conducted a survey of their neighborhood within the city to identify languages spoken and local community centers. One major challenge to EMs are changes in their audiences that are a result from turnover (in cities) or seasonal/visiting populations (in shore towns).

When evacuating areas, EMs are consistent in telling people that if they choose not to leave, they will not put the lives of first responders at risk to come rescue them. Some EMs are using fear tactics (i.e. next of kin cards, social security number written on arms) to encourage people to leave.
One hundred percent of local EMs used evacuation messaging that emphasized that first responders would not be put at risk to rescue those who chose to ignore the evacuation orders. EMs also unanimously chose not to use the word mandatory because they did not have the intention to go in with police and enforce an evacuation. Local EMs were in less

agreement on whether fear and extreme tactics should be used to try to scare residents into evacuating. In evacuating particularly vulnerable areas (i.e. barrier beaches) EMs go door to door having face to face conversations. At that point, if residents stated they were going to stay behind, EMs often employed "scare tactics" such as filling out next of kin cards or writing their social security numbers on their arms in permanent markers in case of death. Other local EMs avoided these approaches stating that they believed it was extreme and could backfire. These discussions led to the development of our survey components testing fear and guilt based evacuation messaging.

Emergency Managers are increasing their use of social media and need guidance and resources to use it effectively.
For many local EMs Sandy was a learning experience about social media. For example, four local EMs reported not having Facebook accounts previous to Sandy but either setting them up during or after the storm.   Differences exist in local EMs structures in regards to on-line communication. For larger municipalities, the local emergency management (in conjunction with leadership) decide on the message and the public information officers disseminate that message through the range of media (Twitter, Facebook, press releases, radio, tv, etc.) For smaller municipalities the local emergency manager his or herself or a volunteer are often responsible for updating social media accounts. One issue is because of the two way flow of information and potential for disinformation, some local EMs doubt the usefulness of this medium. The infrastructure needed to respond to tweets back or Facebook comments/questions is needed for local EMs to maximize the usefulness of these medium, which is a challenge for smaller municipalities in particular. Our survey has integrated different messaging medium delivery to test whether people respond differently to the same messages delivered by phone, television, or on-line.

What challenges and questions do EMs have for communicating with the public?

Except for a few, EMs give limited thought to the specific wording of warnings.   They did, however, identify several challenges for communicating with the public.

1. EMs knew that checking literacy levels and ensuring a message is easily understandable was important. One EM pointed out that US FEMA documents were written at a 12th grade reading level.
2. EMs knew not to assume public knowledge of certain things. For example, they didn't assume their public knew if they were in a flood plain or not.
3. EMs were faced with challenges of dynamic information that changed throughout the storm. For example, shelters would fill up and so they need to get out the word to people to go to another shelter.
4. EMs were increasingly paying attention to preparation and how to communicate during the post-storm period and recovery.

Specific questions they had were:
- Where does my public get their information? What are they hearing?

- Do fear appeals and tactics work to get people to evacuate? Is the reaction consistent or does it work only once?
- How can we communicate storm surge to the public effectively and clearly so they understand projections?
- Do visual reminders of past storms work to encourage people to evacuate?

What formats work best for emergency managers to learn about best practices in coastal storm risk communication?

There is currently limited training that deals specifically with public risk communication
One area we explored as was looking into what communications training exist and how risk communication could be integrated. The EMs we spoke to all had extensive training. Half had traveled to Emmitsburg, MD for Emergency Management Institute training. More had received training through state offices of emergency management or local/state emergency manager associations. Many utilized both in person and on-line trainings. When asked if they had received training on communications most had (9 out of 12). The training most often related to how they communicated with the media in emergencies and was a 1-2 hour component integrated into a day or two day long training. From this part of the interviews we got confirmation that our EMs would benefits with further training on risk communication with the public and proposed a training session for the New Jersey EMs training program along with informing the development of our website.

On-line formats are useful for the majority of emergency managers
Most EMs we interviewed were tech savvy and fairly computer proficient. Approximately ¾ had smartphones and used them regularly. All indicated that an on-line web resource would be useful. Some suggested a printable guide would also be useful to have on site. Some indicated that a check-list of communication procedures and templates they could fill in would also be useful.

Phase 2: Build the website.

After the interviews, we searched the academic literature and compiled the relevant research on risk communication and coastal storms. Where there was research on coastal storms and evacuation specifically, we used that literature. In cases where coastal storms had not been studied specifically we drew from broader risk communication principles in the fields of health or environmental risks. We also pull from other CSAP research.

We used the qualitative interviews with EMs, the background literature, and the existing literature to build the website--coastalstormriskcommunication.org.

The website provides empirically based guidance about communicating with the public using the rubric of the four phases of emergency management: mitigation, preparation, response, and recovery.

Phase 3: Usability testing on the website.

So far, we have conducted four usability studies to find out how useful the website was for EMs.   We asked EMs to conduct a few simple tasks we would like the website to be useful for such as constructing a risk message for a hypothetical storm or finding information about putting together a communications plan. The usability interview guide is attached as Appendix 3.

The usability interviews gave us important feedback on the website. There were four key findings and actions taken to improve the website.

Finding 1: The EMs did not easily find the information about generating messages that help their public understand and take appropriate action in the face of an impending storm. This information was in the "response" section of the webpage. The EMs would firstlook under preparation rather than response.   They also would have no idea what "generating understanding" and "motivating response" meant as headings that dropped down under response since they were not thinking of messages there.

Action 1: We kept the information in the response section since it is something that EMs are doing in the face of a storm, but we changed the drop down to read "writing messages to create understanding" and "writing messages to motivate action".

Finding 2: The EMs were comfortable with the general set-up saying things like "it looks like a FEMA website" or "yeah - I know these points." They tended to miss the COMMUNICATIONS focus. In general their mental model is that communications is a very small part of what they do and it's rare that they are focused on it in general.

Action 2: Text was changed on the front page and all introductory sections to emphasize communications in all cover titles.

Finding 3: Under supplementary resources EMs expect to see additional links to sites with more information - weather updates, templates for filling in communications, checklists, EM information, further training, etc. They are not looking for the scientific evidence for the recommendations (which is what was currently provided).

Action 3: Under the additional resources tab at top, a "recommended links" page was added that aggregated other links and tools identified throughout all pages, while other additional ones were added. The "science behind recommendations" was maintained as a drop-down option.

Finding 4: Some EMs used in this round of usability studies were coastal, but not flood prone people (i.e. Fort Lee). This raised the point that the site tends to focus almost exclusively on evacuation around actions. There is the more preparatory messaging (i.e.

batteries and radios) around sheltering in place or state of emergency/stay of the road messaging as well.

Action 4: Integrated more examples reflecting other types of understandings or actions EMs might want their public to take in facing a coastal storm.

3. Disseminate results widely, ensuring that we maximize the number of EMs who are aware of, and use these best practices in coastal storm risk communication.

We have presented the website at the New Jersey Emergency Management Association meeting. As we finalize the website through our final rounds of usability interviews, we will begin disseminating more broadly.

4. Increase the likelihood that residents and visitors will take appropriate protective action during coastal storms.

We hope that through the use of this newly created website, the effectiveness of the messages the public receives will increase, thereby increasing the likelihood of appropriate and recommended actions.

C. COLLABORATORS, PARTNERS, and INTERACTIONS: *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*
On one of the scenarios in the Internet based survey, we are working in close collaboration with Julie Demuth and Rebecca Morss at the Center for Atmospheric Research in Boulder, CO.

D. PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers:

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.:

Coastalstormriskcommunication.org

Technical Reports / Other Publications:

Other Products (including popular articles):

Planned Publications:

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

Cuite, C.L., Shwom, R.L., & Robinson, D. (May 7, 2015). Best Practices in Coastal Storm Risk Communication. Presented to the New Jersey Emergency Management Annual Conference, Atlantic City, NJ.

Toke, A. & Cuite, C.L. (April 24, 2015). Using Social Media to Analyze Public Perceptions of Risk Communications Practices. Poster presented to the Aresty Undergraduate Research Symposium, New Brunswick, NJ.

E.   **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

PI Cuite was invited to spend one week at the National Center for Atmospheric Research to collaboratively analyze some of the Internet survey data, work on publications together, and consider future collaborative funding opportunities.

F.   **STUDENTS:** *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "**New**" students are those who **have not** worked on this project previously. "**Continuing**" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

Total number of **new** K-12 students:
Total number of **new** undergraduates:
Total number of **new** Masters degree candidates:
Total number of **new** Ph.D. candidates:

Total number of **continuing** K-12 students:
Total number of **continuing** undergraduates: 1
Total number of **continuing** Masters degree candidates:
Total number of **continuing** Ph.D. candidates:

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name:
Degree Sought:
Thesis or Dissertation Title:
Date of thesis completion:

Expected date of graduation:

G. **VOLUNTEER HOURS:**
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.)*

I have attached a photograph of Alexander Toke, an undergraduate student presenting a research poster at an undergraduate poster session.

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.)*
Specify:
a) Name of person or group receiving recognition:
b) Name of award or honor:
c) Group or individual bestowing the award or honor:
d) What it was for:
e) Date:

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*
Communicating about coastal storms is difficult, and we know that often the public does not follow the advice of professionals. We wanted to identify important message variables that could increase the likelihood of the public responding appropriately to coastal storm messages, and communicate them to EMs in a manner that will facilitate their use.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

- **We interviewed EMs to determine their understanding of coastal storm risk communication, to gather examples of messages and channels that they had used, and to determine how to best create a resource that will have maximum reach and impact.**

- **We conducted an Internet-based survey to test the effectiveness of coastal storm risk message variables.**
- **We created a website designed to provide empirically-based coastal storm communications guidance for EMs.**

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

We have developed a new Internet-based tool for EM, located at coastalstormriskcommunication.org. This tool allows EMs to better understand the role of EMs in communicating with the public, as well as how to create the most effective messages.

We hope that as we continue to do outreach on the website, in collaboration with Sea Grant, that we will have an impact on EM coastal storm communications.

Consider the following as they apply to your research and any related outreach/education.

· What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?

· What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?

· What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?

· What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

In an effort to understand how to improve public response to coastal storm risk communications, researchers engaged in a range of activities that culminated in a website designed for emergency managers (EMs). First, in interviews with EMs, who are frequently on the front lines of communicating with the public about coastal storms, researchers sought to understand the communications topics EMs would like to see addressed in the website, and their specific needs

and questions about how to best communicate with the public. We then conducted an Internet-based survey to test messages of the sort that EMs often use. Among a large number of message variables tested, some findings stand out. Researchers found that using the word "voluntary" in evacuation notices may result in less evacuation than other similar messages. While "mandatory" is most effective, it is not always feasible, however, using "evacuation advisories" is more effective than saying "voluntary." In addition, while localizing evacuation messages to town level has been shown to be important, we found that drilling down to street level notices may not significantly improve evacuation rates. Targeting "flood-prone areas" and "flood zones" helps to motivate those who believe they live in flood zones to evacuate, and could reduce shadow evacuation among those who do not, but risks leaving behind the sizable proportion of the population who are not sure if they live in a flood zone. The findings of this study, as well as the existing risk communication literature were compiled into a website that provides coastal storm risk communications guidance, coastalstormriskcommunication.org, and outreach to alert EMs about this resource continues.

CSAP Final Progress Report Form

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Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Rachel Hogan Carr

Date of Report submission: 5/30/15

Project #: R/CSAP-2-NJ

Dates of the project: From [1/2/2014]   to   [6/1/2015].

Project Title: "They had the facts: Why didn't they act? Understanding and improving public response to NWS coastal flooding forecasts;'"

Principal Investigator(s) and Affiliation(s):

1. Rachel Hogan Carr, Director, Nurture Nature Center

2. Dr. Burrell Covey Montz, East Carolina University

A. PROJECT GOALS AND OBJECTIVES:
Objectives:

1. To identify which products and sources of information coastal residential and emergency management audiences are currently using to understand, assess and make decisions about their coastal flood risk; and to delineate the network of information sources as an event approaches.

2. To document the challenges public and emergency management audiences face in navigating and understanding the forecast (i.e., suite of multi-media coastal flood tools) during a coastal flood scenario; and to assess the relative importance of forecast sources over time as an event proceeds.

3. To understand a) whether and how the introduction of an emergency management briefing package influences understanding and motivation to evacuate or take protective actions during a coastal flood scenario; b) how this influence differs between audiences; c) to document the influence of briefings on understanding uncertainty; and d) the situations in which such products are most helpful.

4. To share these findings, as well as offer best practice recommendations on the use of briefings, with a broad audience of NOAA, National Weather Service and weather enterprise professionals.

B. **RESULTS: (***Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*

For this project, Nurture Nature Center conducted two rounds of focus groups and surveys with residents and emergency managers in Ocean and Monmouth Counties in New Jersey, and additionally completed several interviews with broadcast meteorologists in the coastal New Jersey region. These focus groups, surveys and interviews focused on the ways in which these audiences used and responded to NWS coastal flood forecast products, with a particular focus on the emergency briefings issued by NWS Weather Forecast Offices (WFO) during coastal storm events. NNC used the feedback from these audiences to redesign a number of the coastal flood forecast and warning products being studied through the project, and to make a series of recommendations for best practices related to the use of emergency briefings. Partners on the project included East Carolina University (Dr. Burrell Montz and Stephanie Hoekstra), Jacques Cousteau National Estuarine Research Reserve (Lisa Auermuller) and RMC Research Corporation (Dr. Susan Frankel and Elizabeth Goldman).

NNC has completed a final study report that is available on the website socialscience.focusonfloods.org/reports-and-findings/. A final project video was filmed with commentary from Michael Oppegaard (Emergency Management Coordinator for Monmouth County, NJ), Gary Szatkowski (Meteorologist-in-Charge, NWS Mt. Holly, NJ), Rachel Hogan Carr (Director, NNC) and Keri Maxfield (Art Director, NNC) and is available on the website coastal.focusonfloods.org. In addition, a short one-page findings fact sheet was created and disseminated to partners and other interested organizations (see Appendix A).

Findings from the study answer the first three objectives in detail. Specifically, the study details which sources of information the participants preferred, and finds that Internet and television are primary sources of information for residential audiences. Additionally, the study looks in detail at the timing at which they would use specific products, finding that day T-5 (five days prior to storm landfall) is the most preferred date for most products.   The study also identifies a series of challenges associated with understanding various NWS coastal flood forecast and warning products, including difficulty understanding terminology, unclear graphic design and other visual challenges. The report makes recommendations for revising the graphical and text elements of various coastal products, including the extratropical surge graphic, surface

prognosis maps, coastal flood watches and warnings, and wind speed and direction maps. Revisions are designed to make these products easier to understand and more likely to motivate residents to take protective actions during coastal storm events. Additionally, the report details participant response to the emergency briefings, and suggests that emergency briefings issued by WFOs are highly valuable tools for emergency managers, residents and broadcast meteorologists. These groups, which have different needs and purposes in using the briefings, all favor the briefings because they consolidate and simply the process of finding information and provide a chance for forecasters to prioritize risk and convey tone in warnings. The report details recommendations for best practices for emergency briefings (including recommendations for keeping briefings as short as possible with an emphasis on action steps rather than meteorological detail, and a recommendation to reserve briefings for very high-impact events).

The fourth objective of this study addresses dissemination of findings. In addition to issuing the final study report online, NNC presented about this project in several venues, including the Pennsylvania Floodplain Managers Association Annual Meeting in September 2014, the New Jersey Floodplain Managers conference in October 2014, the American Meteorological Society Annual Meeting in January 2015, the New Jersey Emergency Preparedness Association Annual Meeting in May 2015, the North Carolina Hurricane Conference in May 2015 and the National Weather Service Hydrology Program Managers Conference in May 2015. Several webinars and presentations are scheduled in the near future to further disseminate these findings in coordination with NWS partners as well as project team partners, including a webinar to the Silver Jackets during July 2015. Additionally, a short article for the Silver Jackets Buzz newsletter was submitted for the Summer 2015 issue. A longer journal article (currently in preparation) is planned for submission to the peer-reviewed journal Environmental Hazards.

East Carolina University has coordinated compliance with NNC's submitted data management plan.

C. **COLLABORATORS, PARTNERS, and INTERACTIONS:** *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

NJ Sea Grant Consortium's Peter Rowe and Matt McGrath observed the second round of focus groups in Brick, NJ and were helpful in announcing focus group sessions via social media to help recruit participants.

NOAA/NWS partners: During the project, NNC research team worked with Gary Szatkowski, of the National Weather Service Weather Forecast Office in Mt. Holly, NJ. Szatkowski provided guidance and technical assistance related to the NWS coastal products. NNC has also worked with NWS partners at the Middle Atlantic River Forecast Center, who have been helpful in coordinating dissemination of project findings to NWS offices and audiences.   Following a presentation in May to the NWS Hydrology Program Managers in

Tuscaloosa, Alabama, in which this study was referenced, PI Rachel Hogan Carr discussed the project and its findings with staff at various NOAA offices, including National Ocean Service.

Regional audiences: Monmouth County Emergency Management Coordinator Michael Oppegaard assisted in footage and commentary for the project opening video as well as the closing video, now posted at coastal.focusonfloods.org.

In addition to providing substantive insights into the findings and the audiences that use coastal products in NJ, Lisa Auermuller of JCNERR was helpful in identifying study areas during proposal development, identifying location for focus groups, and in connecting with local community resources and organizations for recruitment of participants.

D. **PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS**: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers:

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.: www.coastal.focusonfloods.org

Technical Reports / Other Publications: Final Project Report - http://socialscience.focusonfloods.org/wp-content/uploads/2015/05/CSAPReportFinal.pdf

Other Products (including popular articles):

Planned Publications: We are developing a paper that will be submitted for peer review, and are considering submission to the Environmental Hazards journal.

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

● Pennsylvania Floodplain Managers Association, Annual Meeting, September 30, 2014. "From Risk to Resiliency: Insights into Flood Messaging." Presented by Rachel Hogan Carr.

● New Jersey Association of Floodplain Managers, Annual Conference, October 16, 2014, Atlantic City, NJ. "They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts." Presented by Rachel Hogan Carr with co-presenter Gary Szatkowski, Meteorologist-in-Charge of the National Weather Service Weather Forecast Office in Mt. Holly, NJ/Philadelphia PA.

● American Meteorological Society, Annual Meeting, January 4-8, 2015 in Phoenix, AZ. Attached please find Appendix B, a copy of a .jpg image of a poster that was presented by NNC Science Director Dr. Kathryn Semmens and East Carolina University research student Stephanie Hoekstra during this conference.

● New Jersey Emergency Preparedness Association Annual Meeting, Atlantic City, NJ. May 8, 2015. "They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts." Presented by Rachel Hogan Carr.

● Poster presented at the NJ Sea Grant Consortium Site Review. May 13, 2015. "They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts." Presented by Dr. Kathryn Semmens.

● National Weather Service National Hydrology Program Managers Conference, May 13, 2015, Tuscaloosa, Alabama. "Flood Risk and Uncertainty: Assessing National Weather Service's Flood Forecast and Warning Tools." Presented by Rachel Hogan Carr.

● North Carolina Hurricane Workshop, May 27, 2015.   "They Had the Facts, Why Didn't They Act? Understanding and Improving Public Response to National Weather Service's Coastal Flood Forecasts." Presented by Dr. Burrell Montz.

E. **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

F. **STUDENTS:** *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "**New**" students are those who **have not** worked on this project previously. "**Continuing**" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

Total number of **new** K-12 students:
Total number of **new** undergraduates:
Total number of **new** Masters degree candidates:
Total number of **new** Ph.D. candidates:

Total number of **continuing** K-12 students:
Total number of **continuing** undergraduates:
Total number of **continuing** Masters degree candidates:
Total number of **continuing** Ph.D. candidates: 1

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name: Stephanie Hoekstra
Degree Sought: PhD in Coastal Resources Management, East Carolina University
Thesis or Dissertation Title: To order an evacuation or not: influences on official decision making during Superstorm Sandy
Date of thesis completion: December 2015
Expected date of graduation: December 2015

G. VOLUNTEER HOURS:
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?) N/A.

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.*)

Please note that due to IRB constraints, we are unable to provide photos of the events or participants, in order to protect the participants' anonymity.

Attached please find Appendix C for graphic images of product revisions suggested by NNC as part of the findings of this study.

Website links: coastal.focusonfloods.org and socialscience.focusonfloods.org/reports-and-findings

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.*)
Specify:
   a) Name of person or group receiving recognition:
   b) Name of award or honor:
   c) Group or individual bestowing the award or honor:
   d) What it was for:
   e) Date:

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

National Weather Service offers a suite of flood forecast and warning tools that provide timely and accurate forecast information during coastal flood events. Despite these products and warnings, many residents do not understand or respond appropriately to warnings and incur significant losses due to extreme weather events and flooding. Specifically, during Sandy, forecasts were highly accurate - yet many residential audiences failed to respond sufficiently to protect their lives and properties.

In 2012, Nurture Nature Center was awarded a grant from NOAA's Office of Oceanic and Atmospheric Research to study how public audiences use and respond to NWS riverine flood forecast tools, and made a series of recommendations for improving these products. Following that project NNC and project partners identified that NWS coastal flood forecast products similarly needed to be understood in the context of how public audiences use, understand and respond to them. NNC proposed this study in order to help NWS understand how to improve its communication during acute coastal flood events, and specifically, to understand the ways in which emergency briefings can help communicate multiple risks from coastal storms. Briefings were identified as a critical component of this study after they emerged as an important public information tool during Superstorm Sandy. Briefings have historically been reserved as communication tools for emergency and municipal personnel, and this study examined their utility for public audiences as well as emergency managers.

In summary, NNC sought answers to two questions: 1) how does the public navigate and translate the forecast for coastal flooding as it is presented through multiple products, sources, and channels, and 2) what is the potential of an emerging public warning tool - the emergency management briefing package - for improving understanding of and response to this array of coastal flood products and messages?

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

To answer these questions, NNC conducted a series of five focus groups and surveys with residential audiences in flood-affected areas in Ocean and Monmouth Counties in New Jersey (for four focus groups) and emergency managers from the same counties (for one focus group). Focus group registration was strong and effective at reaching the target audience of residents and emergency managers affected by coastal flooding.

During the first round of focus groups, (which included two residential focus groups and one emergency personnel-only group) participants spent two hours with the research team responding to a 7-day storm scenario based on Superstorm Sandy. Dr. Burrell Montz led the audiences in looking at a series of National Weather Service coastal flood forecast and warning products and facilitated a discussion about the ways in which the audience understood and used the products. At the end of the scenario, the research team introduced two separate emergency briefings, and facilitated an intensive discussion with participants about how they have used or might use the briefings in future storm events.   Participants in all three sessions

were highly engaged and gave specific and detailed feedback about ways to improve the series of products they reviewed, which included:

- National Hurricane Center Tropical Storm Cone
- Weather Prediction Center Surface Prognosis Map
- Quantitative Precipitation Forecasts
- Wind Speed/Gust Maps
- Temperature Maps
- NWS WFO Emergency Briefing Packages
- Extratropical Surge Forecast
- Coastal flood watches and warnings

All sessions were audio-recorded and transcribed. Participants also completed pre- and post-surveys providing more specific demographic and personal experience information, as well as more specific feedback about the products, including recommendations for improvement.

During the late spring and summer months, the research team analyzed the findings and prepared a series of revised products, including revamping the emergency briefing packages to reflect the recommendations of both resident and emergency manager feedback. Changes to the products included revised and expanded legends, re-labeling and titling of products, revised graphic presentation, and changes in word choice, text content and ratio of text to graphics. Emergency briefings specifically were revamped to re-order information, reduce text and briefing length, to include an emphasis on action steps and to simplify language.

In November 2015, Nurture Nature Center hosted its second round of focus groups. Again in Round 2, Dr. Montz facilitated a two-hour dialogue with each group to review how the audiences use and understand the various coastal products. In this round, the emergency briefings were presented throughout the 7-day scenario (at days T-6, T-4 and T-1 specifically) as they normally would be by NWS. Again, participants completed pre- and post-surveys, and focus group discussions were audio recorded and transcribed.

For all sessions, survey data was analyzed using SPSS software, and open-ended survey questions were hand coded. Content analysis of the focus group discourse was completed in NVivo software.

After the second round of focus groups, the research team analyzed the results and identified key findings that answer the first three objectives of the project. Additionally, throughout the period, the research team interviewed broadcast meteorologists to gather their perspectives on the use of emergency briefings. These interviews were rich and helpful in understanding how broadcasters incorporate the briefings into their forecast processes and also provided additional perspective on how items such as the forecasters' tone can be communicated through the briefings. To further understand how the NWS Weather Forecast Offices are using briefings, the research team routinely reviewed active emergency briefings issued during the course of the project.

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

Consider the following as they apply to your research and any related outreach/education.

The results of Nurture Nature Center's study revealed much about the ways that coastal residents in Ocean and Monmouth Counties in New Jersey navigate through various channels of information as a coastal storm approaches. The findings suggest that in addition to turning to internet and television for information, residents relied heavily on information shared from friends, family and neighbors when deciding how to respond. Highly local, geographic-specific information was more motivational than regional forecast information. Residents reported that NWS coastal products would be most valuable five days prior to a storm, while emergency managers hope to receive the information as many as seven days in advance, or more, whenever possible. Residential and emergency management participants gave very helpful suggestions for improving the clarity of various NWS coastal flood products, and the study identified many areas in which the design and language used in products presented barriers to the public's understanding and motivation to take action.

NNC's complete study (found at socialscience.focusonfloods.org/reports-and-findings and appended here as Appendix A) contains an extensive number of tables and figures that quantify the specific responses to these questions. Additionally, the report shows and describes detailed changes to each of the products under study. Included here is a sample of a product revision suggested by Nurture Nature Center. This product, the Extratropical Surge Forecast product, shows observed and forecast water levels in an extratropical context. Participants found this product to be very difficult to interpret, and NNC made a series of design revisions that appeared effective in helping residents to better understand the graphic.

Existing NWS Extratropical Surge Forecast Product:
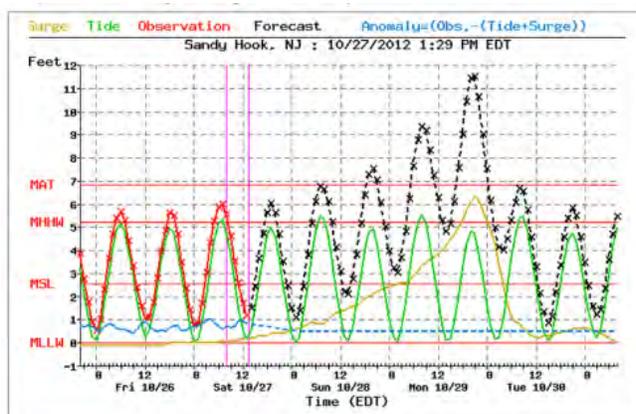
Revised Extratropical Surge Forecast product:
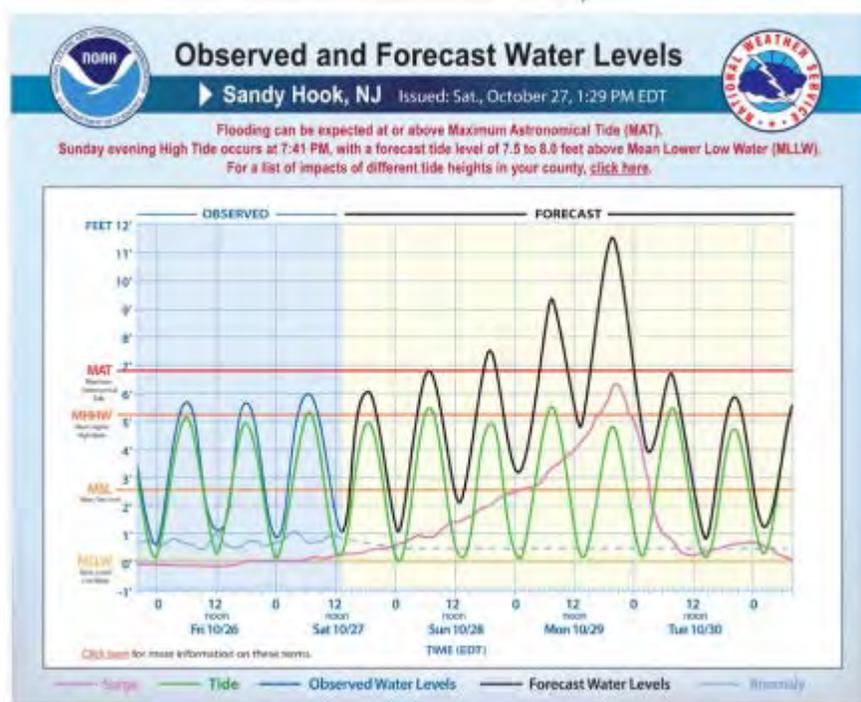
This revision makes a number of design changes, including re-titling the product, adding a summary text statement at the top in red, and a redesign of the product information presentation that more clearly distinguishes between observed and forecast levels. In this product as with the other redesigns, clearer legends with more detailed explanations are provided to assist users in understanding information.

In addition to these product-specific findings, the final study report makes another important finding. Specifically, the focus group discussions, surveys and interviews suggest that emergency briefings are a valuable tool for presenting this complex coastal storm information to public audiences, emergency managers and broadcast meteorologists. Though these audiences have distinct needs for information, they converge in identifying the briefings as a simplified mechanism for receiving information. All three audiences acknowledged that the ability of forecasters to present a tone of urgency through the briefings is helpful in motivating action: for instance, the use of a "personal plea" for action during Sandy was cited as highly motivational.   As with the other products, NNC's research team provided design recommendations to improve the clarity and usability of these briefings for public audiences in particular.   Among other changes, the redesigns emphasized shortening the length of the briefings, summarizing action information about steps to take right up front, and using color within the text to draw attention to key concepts.

NNC's findings from this study build upon and support findings from its previous study, "Flood Risk and Uncertainty: Assessing the National Weather Service's Flood Forecast and Warning

Tools." Together, these studies suggest that scenario-based focus groups, and focusing discussion on recommendations for improving products, can be a helpful way to provide meaningful feedback about how public audiences use NWS products to respond to flood warning messages.

· *What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?*

Nurture Nature Center has proposed revisions to a number of NWS coastal flood forecast products. Specifically, NNC has made graphical revisions to the extratropical surge product, the wind speed and direction map, surface prognosis maps and coastal flood watches and warnings. Additionally, NNC has proposed revisions and recommendations for the design, use and delivery of emergency briefings issued by NWS WFOs.

These recommendations have been shared with our NWS project partners. Additionally, Gary Szatkowski has presented a summary of the findings to a meeting of the Meteorologists-in-Charge in the NWS Eastern Region. It is anticipated that these product revisions will be studied by NWS offices and considered for implementation. Many of the recommendations for briefings can be adopted without a formal change process being initiated by NWS, as the content of these briefings are within the discretion of the WFO staff directly.

· *What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?* N/A.

· *What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?*

Understanding what motivates pubic action in the face of a coastal storm is tremendously important in tailoring effective communication. Actionable recommendations and feasible, implementable graphic changes to address communication barriers are key outcomes of the study which can help the NWS, emergency managers, state emergency organizations, and other agencies improve how they communicate their data and forecasts to the public.

The results of this study will assist these entities in understanding practical changes they can make to their communication in order to create products and messages that are easily understood and likely to motivate action. Recommendations by NNC for NWS' riverine forecast products are now being considered for operationalization, and the recommendations from this study have similarly been designed for quick and easy adaptation. Design recommendations have been made to work within current operations to the extent possible.

Though the particular product recommendations are intended for use by NWS, the findings about the channels by which public audiences seek and respond to information are important

for all levels of government and emergency response. One of the findings of the study suggests that while NOAA data is the trusted source for information, residents expect and want to receive information from their local emergency management or municipal offices. As such, this study offers considerations for local emergency personnel about how they communicate with the public, and which tools they use in doing so.

Further, this study includes a recommendation that the scenario-based approach be considered for use in education and outreach about extreme weather. Though the focus groups in this instance were designed for gathering insights, they had the consequence of offering tremendous information, education and practical assistance to coastal residents, who were exposed to new tools and helped to understand how they could assist them during future storm events. Participant feedback suggests that residential participants strongly valued the sessions as helpful and informative.

· What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?

Economic impacts from coastal storms are enormous. After the storm, estimates for financial losses in New Jersey alone from Superstorm Sandy came in at more than $30 billion. Helping NWS and emergency managers to improve their coastal flood forecast and warning communication is critical to helping residents identify their risks and take action to reduce losses in future storms.

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

National Weather Service's suite of coastal flood forecast and warning products are a critical source of information for residents in determining their flood risk and which actions to take to prevent loss of life and property. To assess how coastal residents understand and interpret NWS coastal flood products, and the best mechanism for delivery, Nurture Nature Center, together with East Carolina University, Jacques Cousteau National Estuarine Research Reserve, and RMC Research, conducted a social science research study to investigate how the public responds to and interprets the NWS's coastal flood and storm surge forecast and warning products and tools. The study involved a series of focus groups, surveys, and interviews that drew feedback from coastal community residents (Ocean and Monmouth Counties in New Jersey), emergency personnel and broadcast meteorologists about the ways in which they use these products. Participants in focus groups were exposed to a seven day Superstorm Sandy scenario illustrated with NWS products, focusing in particular on the use of emergency briefing packages. Modified versions of the products were shown in a second round of focus groups and surveys to test improvements for clarity and to examine factors in how framing and conveying extreme weather messages can facilitate public understanding and motivate action. Participants gave feedback about how the

timing, the verbal and graphic clarity of the information conveyed, and the inclusion of uncertainty information affected their understanding of and response to the storm (actual or anticipated).

Findings support the use of emergency briefing packages as a preferred method for disseminating storm and flood risk information. However, necessary changes to improve visual clarity, provide more succinct information, and localize messages must be employed for risk communication to be effective. The study offers specific design recommendations to NWS coastal flood forecast products, as well as best practice recommendations for the use of briefings. Results also provide detailed analysis of the sources that participants rely upon for receiving and sharing information, as well as the timing they prefer for receiving information. Findings suggest that NOAA is an authoritative source of weather information, but also that residents expect and want to receive weather warnings from local municipal and emergency management audiences. Further, while residents prefer storm information five to four days prior to storm landfall date, Emergency Managers preferred information seven days prior to have time to reach out into the community.

Specific product design recommendations from this study are intended to be easily implemented by NWS to improve public response to its products. Study results also provide recommendations and findings that will be of benefit to the emergency management community, and which will improve risk communication and community resiliency in the face of coastal storm threats.

APPENDIX A

One-page Fact Sheet

FACT SHEET: They Had The Facts, Why Didn't They Act?: Understanding and Improving Public Response to NWS Coastal Flood Forecasts

OVERVIEW

In 2014, Nurture Nature Center, together with East Carolina University, Jacques Cousteau National Estuarine Research Reserve, and RMC Research Corporation, conducted a social science research study to investigate how the public responds to and interprets the National Weather Service (NWS)'s coastal flood and storm surge forecast and warning products and tools. The study involved a series of focus groups, surveys, and interviews that drew feedback from coastal community residents (Ocean and Monmouth Counties), emergency personnel and broadcast meteorologists by leading them through a seven day Superstorm Sandy scenario illustrated with NWS products, focusing in particular on the use of emergency briefing packages. Modified versions of the products were shown in a second round of focus groups and surveys to test improvements for clarity and to examine factors in how framing and conveying extreme weather messages can facilitate public understanding and motivate action.

Examples of revised versions of NWS flood forecast products used in the study.
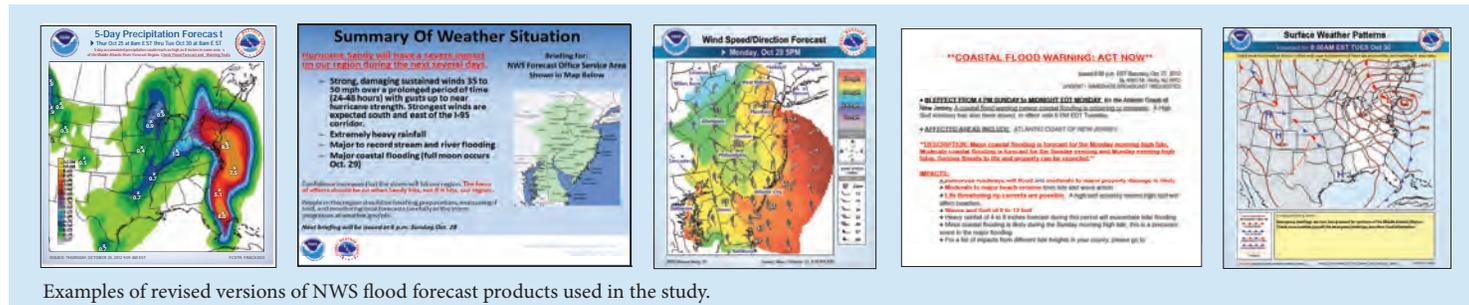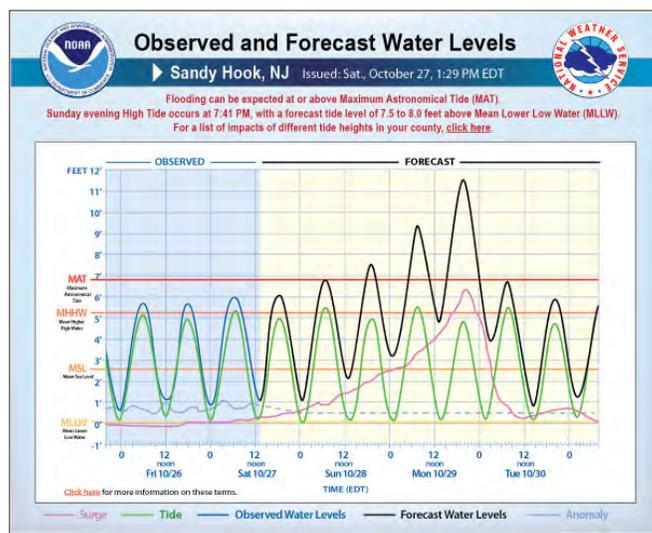
FINDINGS

Participants gave feedback about how the timing, the verbal and graphic clarity of the information conveyed, and the inclusion of uncertainty information affected their understanding of and response to the storm (actual or anticipated). Residents of coastal flood-prone communities in New Jersey rely on NWS forecast and warning products and tools as part of a suite of resources they use to evaluate their flood risk, including deliberations with friends, family, and neighbors, personal experience, contacts from local officials; and weather reports from mass media as well as social media.

Timing – Residents prefer NWS products and tools 5 days prior to the storm: when farther away, the threat is not viewed as imminent, and when too close to the event, preparations and evacuations are already underway (though residents do continue to seek information as a storm approaches). Emergency personnel prefer information and briefings 7 days prior to the storm (or longer if possible) in order to have adequate time to prepare and inform others.

Delivery – Residents expect and want local municipal officials and emergency managers to deliver NWS information and directions on storm details and how to prepare. Residents and emergency personnel prefer the internet as an information source, and frequently depend on smartphones when utilities are disrupted.

Geographic Specificity – Residents prefer and are more motivated to take protective action when provided with locally specific information. Seeing their specific community, not just region, called out in forecasts significantly draws attention.

Graphics – Overly technical and confusing visual products are a major barrier to understanding NWS coastal forecasts. Participants preferred a mixture of graphics and text, easy to interpret color schemes and legends, and direct statements about actions they should take; suggested product revisions address these concerns. Visual evidence of past storm impacts, and comparison to past storms, provide context for residents and motivate action.

Briefing Packages – Residents, emergency personnel, and broadcast meteorologists valued briefing packages as an important, integrated, and simplified mechanism for receiving coastal storm information. Residents stressed the need for brief information focused on local risk and actions to take, with detailed meteorological details reserved for emergency personnel. The inclusion of a personal and emotional appeal in briefings was highly effective in motivating action.

Please refer to NNC's final report at socialscience.focusonfloods.org for more detailed findings and recommendations.

NURTURE NATURE CENTER
518 Northampton Street, Easton, PA 18042
610.253.4432
www.nurturenaturecenter.org

APPENDIX B

Poster for presentation at American Meteorological Society Annual Meeting

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Burrell Montz[1], Rachel Hogan Carr[2], Keri Maxfield[2], Stephanie Hoekstra[1,], Kathryn Semmens[2,*]
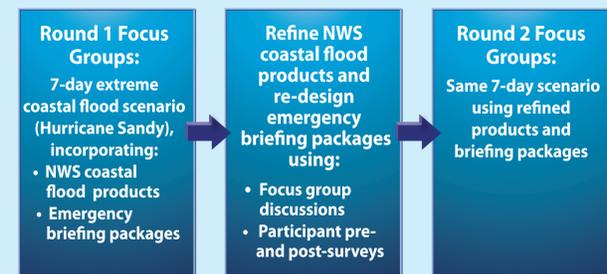
[1]East Carolina University, Greenville, NC; [2]Nurture Nature Center, Easton, PA; *Presenter

Introduction

In the face of an incoming high risk storm, it is not enough to have an accurate forecast; it is also necessary to have effective communication of that risk to motivate public action and reduce losses. Through focus groups and surveys with emergency managers and residents in Ocean and Monmouth Counties, New Jersey, use of and responses to National Weather Service (NWS) coastal flood forecast products were evaluated as were how these tools can be improved to better motivate people to take protective actions. Specifically, the study examined the emerging use of the emergency briefing package as a public risk communication tool. The current study will result in recommendations for revisions to NWS coastal flood products, and particularly, recommendations for the best use of emergency briefing packages.

Methods

Total of 5 focus group sessions (2 rounds of 2 residential groups and 1 emergency manager group). Interviews with broadcast meteorologists helped to identify their current and potential use of briefing packages.

Round 1 Focus Groups:
7-day extreme coastal flood scenario (Hurricane Sandy), incorporating:
- NWS coastal flood products
- Emergency briefing packages

Refine NWS coastal flood products and re-design emergency briefing packages using:
- Focus group discussions
- Participant pre- and post-surveys

Round 2 Focus Groups:
Same 7-day scenario using refined products and briefing packages

Products Tested

- Mt. Holly, NJ WFO Briefing Package
- National Hurricane Center Tropical Storm Cone
- Weather Prediction Center Surface Prognosis Map
- NWS Precipitation Forecast Map
- WFO Wind Speed/Gust Forecast Map
- NWS Temperature Map
- Local Weather Office Extratropical Surge Forecast
- NWS Coastal Flood Watch/Warning
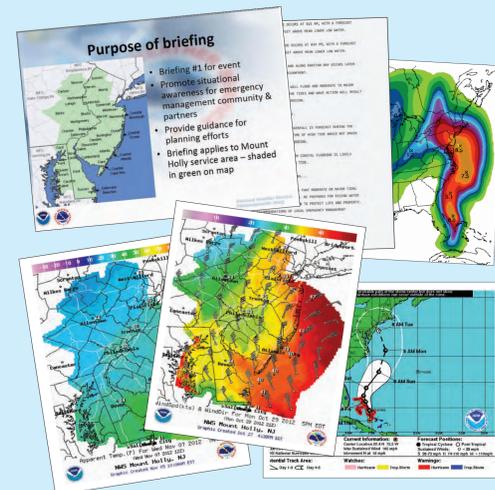
Surface Prognosis Map
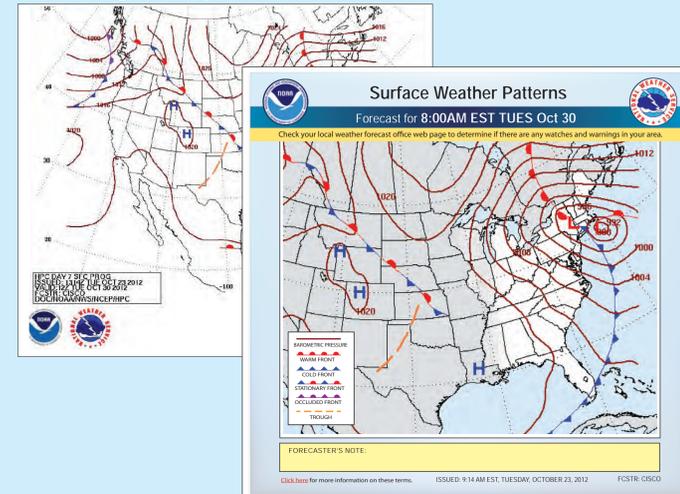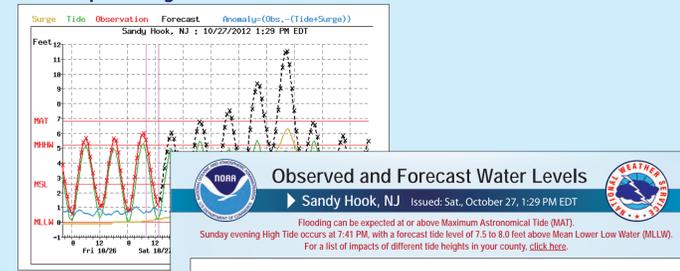
Extratropical Surge Forecast
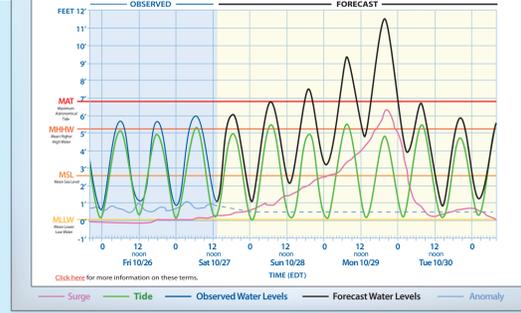
Questions Asked

- Current use of the tools
- Other tools used during Sandy to assess their risk
- How they receive and share information
- How they interpret and understand the products
- How information in warning messages influences understanding
- How these various factors influence motivation to prepare

Selected Findings and Recommendations

Emergency Managers
- Almost all rated their community flood risk as extremely high
- Most preferred an equal mix of text and graphics in NWS products
- All products were valuable and most likely to be used on day T-7
- Accuracy and local use were key characteristics motivating use of a product

Residents
- Most had personal experience with coastal flooding damage/ evacuation
- 3/4 rated their flooding risk as somewhat to very high
- Most got information through the internet and valued having a smartphone app
- Most anticipated use of products on day T-5, suggesting this is the optimal day for NWS to distribute tools widely
- Recommendations include attention to geographic locality, careful use of color and formatting, and clear action statements
- Wanted a road closure/detour product

Briefing Package
- Highly valued by residents and EMs
- Reducing text, highlighting key take-away messages and action steps, and improving understandability of graphics enhanced effectiveness
- Including a personal plea significantly increased residents' motivation to take action

Partners

APPENDIX C

NWS Coastal Flood Forecast and Warning product revisions by NNC

Surface Prognosis Map

HPC DAY 5 SFC PROG
ISSUED: 1314Z TUE OCT 23 2012
VALID:12Z SUN OCT 28 2012
FCSTR: CISCO
DOC/NOAA/NWS/NCEP/HPC

REVISED - Surface Weather Patterns

Surface Weather Patterns

Forecast for **8:00AM EST SUN Oct 28**

Check your local weather forecast office web page to determine if there are any watches and warnings in your area.

BAROMETRIC PRESSURE

WARM FRONT

COLD FRONT

STATIONARY FRONT

OCCLUDED FRONT

TROUGH

FORECASTER'S NOTE:

Click here for more information on these terms.   ISSUED: 9:14 AM EST, TUESDAY, OCTOBER 23, 2012   FCSTR: CISCO

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Surface Prognosis Map

HPC DAY 6 SFC PROG
ISSUED: 1314Z TUE OCT 23 2012
VALID:12Z MON OCT 29 2012
FCSTR: CISCO
DOC/NOAA/NWS/NCEP/HPC

REVISED - Surface Weather Patterns

Surface Weather Patterns

Forecast for **8:00AM EST MON Oct 29**

Check your local weather forecast office web page to determine if there are any watches and warnings in your area.

BAROMETRIC PRESSURE

WARM FRONT

COLD FRONT

STATIONARY FRONT

OCCLUDED FRONT

TROUGH

FORECASTER'S NOTE:

Click here for more information on these terms.   ISSUED: 9:14 AM EST, TUESDAY, OCTOBER 23, 2012   FCSTR: CISCO

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Surface Prognosis Map

HPC DAY 7 SFC PROG
ISSUED: 1314Z TUE OCT 23 2012
VALID:12Z TUE OCT 30 2012
FCSTR: CISCO
DOC/NOAA/NWS/NCEP/HPC

REVISED - Surface Weather Patterns

Surface Weather Patterns

Forecast for **8:00AM EST TUES Oct 30**

Check your local weather forecast office web page to determine if there are any watches and warnings in your area.

BAROMETRIC PRESSURE
WARM FRONT
COLD FRONT
STATIONARY FRONT
OCCLUDED FRONT
TROUGH

FORECASTER'S NOTE:
Emergency briefings are now being issued for portions of the Middle Atlantic Region. Check www.weather.gov/phi for emergency briefings and other lcoal information.

Click here for more information on these terms.   ISSUED: 9:14 AM EST, TUESDAY, OCTOBER 23, 2012   FCSTR: CISCO

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518 Northampton Street, Easton, PA 18042
www.nurturenaturecenter.org
socialscience.focusonfloods.org

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Precipitation Forecast Map

REVISED - 5 - Day Precipitation Forecast

5-Day Precipitation Forecast
Thur Oct 25 at 8am EST thru Tue Oct 30 at 8am EST
5-day accumulated precipitation could reach as high as 8 inches in some areas of the Middle Atlantic River Forecast Region. Check Flood Forecast and Warning Tools.

HPC 5-DAY PRECIPITATION
ISSUED: 1359Z THU OCT 25 2012
VALID:12Z THU OCT 25 2012
THRU:12Z TUE OCT 30 2012
FORECASTER: FRACASSO
DOC/NOAA/NWS/NCEP/HPC

ISSUED: THURSDAY, OCTOBER 25, 2012 9:59 AM EST

FCSTR: FRACASSO

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Storm Tide

REVISED - Observed and Forecast Water Levels

Storm Tide

Surge   Tide   Observation   Forecast   Anomaly=(Obs.-(Tide+Surge))

Sandy Hook, NJ : 10/27/2012 1:29 PM EDT

REVISED - Observed and Forecast Water Levels

Observed and Forecast Water Levels

▶ Sandy Hook, NJ   Issued: Sat., October 27, 1:29 PM EDT

Flooding can be expected at or above Maximum Astronomical Tide (MAT).
Sunday evening High Tide occurs at 7:41 PM, with a forecast tide level of 7.5 to 8.0 feet above Mean Lower Low Water (MLLW).
For a list of impacts of different tide heights in your county, click here.

Click here for more information on these terms.

Surge   Tide   Observed Water Levels   Forecast Water Levels   Anomaly

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.
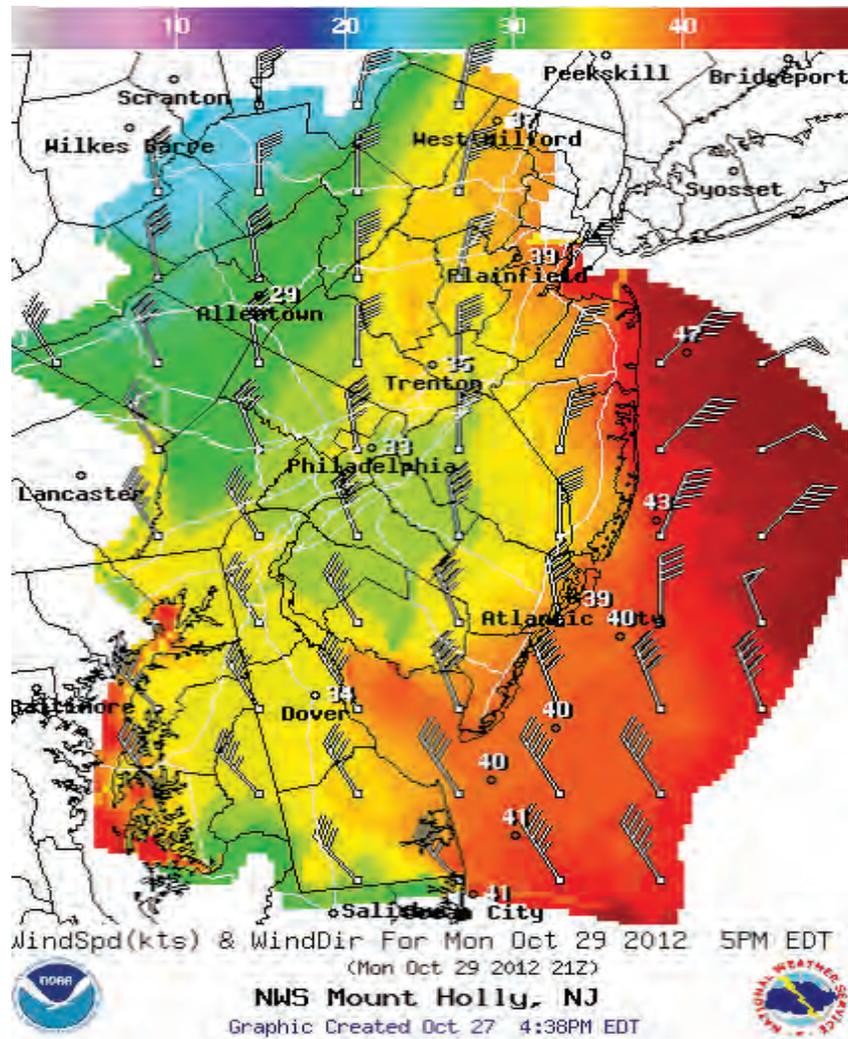
Wind Forecast

REVISED - Wind Speed/Direction Forecast

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

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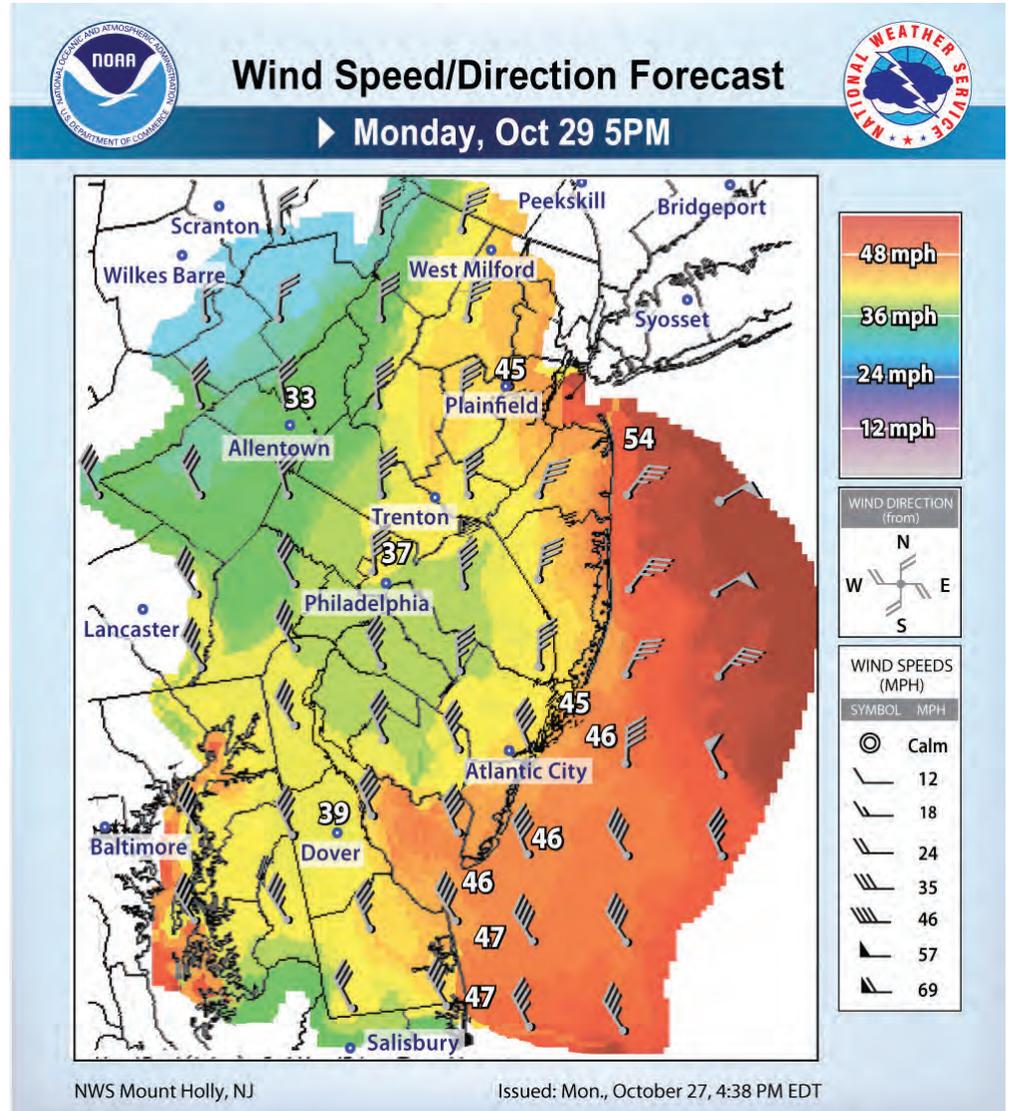
Flood Watch

DEZ001>004 - NJZ015>019 - PAZ068>071 - 272215 -

/O.NEW.KPHI.CF.A.0001.121028T2200Z - 121029T2000Z/

NEW CASTLE - KENT - INLAND SUSSEX - DELAWARE BEACHES - MERCER - SALEM -

GLOUCESTER - CAMDEN NORTHWESTERN BURLINGTON - MONTGOMERY BUCKS

DELAWARE PHILADELPHIA -

647 AM EDT SAT OCT 27 2012

...COASTAL FLOOD WATCH IN EFFECT FROM SUNDAY EVENING THROUGH
MONDAY AFTERNOON...

THE NATIONAL WEATHER SERVICE IN MOUNT HOLLY HAS ISSUED A COASTAL
FLOOD WATCH...WHICH IS IN EFFECT FROM SUNDAY EVENING THROUGH
MONDAY AFTERNOON.

* LOCATION...COASTAL AREAS OF DELAWARE...INCLUDING DELAWARE BAY
  AND THE TIDAL DELAWARE RIVER.

* COASTAL FLOODING...MODERATE TO MAJOR COASTAL FLOODING IS
  ANTICIPATED WITHIN 2 TO 3 HOURS EITHER SIDE OF THE HIGH TIDES
  SUNDAY EVENING AND AGAIN MONDAY MORNING - MIDDAY. THIS WILL BE
  LONG DURATION TIDAL FLOODING AND PROBABLE ROAD CLOSURES AND
  POTENTIAL FOR DAMAGE WHERE WATER ENCROACHES ON PARKING LOTS AND
  BUILDINGS.

* AT LEWES DELAWARE THE TIMES OF HIGH TIDE ARE 838 PM SUNDAY AND
  855 AM MONDAY. AT REEDY POINT DELAWARE THE TIMES OF HIGH TIDE
  ARE 1111 PM SUNDAY AND 1131 AM MONDAY. AT PHILADELPHIA THE TIMES
  OF HIGH TIDE ARE 138 AM SUNDAY AND 2 PM MONDAY.

* SEAS...ALONG THE ATLANTIC OCEAN SIDE OF DELAWARE SEAS WILL BE
  15 TO POSSIBLY 20 FEET WHILE IN THE LOWER DELAWARE SEAS WILL BE
  6 TO 10 FEET AND THE UPPER PART OF DELAWARE BAY BETWEEN 2 AND 4
  FEET. THIS ADDED OVER - WASH WILL THREATEN CONSIDERABLE DAMAGE TO
  BEACHFRONT PROPERTIES.

* RAINFALL...4 TO POSSIBLY 8 INCHES OF RAINFALL BY NOON MONDAY
  WILL ADD TO THE LOCAL STREAM FLOW ON THE TIDAL DELAWARE

  INCREASING THE ODDS OF MAJOR FLOODING!

* DURATION...MODERATE OR GREATER TIDAL FLO0DING MAY LAST 3 TO 5
  HOURS DURING THE HIGH TIDE CYCLE!

* PRECURSOR FLOOD EPISODE...MINOR COASTAL FLOODING IS LIKELY
  DURING THE SUNDAY MORNING - MIDDAY HIGH TIDE BUT THAT WILL BE
  DWARFED BY WHAT FOLLOWS SUNDAY NIGHT AND MONDAY.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A COASTAL FLOOD WATCH MEANS THAT CONDITIONS ARE FAVORABLE FOR THE
DEVELOPMENT OF MODERATE OR MAJOR COASTAL FLOODING. PAY CLOSE
ATTENTION TO UPDATED FORECASTS AND STATEMENTS AND TAKE
APPROPRIATE ACTION TO PROTECT LIFE AND PROPERTY. FOLLOW THE
RECOMMENDATIONS OF LOCAL EMERGENCY MANAGEMENT OFFICIALS.

FOR A LIST OF THE IMPACT OF DIFFERENT TIDE HEIGHTS IN YOUR
COUNTY PLEASE GO TO WWW.WEATHER.GOV/PHI/TIDES.HTM (ALL IN LOWER
CASE).

&&

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They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

COASTAL FLOOD WATCH: PREPARE NOW

Issued 6:47 AM, Saturday, Oct. 27, 2012
By NWS Mt. Holly, NJ WFO

● **IN EFFECT THROUGH MONDAY AFTERNOON**, for coastal areas, including Delaware Bay and the Tidal Delaware River. A coastal flood watch means conditions are favorable for development of moderate or major coastal flooding.

● **AFFECTED AREAS INCLUDE**: New Castle; Kent; Inland Sussex; Delaware Beaches; Mercer; Salem; Gloucester; Camden; Northwestern Burlington; Montgomery; Bucks; Delaware; Philadelphia.

DESCRIPTION: Moderate to Major Coastal Flooding is anticipated within 2 to 3 hours on either side of the High Tides on Sunday evening and again Monday morning to midday.

IMPACTS:
● **Long duration tidal flooding** and probable road closures and damage where water encroaches on parking lots and buildings.
● **Considerable damage to beachfront properties** is possible from over-wash from seas (storm surge?).
● **Major river flooding possible:** Rainfall of 4 to possibly 8 inches by Monday will add to the local stream flow on the tidal Delaware.
● For a list of impacts from different tide heights in your county, please go to www.weather.gove/phi/tides.htm.

ACTIONS:

● Pay close attention to forecasts and statements and take actions to protect life and property.
● Follow directions from local emergency management officials.
● Follow complete forecast at weather.gov/phi. Follow emergency briefings, which will contain more information about impacts and actions.

TIDES:

● **At Lewes, DE**, the times of high tide are 8:38 pm Sunday and 8:55 am Monday.
● **At Reedy Point, DE**, the times of high tide are 11:11 pm Sunday and 11:11 am Monday
● **At Philadelphia**, the points of high tide are 1:38 am Sunday and 2 p.m. Monday

SEAS:
● Along the Atlantic Ocean Side of Delaware, seas will be 15 to possibly 20 feet
● In the Lower Delaware, seas will be 6 to 10 Feet
● In the Upper Part of the Delaware Bay, seas will be between 2 to 4 feet

ADDITIONAL INFO:
● Duration: Moderate or greater tidal flooding may last 3 to 5 hours during high tide cycle
● Precursor flood episode: minor coastal flooding is likely during Sunday morning to midday high tide, but that will be dwarfed by what follows Sunday night and Monday

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They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Coastal Flood Warning

570

WHUS41 KPHI 272108

CFWPHI

URGENT - IMMEDIATE BROADCAST REQUESTED

COASTAL HAZARD MESSAGE

NATIONAL WEATHER S ERVICE MOUNT HOLLY NJ

508 PM EDT SAT OCT 27 2012

NJZ014 - 024>026 - 281100 -

/O.UPG.KPHI.CF.A.0001.121029T1000Z - 121030T0400Z/

/O.NEW.KPHI.CF.W.0004.121028T2000Z - 121030T0400Z/

/O.NEW.KPHI.SU.Y.0001.121027T2108Z - 121030T2200Z/

EASTERN MONMOUTHATLANTIC COASTAL CAPE MAY- COASTAL ATLANTIC

COASTAL OCEAN-

508 PM EDT SAT OCT 27 2012

...HIGH SURF ADVISORY IN EFFECT UNTIL 6 PM EDT TUESDAY...

...COASTAL FLOOD WARNING IN EFFECT FROM 4 PM SUNDAY TO MIDNIGHT
EDT MONDAY NIGHT...

THE NATIONAL WEATHER SERVICE IN MOUNT HOLLY HAS ISSUED A COASTAL
FLOOD WARNING...WHICH IS IN EFFECT FROM 4 PM SUNDAY TO MIDNIGHT
EDT MONDAY NIGHT. A HIGH SURF ADVISORY HAS ALSO BEEN ISSUED. THIS
HIGH SURF ADVISORY IS IN EFFECT UNTIL 6 PM EDT TUESDAY. THE
COASTAL FLOOD WATCH IS NO LONGER IN EFFECT.

* LOCATION...THE ATLANTIC COAST OF NEW JERSEY.

* COASTAL FLOODING...MAJOR COASTAL FLOODING IS FORECAST FOR THE
   MONDAY MORNING HIGH TIDE. MODERATE COASTAL FLOODING IS FORECAST
   FOR THE SUNDAY EVENING AND MONDAY EVENING HIGH TIDES.

* AT SANDY HOOK, NEW JERSEY (SANDY HOOK BAY) THE SUNDAY EVENING
   HIGH TIDE OCCURS AT 741 PM, WITH A FORECAST TIDE LEVEL OF
   7.5 TO 8.0 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY MORNING HIGH TIDE OCCURS AT 801 AM, WITH A FORECAST
   TIDE LEVEL OF 9.0 TO 9.5 FEET ABOVE MEAN LOWER LOW WATER.

THE MONDAY EVENING HIGH TIDE OCCURS AT 822 PM, WITH A FORECAST
TIDE LEVEL OF AROUND 8.0 FEET ABOVE MEAN LOWER LOW WATER.

* AT SEASIDE HEIGHTS, NEW JERSEY (OCEANFRONT) THE SUNDAY EVENING
   HIGH TIDE OCCURS A T 711 PM, WITH A FORECAST TIDE LEVEL OF
   AROUND 7.5 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY MORNING HIGH TIDE OCCURS AT 731 AM, WITH A FORECAST
   TIDE LEVEL OF 8.5 TO 9.0 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY EVENING HIGH TIDE OCCURS AT 752 PM, WITH A FORECAST
   TIDE LEVEL OF 7.5 TO 8.0 FEET ABOVE MEAN LOWER LOW WATER.

* AT ATLANTIC CITY, NEW JERSEY (OCEANFRONT) THE SUNDAY EVENING
   HIGH TIDE OCCURS AT 722 PM, WITH A FORECAST TIDE LEVEL OF
   7.0 TO 7.5 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY MORNING HIGH TIDE OCCURS AT 741 AM, WITH A FORECAST
   TIDE LEVEL OF AROUND 8.5 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY EVENING HIGH TIDE OCCURS AT 800 PM, WITH A FORECAST
   TIDE LEVEL OF AROUND 7.5 FEET ABOVE MEAN LOWER LOW WATER.

* AT CAPE MAY, NEW JERSEY (OCEANFRONT) THE SUNDAY EVENING
   HIGH TIDE OCCURS AT 756 PM, WITH A FORECAST TIDE LEVEL OF
   7.5 TO 8.0 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY MORNING HIGH TIDE OCCURS AT 815 AM, WITH A FORECAST
   TIDE LEVEL OF 8.5 TO 9 .0 FEET ABOVE MEAN LOWER LOW WATER.

   THE MONDAY EVENING HIGH TIDE OCCURS AT 834 PM, WITH A FORECAST
   TIDE LEVEL OF 7.5 TO 8.0 FEET ABOVE MEAN LOWER LOW WATER.

Coastal Flood Warning (continued)

* HIGH TIDE ON THE BACK BAYS AND ALONG RARITAN BAY OCCURS LATER
  THAN THE HIGH TIDE ON THE   OCEANFRONT.

* IMPACTS...NUMEROUS ROADWAYS WILL FLOOD AND MODERATE TO MAJOR
  PROPERTY DAMAGE IS LIKELY. THE TIDES AND WAVE ACTION WILL RESULT
  IN MODERATE TO MAJOR BEACH EROSION.

* WAVES AND SURF...8 TO 12 FEET.

* RAINFALL...4 TO 8 INCHES OF RAINFALL   IS FORECAST DURING THE
  PERIOD. HEAVY RAINFALL NEAR TIME OF HIGH TIDE WOULD NOT DRAIN
  AND WOULD EXACERBATE TIDAL FLOODING.

* PRECURSOR FLOOD EPISODE...MINOR COASTAL FLOODING IS LIKELY
  DURING THE SUNDAY MORNING HIGH TIDE.

PRECAUTIONARY/PREPAREDNESS A CTIONS...

A COASTAL FLOOD WARNING INDICATES THAT MODERATE OR MAJOR TIDAL
FLOODING IS IMMINENT OR OCCURRING. BE PREPARED FOR RISING WATER
LEVELS AND TAKE APPROPRIATE ACTION TO PROTECT LIFE AND PROPERTY.
FOLLOW THE RECOMMENDATIONS OF LOCAL EMERGENCY MANAGEMENT
OFFICIALS.

DO NOT DRIVE YOUR VEHICLE THROUGH FLOOD WATERS. THE WATER MAY BE
DEEPER THAN YOU THINK. YOU WILL BE PUTTING YOURSELF IN DANGER AND
YOUR VEHICLE MAY BE DAMAGED...LEADING TO COSTLY REPAIRS.

FOR A LIST OF THE IMPACT OF DIFFERENT TIDE HEIGHTS   IN YOUR
COUNTY...PLEASE GO TO WWW.WEATHER.GOV/PHI/TIDES.HTM (ALL IN LOWER
CASE).

A HIGH SURF ADVISORY MEANS THAT HIGH SURF WILL AFFECT BEACHES IN

THE ADVISORY AREA. LIFE THREATENING RIP CURRENTS AND LOCALIZED
BEACH EROSION WILL ALSO BE POSSIBLE.

&&

COASTAL FLOOD WARNING: ACT NOW

Issued 5:08 p.m. EDT Saturday, Oct. 27, 2012
By NWS Mt. Holly, NJ WFO
URGENT - IMMEDIATE BROADCAST REQUESTED

● **IN EFFECT FROM 4 PM SUNDAY to MIDNIGHT EDT MONDAY**, for the Atlantic Coast of New Jersey. A coastal flood warning means coastal flooding is occurring or imminent. A High Surf Advisory has also been issued, in effect until 6 PM EDT Tuesday.

● **AFFECTED AREAS INCLUDE**: ATLANTIC COAST OF NEW JERSEY.

DESCRIPTION: Major coastal flooding is forecast for the Monday morning high tide. Moderate coastal flooding is forecast for the Sunday evening and Monday evening high tides. Serious threats to life and property can be expected.

IMPACTS:
● **numerous roadways will flood** and **moderate to major property damage is likely**.
● **Moderate to major beach erosion** from tide and wave action
● **Life threatening rip currents are possible**. A high surf advisory means high surf will affect beaches.
● **Waves and Surf of 8 to 12 feet**
● Heavy rainfall of 4 to 8 inches forecast during this period will exacerbate tidal flooding
● Minor coastal flooding is likely during the Sunday morning high tide; this is a precursor event to the major flooding
● For a list of impacts from different tide heights in your county, please go to www.weather.gov/phi/tides.htm.

ACTIONS:
● Be prepared for rising water levels.
● Take actions to protect life and property.
● Follow recommendations and orders from local emergency management officials. Evacuate if told; do not delay and cause dangerous rescue situations for emergency personnel.
● Do not drive your vehicle through flood waters. The water may be deeper than you think and you can put yourself and others in serious danger and cause costly repairs to your vehicle.
● Follow complete forecast at weather.gov/phi. Follow emergency briefings, which will contain more information about impacts and actions.

TIDES:

● **At Sandy Hook, NJ** (Sandy Hook Bay)
….the Sunday evening tide occurs at 7:41 p.m., with a forecast tide level of 7.5 to 8 feet above mean lower low water.

….The Monday morning high tide occurs at 8:01 am., with a forecast tide level of 9 to 9.5 feet above mean lower low water.
….The Monday evening high tide occurs at 8:22 p.m., with a forecast tide level of around 8 feet above mean lower low water

● **At Seaside Heights, NJ** (Oceanfront)
….the Sunday evening high tide occurs at 7:11 p.m., with a forecast tide level of around 7.5 feet above mean lower low water
….the Monday morning high tide occurs at 7:31 a.m., with a forecast tide level of 8.5 to 9 feet above mean lower low water
….the Monday evening high tide occurs at 7:52 p.m. with a forecast tide level of 7.5 to 8 feet above mean lower low water

● **At Atlantic City, NJ** (Oceanfront)
….The Sunday evening high tide occurs at 7:22 pm, with a forecast tie level of 7 to 7.5 feet above mean lower low water
....The Monday morning high tide occurs at 7:41 a.m. with a forecast tide level of around 8.5 feet above mean lower low water
….The Monday evening high tide occurs at 8:00 p.m. with a forecast tide level of around 7.5 feet above mean lower low water

● **At Cape May, NJ** (Oceanfront)
….the Sunday evening high tide occurs at 7:56 p.m. with a forecast tide level of 7.5 to 8 feet above mean lower low water
….the Monday morning high tide occurs at 8:15 a.m. with a forecast tide level of 8.5 to 9 feet above mean lower low water
….the Monday evening high tide occurs at 8:34 p.m. with a forecast tide level of 7.5 to 8 feet above mean lower low water

● High tide on the back bays and along the Raritan Bay occurs later than the high tide on the Oceanfront

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They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Active Weather Threat
Halloween Week nor'easter
October 28th -31st 2012

Prepared 1145 AM EDT – Tuesday, October 23rd, 2012
Gary Szatkowski
NOAA's National Weather Service
Philadelphia/Mt. Holly NJ Forecast office
Weather.gov/phi

*National Weather Service
Philadelphia/Mt. Holly*

Purpose of briefing

- Briefing #1 for event
- Promote situational awareness for emergency management community & partners
- Provide guidance for planning efforts
- Briefing applies to Mount Holly service area – shaded in green on map

Executive Summary

- Potential for a very dangerous autumn storm system to affect the region early next week.
- This storm will be associated with what is currently Tropical Storm Sandy. This storm system will bring multiple potential threats to the region.
- Strong damaging wind gusts, extremely heavy rainfall, major inland flooding and major coastal flooding are all possible with the storm.
- The track of the storm will determine the area which is impacted; there is considerable uncertainty with the storm track this far in advance of the event.
- Next briefing package will be issued on Wednesday, October 24th.
- Monitor our website at weather.gov/phi

Where does Sandy go after it is no longer tropical?

TROPICAL STORM SANDY (AL18)
NCEP GFS Ensemble track guidance initialized at 0600 UTC, 23 October 2012
Current Intensity: 40 kt   Current Basin: North Atlantic
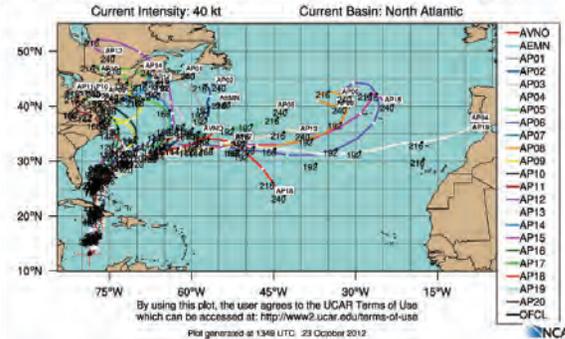
- Map on the left is one of the forecast tools meteorologists use.
- Its shows over 20 potential tracks for the storm. Although many go out to sea, there are a considerable number which bring the storm onto the East Coast, ranging from Virginia up to New England.

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

National Weather Service Briefing for Potentially Damaging Storm — October 28 – 31st 2012

Early alert
Forecast Halloween Nor'easter storm could have damaging impacts for portions of Pennsylvania, New Jersey and beyond. Details inside.

Prepared 11:45 AM EDT on Tuesday, October 23, 2012 by Gary Szatkowski, NOAA's National Weather Service Forecast Office in Philadelphia/Mt. Holly NJ (weather.gov/phi)

Summary Of Weather Situation

A very dangerous autumn storm may affect large parts of the region early next week. Conditions may include:

Briefing for:
NWS Forecast Office Service Area
Shown in Map Below

- Strong, damaging wind gusts
- Extremely heavy rainfall
- Major inland flooding
- Major coastal flooding

This storm is associated with current Tropical Storm Sandy. Impacts will depend on the track of the storm.

WHAT TO DO: People in this region should monitor local forecasts carefully as the storm progresses at weather.gov/phi. See inside for more details.

Next briefing will be issued Wed. Oct. 24.

What You Need to Know About This Storm

- A very large region will be affected by very strong winds.
- Very heavy rainfall is likely will occur with the storm.
- The storm threatens major river flooding and coastal flooding.
- The storm will be slow moving, and will occur during multiple high tides, increasing impacts of coastal and riverine flooding.
- Impacts will depend on the track of the storm, which has considerable forecast uncertainty, but:
- Our region is clearly at risk.

Please share this briefing with friends, family and neighbors.

When will this system reach us?

8 a.m. Sunday, Oct. 28, east of the Carolinas, 60-70 MPH winds possible

8 a.m. Monday, Oct. 29, east of DelMarva

8 a.m. Tuesday, Oct. 30, storm center off the Southern New England Coast

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They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

Very Dangerous Hurricane Sandy
October 28th – 31st 2012

Prepared Noon EDT – Sunday October 28, 2012
Gary Szatkowski
NOAA's National Weather Service
Philadelphia/Mt. Holly NJ Forecast Office
Weather.gov/phi

Purpose of Briefing

- Briefing #8 for event
- Promote situational awareness for emergency management community & partners
- Provide guidance for planning efforts
- Briefing applies to Mount Holly service area – shaded in green on map

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Changes from previous briefing

- **Confidence continues to increase that our region will see very severe impacts from this storm.**

Executive Summary

- Hurricane Sandy will have a severe impact on our region over the next several days:
  - Strong damaging sustained winds 35 to 50 mph over a prolonged period of time (24 to 48 hours), with gusts up to near hurricane strength. Strongest winds are expected south and east of the I-95 corridor.
  - Extremely heavy rainfall.
  - Major to record inland flooding along streams and rivers.
  - Major to record coastal flooding. The full moon on October 29 just makes things worse.

- Options for the storm to miss our area are rapidly dwindling. Confidence on the storm having a major impact on our region continues to increase. The focus of efforts should be on when Sandy hits our region, not if Sandy hits our region.
- Next briefing package will be issued by 600 PM on Sunday, October 28th.
- Monitor our website at weather.gov/phi.

Personal plea

- If you are being asked to evacuate a coastal location by state and local officials, please do so.
- If you are reluctant to evacuate, and you know someone who rode out the '62 storm on the barrier islands, ask them if they would do it again.
- If you are still reluctant, think about your loved ones, think about the emergency responders who will be unable to reach you when you make the panicked phone call to be rescued, think about the rescue/recovery teams who will rescue you if you are injured or recover your remains if you do not survive.
- Sandy is an extremely dangerous storm. There will be major property damage, injuries are probably unavoidable, but the goal is **zero fatalities**.
- If you think the storm is over-hyped and exaggerated, please err on the side of caution. You can call me up on Friday (contact information is at the end of this briefing) and yell at me all you want.
- I will listen to your concerns and comments, but I will tell you in advance, I will be very happy that you are alive & well, no matter how much you yell at me.
- Thanks for listening.
- Gary Szatkowski – National Weather Service Mount Holly

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

National Weather Service Briefing
for
**VERY DANGEROUS
HURRICANE SANDY**
October 28 – 31st 2012

Alert
Confidence is high that Sandy will hit our region.
This is a dangerous situation. Taking protective actions now can
reduce loss of life and property. Details inside.

Prepared NOON EDT on Sunday, October 28, 2012 by
Gary Szatkowski, NOAA's National Weather Service Forecast Office
in Philadelphia/Mt. Holly NJ (weather.gov/phi)

Summary Of Weather Situation

Hurricane Sandy will have a severe impact
on our region during the next several days.

Briefing for:
NWS Forecast Office Service Area
Shown in Map Below

— Strong, damaging sustained winds 35 to
50 mph over a prolonged period of time
(24-48 hours) with gusts up to near
hurricane strength. Strongest winds are
expected south and east of the I-95
corridor.
— Extremely heavy rainfall
— Major to record stream and river flooding
— Major coastal flooding (full moon occurs
Oct. 29)

Confidence increases that the storm will hit our region. The focus
of efforts should be on when Sandy hits, not if it hits, our region.

People in this region should be finishing preparations, evacuating if
told, and monitoring local forecasts carefully as the storm
progresses at weather.gov/phi

*Next briefing will be issued at 6 p.m. Sunday, Oct. 28*

Personal Plea

If you are being asked to evacuate a coastal location by state and local
officials, please do so.

- Sandy is an extremely dangerous storm. There will be major property damage,
injuries are probably unavoidable, but the goal is zero fatalities.
- If you are reluctant to evacuate, and you know someone who rode out the '62
storm on the barrier islands, ask them if they would do it again.
- If you are still reluctant, think about your loved ones, think about the emergency
responders who will be unable to reach you when you make the panicked phone
call to be rescued, think about the rescue/recovery teams who will risk their lives to
rescue you if you are injured, or recover your remains if you do not survive.
- If you think the storm is overhyped and exaggerated, please err on the side of
caution. You can call me up on Friday (contact information is at the end of this
briefing) and yell at me all you want.
- I will listen to your concerns and comments, but I will tell you in advance, I will be
very happy that you are alive & well, no matter how much you yell at me.
- Thanks for listening.
- Gary Szatkowski – National Weather Service, Meteorologist-in-Charge, Mt. Holly, NJ
Please share this briefing with friends, family and neighbors.

Coastal Flood Risk for the Atlantic Coast,
Delaware Bay and Raritan Bay

- Water is the most life threatening aspect of this storm. Hurricane Sandy is already
the deadliest hurricane of the 2012 season. Please respect its power and heed
the advice of local and state officials regarding any evacuations.
- The two high tides on Monday will be the most dangerous high tides with major to
record coastal flooding expected. Barrier islands will likely be cut off from the
mainland during both high tides as a result of coastal flooding and high winds.
- The first high tide cycle today (Sunday) produced minor to moderate coastal
flooding. Subsequent high tides will be worse.
- The second high tide cycle today will produce moderate to major coastal flooding.
- The two high tides on Monday will produce major to record coastal flooding.
- Seas will continue to build; there will be 10-12 foot breakers in the surf on Monday.

Please share this briefing with friends, family and neighbors.

Coastal Flood Levels

**Major coastal flooding is expected based
on the current track forecast. Record
coastal flooding is likely.**
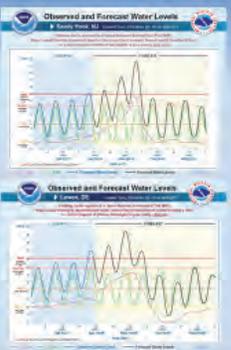
A 12 to 15 foot storm tide (surge +
astronomical tide) is possible in the Raritan
Bay. This would produce record coastal
flooding.

A 10 to 12 foot storm tide is possible along
the Atlantic Coast & the Delaware Bay. This
would result in record coastal flooding in
many locations.

A 3 to 5 foot storm tide (surge +
astronomical tide) is possible in the
Chesapeake Bay based on where the storm
center comes ashore. This would produce
moderate coastal flooding.

They had the facts, why didn't they act?: Understanding and improving public response to National Weather Service's coastal flood forecasts.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Peter Rowe prowe@njseagrant.org Associate Director, New Jersey Sea Grant Consortium. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Pete Rowe at (732) 872-1300 x 31. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: **Christina W. Hoven, DrPH, MPH**

Date of Report submission: 06/01/2015

Project #: __**NA13OAR4830227: R/CSAP-3-NJ**_____

Dates of the project: From [01/02/2014]   to   [06/15/2015].

Project Title: ***"Adolescent and Family Decision Making In Time of Disaster"***

Principal Investigator(s) and Affiliation(s):

1. Christina W. Hoven, DrPH, MPH --- Principal Investigator/ Research Foundation for Mental Hygiene, Inc. /Columbia University

2. Lawrence Amsel, MD, MPH --- Co-Principal Investigator/ Research Foundation for Mental Hygiene, Inc. /Columbia University

3. George J. Musa, PhD --- Co-Principal Investigator/ Research Foundation for Mental Hygiene, Inc.

A. **PROJECT GOALS AND OBJECTIVES:**
As many families told to evacuate during weather emergencies do not do so, it is important to understand individual and family decision making if we are to improve communications that work. We were especially interested in the role that adolescents play in influencing family decision making. The goals of this project were therefore to combine, for the first time, three different measures related to individual and family decision making attitudes and styles. We combined 1- focus group-like research with 2- traditional epidemiologic questionnaire methodology and with 3- measures of individual decision-making styles, using formal behavioral laboratory tasks that capture risk perception/tolerance (Balloon Analog Risk Task [BART]), as well as interpersonal trust/reciprocity (Developmental Trust Game [DTG]), factors known to be important in individual and group decision-making. Thus, we hope to combine the insights from these complementary methodologies to gain a deeper

understanding of the role that adolescents play in the family decision-making regarding weather related disasters.

Objective 1. To test the effect of Decision-making Styles (DMS) and Decision-making Compatibility. (DMC) on Disaster Preparedness (DP) and Actual Disaster Evacuation (DE).

Objective 2. To test the effect of Decision-making Styles (DMS) and Decision-making Compatibility (DMC) on constructive family decision-making processes.

Objective 3. To test the effect of constructive family decision-making on Disaster Preparedness (DP) and Disaster Evacuation (DE).

Objective 4. To impact curriculum for adolescents around DP and DE behavior.

<u>RESULTS:</u> (*Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*

Results:

We successfully recruited 48 families affected by Super-storm Sandy. Twenty-two of these families evacuated during the storm (FSE), and 26 families sheltered-in-place (FSIP). We collected data on families and individual family members using three approaches: individual questionnaires, task based measures of individual decision-making, and focus-group style family discussion groups. Over all objectives, the most significant findings were:

1. Among families deciding to evacuate, adolescent involvement in evacuation decision-making was significantly higher than in families who sheltered-in-place.

2. Families that evacuated were more likely to have discussed the evacuation within the family, and were more likely to have had disagreements about evacuation than were families that sheltered-in-place.

3. Families that evacuated were more likely to have been "advised or mandated" to evacuate, and more often accessed web-based information about the storm, than families who did not evacuate.

4. Sixty percent of evacuating families, and 27 percent of non-evacuating families had received a mandatory evacuation order during Sandy. However, there was no difference between evacuating and non-evacuating families in stating they would follow a mandatory evacuation order in the future.

Notably, the findings thus far are mixed, leading us to support some, and reject other hypotheses. Against prediction (Objective 1), parents' high risk tolerance (as measured by

BART) and high trust/reciprocity were unrelated to pre-Sandy preparedness, and Sandy evacuation status; and high trust/reciprocity was negatively associated with current preparedness.   Although parents personal style did not *significantly* predict family decision making style (Objective 2) , the findings suggest that parental trust may lead to more inclusive family decision making process involving adolescent participation in evacuation decisions. An inclusive, constructive family decision style (Objective 3), where adolescents engage in the decision making process, was more common in families that evacuated, than in families that sheltered-in-place. Further planned analyses of personal style, and family decision-making styles based on qualitative analyses, will likely bring many of these features into focus.

The hypothesis that adolescents play an important role in the decision to evacuate, has been supported, laying the foundation for activities aimed at extending this positive influence within families. We will continue to share our findings (Objective 4) with the Sea Grants program of the tri-state area and with our end-users with the objective of revising/creating new curriculum for adolescents focused on decision-making aspects, and family discussion aspects of disaster preparedness and evacuation. In conjunction with our collaborators and end-users we are planning to conduct school-based workshops in the 2015-2016 academic year.

B. COLLABORATORS, PARTNERS, and INTERACTIONS: *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

At the commencement of the project, we invited and held an introductory meeting with a presentation for all of our six end-users, listed here in no particular order of significance - The American Red Cross, The New York City Office of Emergency Management (OEM), The Rockaway Youth Task Force (RYTF), The National Center for Disaster Preparedness (NCDP) at the Earth Institute/Columbia University, The Urban Assembly School for Emergency Management, and the Hunter College High School. We stayed in communication with our end users throughout the project and plan to meet with them to discuss our research findings and to elicit their dissemination expertise, once our data analysis phase is completed.

C. PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

Hoven, C., Amsel, L., Musa, G., Wicks, J., Doan, T., Ryan, M., Sylk, T., Dougherty, A., Eisenberg, R., Bergman, M., Aurora, M., Samet, D. (2015, May 13). *Adolescent and Family Decision-Making In Time of Disaster*. Poster session presented at the NJSGC Site Review, West Long Branch, NJ.
Invited Presenter: Maja Bergman (see attached abstract)

D. <u>**FUNDS LEVERAGED:**</u> *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

> **Not Applicable.**

E. <u>**STUDENTS:**</u> *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "**<u>New</u>**" students are those who **have <u>not</u>** worked on this project previously. "**<u>Continuing</u>**" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

> **Not Applicable.**

F. <u>**VOLUNTEER HOURS:**</u>
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

> We enlisted a total of 16 volunteers for the lifetime of this project; four high school students, six individuals with Bachelor's degrees, and six Masters-level individuals. Depending on their level of competency and ability, these volunteers assisted our research group with literature reviews, preparation work for field data collection, and research participant recruitment. Those with distinguished qualitative and quantitative interview experiences, Bachelor's level at a minimum, were also trained and conducted participant's in-home interviews, along with our experienced field staff.

H. PICTORIAL: *(Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.)*

> **Not Applicable.**

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.)*

> **Not Applicable.**

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

In order to improve public disaster preparedness and public response to disaster warnings, one must understand how warning messages are understood and acted on. This recognition has spurred the study of risk perception and behavioral responses[27]. In particular there has been substantial research, in the context of natural disasters, on adult risk perception, risk tolerance, decision-making, and related risk-reducing behaviors[2,3]. Two key focus areas in the research on adult preparedness behavior have been the effectiveness of (warning) messaging, and adult perception of risk[17,28]. Personal and family risk-perception are strong predictors of evacuation behaviors, as people are more likely to take defensive action and evacuate if they perceive that the threat is real[3,6-8]. As for messaging, some researchers find that local and national television programming followed by radio, peers and local authorities are considered the most important sources of information a family uses to decide to evacuate[3,23], while others find that extended family and peers are the most important sources[13].

Although prior research has increased understanding of how **individuals** react to weather-related warnings, many of the most important response decisions involve families acting as a unit and making a group decision. While there has been some work in this area, there is insufficient research examining how the family behaves as a group decision maker, or what role adolescents play as active participants in these decisions.

The research on Group Decision Making (GDM) in relation to Disaster Preparedness (DP), and group response to disasters has been largely focused on work-based groups and generally involves co-workers and managers rather than families[9,10].

Interestingly, outside the area of disaster preparedness, there is a robust literature on adolescent influence on family decision-making in the areas of consumer purchases[1,29], family recycling[22] and other economic/ecological behaviors[21]. Beatty & Talpade (1994)[1] identified the key variables in this influence equation as: adolescent ability, adolescent motivation, parent/household characteristics, and decision characteristics.

There is the beginning of a literature on children and adolescent disaster preparedness and their influence on family members. For example, the American Red Cross[26] developed programs aimed to help children understand and respond to natural disasters. Interestingly, however, direct work on studying or promoting children and adolescents as sources of influence on family decision-making in disasters has primarily taken place in the less developed countries, as described by Garrett[14] for Cuba and by Mitchell et al (2009)[24] for El Salvador and the Philippines.

There is also the beginnings of educational advancement in this area. For example the Urban Assembly School for Emergency Management (UASEM) in New York, which has just recently opened, with the goal of teaching high school students how to better respond to extreme disaster situations by placing them in the roles of emergency managers. (They will be partnering with this study as one of our end-users, see letter attached.)

Despite these promising beginnings there remains insufficient research on: (1) the effect that adolescents have on family disaster preparedness (DP) and disaster evacuation (DE) decision-making, (2) the family group dynamics in decision-making, (3) formal (behavioral laboratory) measurement of adult and adolescent risk perception and trust/reciprocity, their comparison with each other, and how these affect the family negotiation process, and (4) the adolescent's role in the family.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

A major goal of this study is to create knowledge that, working with our end-user partners, can facilitate the creation of educational materials, programs and procedures to improve disaster-related family-based decision-making. Creating programs that help adults and adolescents to identify their own decision-making and family negotiating styles, to know their strengths and weaknesses, and to appreciate how each individual impacts the family in disaster situations, can address important human-factor issues that may hinder public efforts to save lives in time of disaster. To this end, we are partnering with several community and educational institutions including: The Red Cross, The Office of Emergency Management of New York City, the National Center for Disaster Preparedness (NCDP) at Columbia University, the Rockaway Youth Task Force, the Urban Assembly School for Emergency Management (UASEM) in New York, and Hunter College High School. Each of which are interested in utilizing our findings to develop, and deliver improved educational materials for adolescents and families, which will improve individual and collaborative family decision-making around disasters and evacuation situations.

Our team, the Child Psychiatric Epidemiology Group (CPEG), is in the Division of Child Psychiatry at Columbia University and the New York State Psychiatric Institute (NYSPI). We have a strong history of dissemination and publication based on our investigations of mental health and other sequelae of trauma exposure. For example we extensively study families exposed to 9/11, as well as children of First Responders[11,12,18,20,25]. Our group has been a leader in understanding how children and families cope following severely stressful and traumatic events. Having studied the effects of disasters on adolescents, we now propose to study the effects of adolescents on disaster outcomes for their families.

In this study, we bring our extensive experience in disaster-related field research to the task of assessing the role of adolescents, and of family negotiating style in determining family decision-making regarding disaster preparation (DP) and evacuation (DE). In our well-characterized sample of families and children exposed to 9/11 and to Super-Storm Sandy, their level of Pre-Sandy preparedness is known to us from prior interviews, and their evacuation decisions during Sandy are known and will be used to evaluate this concept. We conducted family discussion groups (using Focus Group methodologies) with a random selection of evacuee (FSE) and non-evacuee families (FSIP), to capture the family's negotiating and decision-making style, including tolerance for and inclusiveness of adolescents' input into the process, in order to better understand how these factors impacted the family decisions around

preparedness and evacuation. Family discussion groups are important in eliciting concrete information about the family's decision-making and negotiation process, allowing for a deeper understanding of how a family chooses to evacuate or not. They also afford a more nuanced understanding of each family member's perception of the situation, as well as the family's collective perception. Finally, through the discussion group, we are able to partially replicate, and thus observe, the active family dynamics (verbal and non-verbal communication patterns, manifestations of power and control and decision-making processes) in real time decision-making.

In addition, we, for the first time, combined focus group-like research with measures of individual decision-making styles, using formal behavioral laboratory tasks that 1) capture risk perception/tolerance (Balloon Analog Risk Task [BART]) and 2) interpersonal trust/reciprocity (Developmental Trust Game [DTG]), factors known to be important in individual and group decision-making. Thus, we are able to combine the insights from these complementary methodologies to gain a deeper understanding of the role that adolescents play in the family decision-making regarding disasters.

Risk Taking: *Balloon Analogue Risk Task (BART)***:** Adolescence is a developmental period of increased risk-taking and novelty-seeking behavior. The BART measures risk tolerance by balancing greater reward with greater risk. It captures subjects' approach to risky decision-making, and is appropriate for both adolescents and adults. Task and Procedure: We followed the procedure of the BART task described in detail by Crowley et al. (2009)[5]. In this task the subject sees a small balloon on the computer screen and a balloon pump. Each mouse click on the pump inflates the balloon incrementally (about 0.3 cm in all directions) and increases the amount of money associated with the balloon. However each balloon has a predetermined explosion point, and if pumped past its individual explosion point, the computer generates a bursting-balloon sound effect, the balloon is seen to explode, and all the money for the current round is lost. On the other hand, participants can stop pumping the balloon and click the 'Collect $ $ $' button at any point. The task captures participants' willingness to risk another pump, with the potential for an incremental gain, but also the possibility of losing all the money in the current round. One approach to the analysis of the task involves the average number of times the subject inflates the balloon before it explodes, and this will be our initial analysis approach. Other analytic approaches will be explored as well. Participants received actual amount won ($8 maximum).

Trust and Reciprocity Game: One of the most important developmental aspects of adolescence is learning appropriate interpersonal behaviors. Decisions regarding disaster preparedness and evacuation all have interpersonal and strategic components that cannot be fully understood without the social component of decision-making. Basic components of these complex behaviors are the ability to trust, including the discernment of when and who to trust, and the capability of social perspective-taking, seeing the world from another's eyes in order to respond appropriately, in other words reciprocity[31]. Moreover, behaviors in Game Theory based tasks have been shown to correlate well with real life behaviors that involve the capacity for trust and reciprocity[4,15]. The task is thus an excellent complement to our focus group research.

For our study we used the Developmental Trust Game (DTG) which was created and tested by van den Bos and colleagues[30]. Designed to include children and adolescents, The DTG can examine both trust and reciprocity. In the trust condition, it measures the subject's willingness to trust the other player in the face of potentially costly monetary loss. In the reciprocity condition, it measures a subject's perspective-taking (also known as Theory of Mind), that is, it measures if the subject recognizes when the other player has chosen to be trusting, and that reciprocating is appropriate. van den Bos has shown that the task can be used effectively in children as young as nine, and has demonstrated that separate paths exist in the normal developmental of trust and reciprocity, establishing the task's sensitivity to different stages of social maturity[30]. One approach to the analysis of the task involves the average number of times the subject chooses to trust (vs. not trust) and the average number of times the subject choose to reciprocate after a trust response, and these will be our initial outcomes in the analysis. Other analytic approaches will be explored as well. Participants received actual amount won ($8 maximum).

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

Consider the following as they apply to your research and any related outreach/education.
·   What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?

·   What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?

·   What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?

·   What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?

Using a highly structured quantitative interview, we obtained information from each participant related to their households, to family characteristics, to preparedness before Sandy and currently, and to consequences of exposure to the storm. Research participants were also asked to perform two formal behavioral laboratory tasks designed to objectively measure risk perception/tolerance (the Balloon Analog Risk Task [BART]) and interpersonal trust/reciprocity (the Developmental Trust Game [DTG]). In addition to these individual measures, the

participants and any family member 12 years or older participated in a focus-group like family discussion group, which was designed to measure the adolescent's involvement in the family decision process.

<u>Quantitative Interviews:</u>

A total of 48 families participated in our study, including 22 that evacuated (FSE) and 26 that did not (FSIP). Families were selected from our WTC Evacuees and First Responder Study[19], which was completed in 2012. All of these families lived within 1/4 mile of the Super-Storm Sandy Storm Surge and had an adolescent (ages 14-18 at the time of the storm).   The adolescents were, on average, 17 years of age at the time of their interview, 58% female, 50% white, not Hispanic, and 19% lived in a single-parent household (HH) (see Table 1). Fifty-four percent of the households were in NYC, 29% in Long Island/Other NY State and 17% in NJ. Most of the families were affluent, with 60% reporting a combined household income above $146,000.

The HHs are, on average, 25 feet above mean sea level and within 0.1 miles to the Storm Surge affected areas. FSE families were more exposed to the Storm than FSIP and were more negatively impacted by the Storm. Exposure (defined by 3+ items endorsed) had a rate of 32% and 4%, respectively, while Impact (defined on 15+ items endorsed) had a rate of 36% and 15%, respectively.

Table 1. Individual and Family Characteristics

Characteristics	FSE (n=22) n (%)	FSIP (n=26) n (%)	Total (N=48) N (%)
Current Age (Mean ± SD) Adolescent Mother (n=41) Father (n=32)	17.2 ± 2.00 50.8 ± 5.76 51.6 ± 4.39	16.7 ± 1.76 53.0 ± 4.63 53.4 ± 4.87	16.9 ± 1.87 52.0 ± 5.24 52.7 ± 4.69
Female Adolescent	14 (63.6)	14 (53.8)	28 (58.3)
White, Not Hispanic Adolescent Mother (n=41) Father (n=32)	13 (59.1) 14 (73.7) 9 (69.2)	11 (42.3) 18 (81.8) 12 (63.2)	24 (50.0) 32 (78.0) 21 (65.6)
Single Parent Household (HH)	4 (19.0)	5 (19.2)	9 (19.1)
HH Income ($146,000+)	13 (59.1)	16 (61.5)	29 (60.4)
Either parent Ever a First Responder	7 (31.8)	12 (46.1)	19 (39.6)
College Graduate Mother (n=41) Father (n=32)	18 (81.8) 7 (53.8)	18 (69.2) 9 (47.4)	36 (75.0) 16 (50.0)
Location of Residence NYC Long Island/Other New York New Jersey	13 (59.1) 6 (27.3) 3 (13.6)	13 (50.0) 8(30.8) 5 (19.2)	26 (54.2) 14 (29.2) 8 (16.7)
Residence above sea level (feet) (Mean ± SD)	14.9 ± 11.17	34.1 ± 42.06	25.3 ± 33.00
Miles to Super-Storm Sandy Storm Surge (Mean ± SD)	0.1 ± 0.07	0.2 ± 0.15	0.1 ± 0.13
Highly Exposed to Super-Storm Sandy (3+ items endorsed)	7 (31.8)	1 (3.8)	8 (16.7)
Highly Negatively Impacted by Super-Storm Sandy (15+ items)	8 (36.4)	4 (15.4)	12 (25.0)
High Perceived Risk to Storms (5+ items)	7 (31.8)	7 (26.9)	14 (29.2)

While 100% of the FSE families reported that they had discussed evacuating (compared to 69% of FSIP) 50% of these families reported having disagreement when making this decision (see Table 2). The FSE families were also more likely to receive a mandatory evacuation order (59%) and to have been advised by another source/person to evacuate (82%). (As these were important determinants of the eventual decision, we will be controlling for these variables in our ongoing analysis.) Surprisingly, while 27% of the FSIP received a mandatory evacuation order and 31% were advised by others to evacuate, they still did not evacuate. All of the families reported that they would evacuate if issued a *mandatory* evacuation order while only 83% would evacuate due to a *voluntary* order.

Table 2. Evacuation Information

Item	FSE (n=22) n (%)	FSIP (n=26) n (%)	Total (N=48) N (%)
Discussed with family evacuating	22 (100.0)*	18 (69.2)	40 (83.3)
Family disagreement about evacuating	11 (50.0)**	3 (11.5)	14 (29.2)
Usually get most information about hurricanes, etc., from web	18 (81.8)[1]	15 (57.7)	33 (68.8)
Obtained most pre-Sandy information from social media	5 (22.7)	12 (46.2)[1]	17 (35.4)
Received a mandatory order to evacuate	13 (59.1)*	7 (26.9)	20 (41.7)
Advised by another source/person to evacuate	18 (81.8)***	8 (30.8)	26 (54.2)
Very likely to evacuate in the future if another storm of same intensity as Super-Storm Sandy	15 (68.2)***	5 (19.2)	20 (41.7)
Would evacuate in the future if a Hurricane Watch were announced	20 (90.9)**	13 (50.0)	33 (68.8)
Would evacuate in the future if issued a voluntary evacuation order	20 (90.9)	20 (76.9)	40 (83.3)
Would evacuate in the future if issued a mandatory evacuation order	22 (100.0)	26 (100.0)	48 (100.0)

[1]$p \leq 0.1$; *$p < 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

All of the families were asked why the decided to evacuate/stay. The top 3 factors that convinced families to evacuate were: 1) severity of the storm (27.1%), 2) personal/family safety (27.1%), and, 3) news outlets like local TV or the National Weather Service (25.0%). The most important factor endorsed was personal/family safety (64.3%). The top 3 factors that convinced family *not* to Evacuate were: 1) past experience (56.3%), 2) didn't think anything would happen (45.8%), and, 3) personal/family safety (35.4%). The most important factor in not evacuating was their past Experience (47.6%).

Families were asked many questions regarding their Current preparedness and Pre-Sandy preparedness. While there was no overall difference between families that evacuated (FSE) and not (FSIP) on these variables, Pre-Sandy preparedness predicted their Current preparedness and Single-parent HHs showed less Current preparedness.

Family Discussion Group:
Using methods derived from standard focus groups, the families were asked to discuss their Super-Storm Sandy experience, their evacuation decision making and a hypothetical storm. The main goal of these discussion groups were to derive three constructs using qualitative coding: 1) adolescent participation in disaster preparedness and evacuation decisions, 2) intergenerational conflict/cooperative attitudes, and, 3) family negotiation style.

(N.B. This report only includes findings related to the first construct (adolescent participation) as the other two constructs have not yet been completely coded. An updated report will be submitted by August of this year to include these constructs and other updated analyses.)

The level of adolescent participation in decision-making was operationalized based on an adaptation of Hart's (1997)[16] 'ladder of child and youth participation', which identifies eight categories of meaningful youth participation in decision-making, arranged along a continuum from 'manipulation', in which young people do what adults tell them to, to 'initiated, shared decision with adults', in which young people take the lead and decisions are made jointly. The ladder of participation used here was adapted and collapsed to 6 rungs to assess the adolescent's involvement in pre-Sandy preparation, Sandy evacuation decision, adolescent's involvement in future evacuation decisions and their role in the discussion group. Interview transcripts were coded and assigned an ordinal score between 1 and 6 reflecting the recorded participation style.

While no difference was found between FSE and FSIP in terms of the adolescent's involvement in the family discussion group and pre-Sandy preparedness, FSE adolescents were significantly more involved in the decision to evacuate due to Super Storm Sandy (see Figure 1).

Figure 1. FSE Adolescent involvement in Discussion Group, Pre-Sandy Preparedness and Storm Evacuation Decision

*p<0.05; **p≤0.01; ***p≤0.001
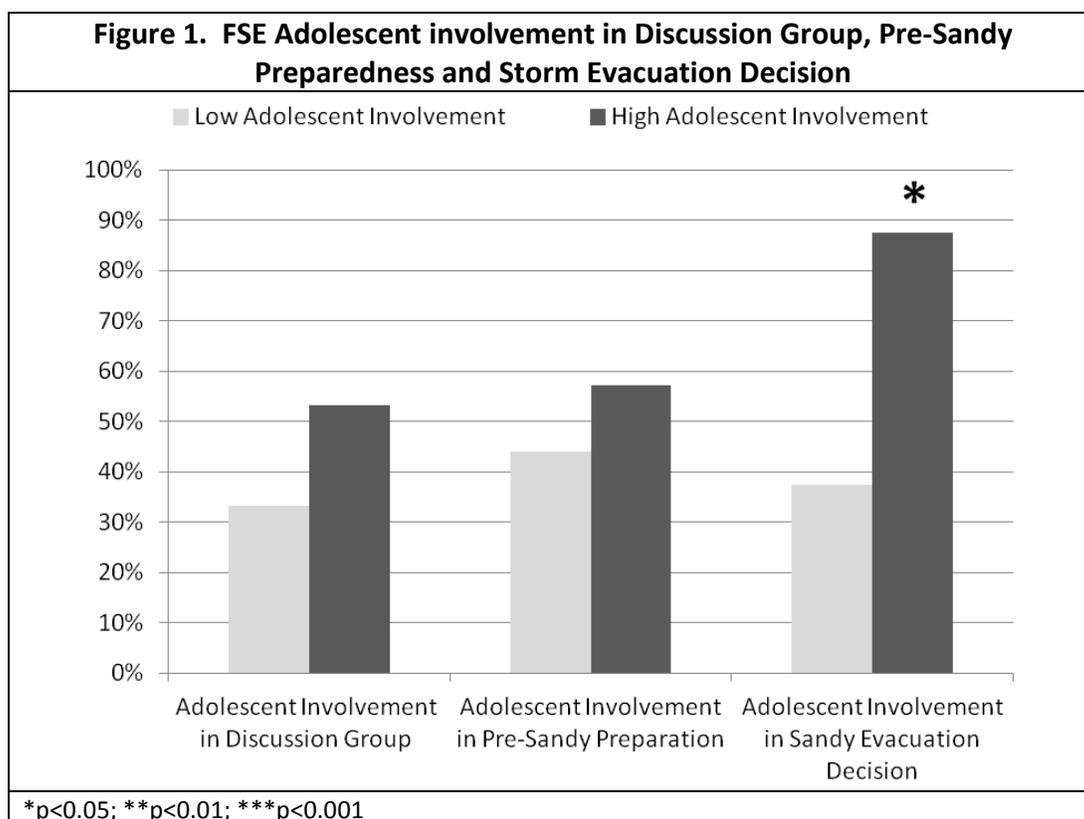
The families were also asked to discuss a hypothetical storm (with 90 mile/hour winds). Although no group differences were found, adolescents in single-parent households and female

adolescents were significantly higher in involvement in the decision-making process (see Figure 2).

Figure 2. Adolescent Involvement in Future Evacuation Decisions

*p<0.05; **p≤0.01; ***p≤0.001
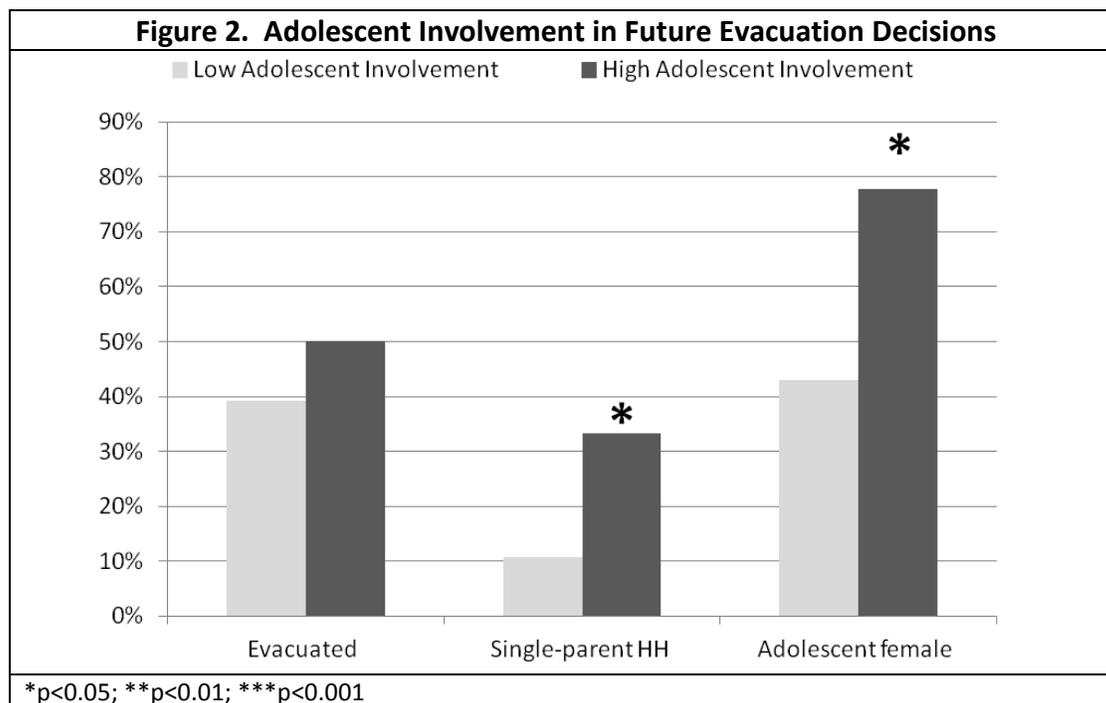
Decision-Making Tasks:

Table 3. BART and DTG

Outcome*	β	p
BART		
Evacuated (ref=FSIP)	1.85	0.4794
Single-parent (ref=2-parents)	2.33	0.5111
Parent Ever FR (ref=non-FRs)	0.29	0.9126
Female (ref=male)	0.67	0.7685
Age	0.05	0.4366
TRUST		
Evacuated (ref=FSIP)	0.05	0.2134
Single-parent (ref=2-parent)	-0.04	0.5357
Parent Ever FR (ref=non-FRs)	0.09	0.0542
Female (ref=male)	0.08	0.0671
Age	0.00	0.3653

* Individuals - All models mutually adjusted and control for correlation among family members

As described earlier, two laboratory style tasks were administered to each participant, the BART (measures risk) and the DTG (Trust and Reciprocity). FSE individuals - controlling for single-parent HHs, parents being a First Responder (FR), gender and age of adolescent - did not differ from FSIP in terms of risk taking or Trust (see Table 3). However, families in which a parent had been a First Responder had significantly higher trust scores.

Main Objectives/Hypotheses:

Objective 1. To test the effect of Decision-making Styles (DMS) and Decision-making Compatibility (DMC) on Disaster Preparedness (DP) and Actual Disaster Evacuation (DE).

Hypothesis 1 Low Risk Taking (as measured by Balloon Analogue Risk Task (BART)), and high Trust/Reciprocity (as measured by the Developmental rust Game (DTG)), in adults and adolescents, predict high family Disaster Preparedness (DP), and actual Disaster Evacuation (DE).

Two linear regression models were constructed with DP scores as the outcomes and parent and adolescent average number of pumps (from the BART) and mean percentage trust and mean percentage reciprocity (from the DTG) as predictors. A logistic regression models was constructed with DE status (evacuated or did not evacuate) as the outcome and parent and adolescent average number of balloon pumps (from the BART) and parent and adolescent mean percentage trust and mean percentage reciprocity (from the DTG) as predictors. All associations were tested in separate models and adjusted for FR family, single-parent family, parent gender, and parent age.

BART, Trust and Reciprocity Scores did not significantly predict evacuation status or Pre-Sandy preparedness. However, negative association was observed with the Trust proportion and Current preparedness (see Figure 3), indicating that those parents who trust less are more currently prepared.
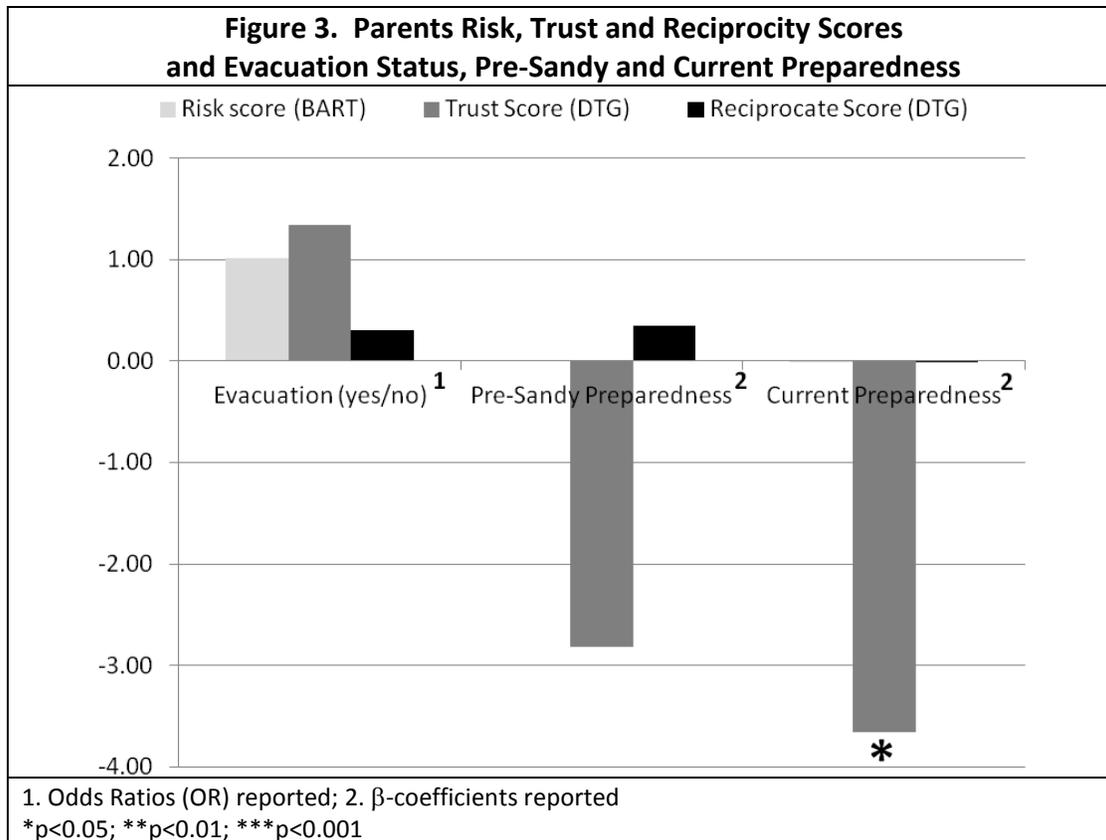
Figure 3. Parents Risk, Trust and Reciprocity Scores and Evacuation Status, Pre-Sandy and Current Preparedness

1. Odds Ratios (OR) reported; 2. β-coefficients reported
*p<0.05; **p≤0.01; ***p≤0.001

Objective 2. To test the effect of Decision-making Styles (DMS) and Decision-making Compatibility (DMC) on constructive family decision-making processes.

Hypothesis 2: Low Risk Taking (BART), high Trust/Reciprocity (DTG) and high level of decision compatibility predict high level of adolescent participation in decision-making, high level of intergenerational cooperative attitudes, and positive family negotiation style.

Logistic models were constructed with the adolescent participation scores (described above) as the outcome variable, and parent and adolescent average number of balloon pumps and mean percentage trust and mean percentage reciprocity as predictors. All associations tested in separate models, include a random intercept to account for correlation among family members, and are adjusted for FR family, single-parent family, gender, and age.

Although families with high adolescent involvement in Super-Storm Sandy evacuation decision making had a Trust Score odds ratio of 11.01, it was not significant (p=0.23). No significant association was observed in these models (see Figure 4).
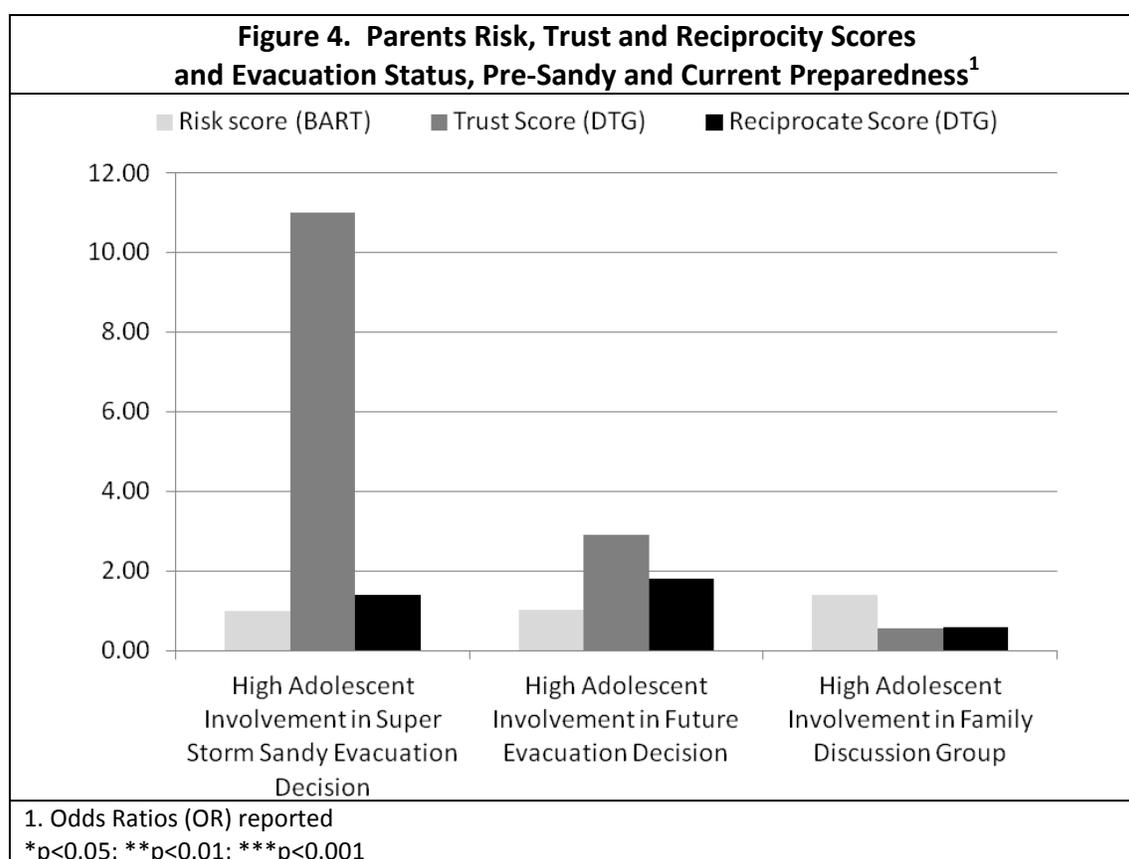
Figure 4. Parents Risk, Trust and Reciprocity Scores and Evacuation Status, Pre-Sandy and Current Preparedness[1]

1. Odds Ratios (OR) reported
*p<0.05; **p$\leq$0.01; ***p$\leq$0.001

Objective 3. To test the effect of constructive family decision-making on Disaster Preparedness (DP) and Disaster Evacuation (DE).

Hypothesis 3: High level of adolescent participation in decision-making predict high family Disaster Preparedness (DP), and actual Disaster Evacuation (DE).

Linear and logistic models were constructed with DP score (linear) or DE status (logistic) as the outcome, and high adolescent participation score as predictor. All associations tested in separate models and adjusted for FR family, single-parent family, child gender, and child age.

High Adolescent involvement did not significantly predict Pre-Sandy or Current preparedness (see Figure 5). High Adolescent Involvement in Super Storm Sandy Evacuation Decision was significantly associated with actual evacuation status, indicating that the adolescent of those families that evacuated did, in fact, play a role in the decision to evacuate. Thus validating a major hypothesis of this study.

Figure 5. Parents Risk, Trust and Reciprocity Scores and Evacuation Status, Pre-Sandy and Current Preparedness

☐ High Adolescent Involvement in Pre-Sandy Preparations
☐ High Adolescent Involvement in Super Storm Sandy Evacuation Decision
■ High Adolescent Involvement in Future Evacuation Decision

1. Odds Ratios (OR) reported; 2. β-coefficients reported
*$p<0.05$; **$p\leq0.01$; ***$p\leq0.001$
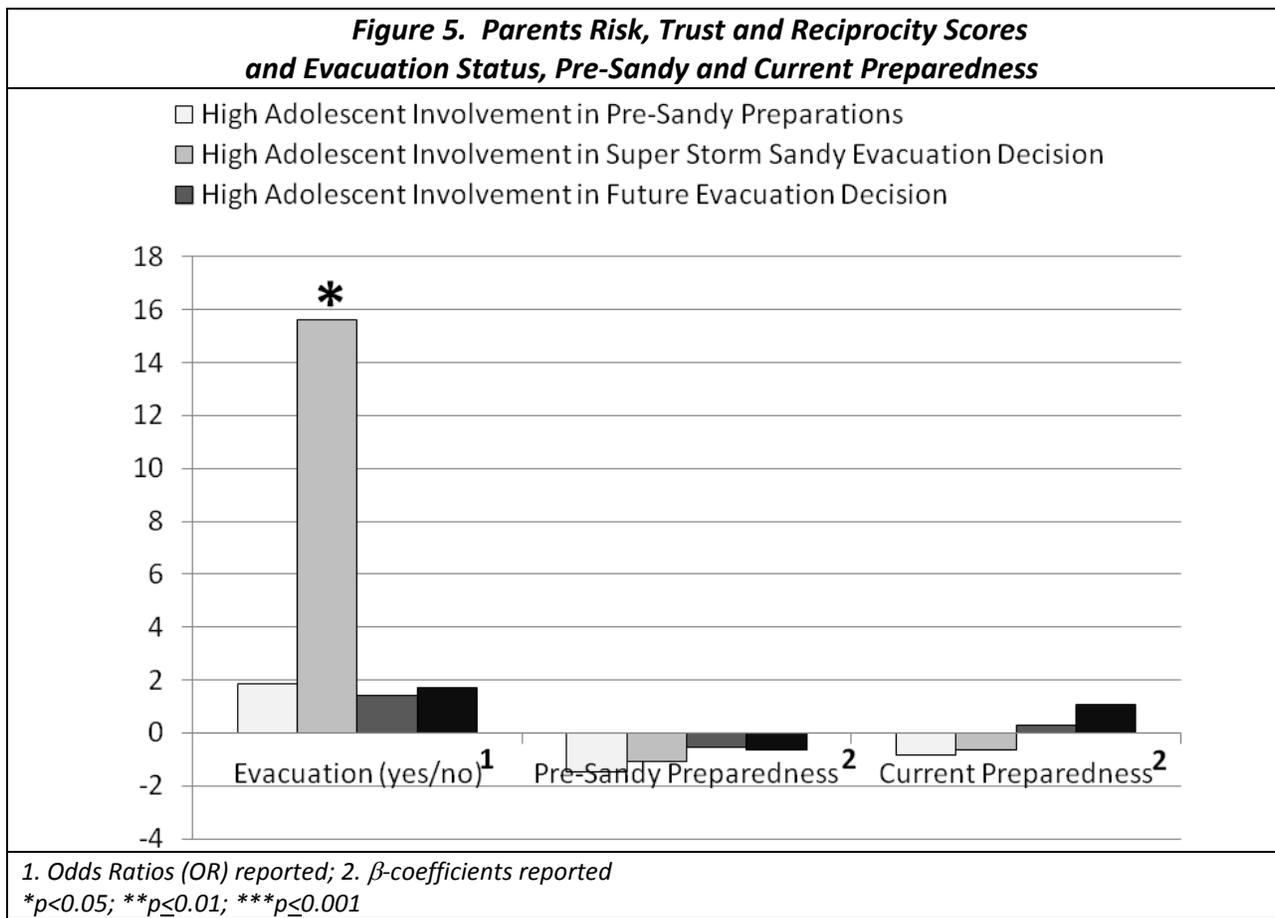
Objective 4. To impact curriculum for adolescents around DP and DE behavior.

Plan: We will share our findings with the Sea Grants program of the tri-state area and our end users with the objective of revising / creating new educational materials and curriculum for adolescents focused on DP and DE. In conjunction with our collaborators and End-Users we are planning to conduct workshops in the schools in the 2015-2016 academic year.

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K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

While there has been considerable attention paid to the most effective ways of engaging adults as individuals in disaster preparedness and actual disaster responses, including evacuation, the role of adolescents and the role of the family as a decision-making group around disaster preparedness and evacuation has not received sufficient attention. This study, carried out by the Child Psychiatric Epidemiology Group - Columbia University/New York State Psychiatric Institute (CPEG), under the direction of Drs. Christina Hoven, Lawrence Amsel and George Musa, studied Super-Storm Sandy exposed families using an innovative study design that combined intense individual family discussion groups with behavioral-decision making tasks, to gain a multidimensional understanding of how adolescent decision-making interacts with family decision-making around disaster preparedness and evacuation. With a particular interest in adolescent inclusion in the family decision-making process. These results, in the hands of our emergency response and educational partners, could be instrumental in creating educational programs that empower youth and improve family engagement around disaster preparedness and evacuation, potentially saving lives.

Our study has found that:

1. Among families deciding to evacuate, adolescent involvement in evacuation decision-making was significantly higher than in families who did not evacuate.

2. Families that evacuated were more likely to have discussed the evacuation within the family, and were more likely to have had disagreements about evacuation than were families that did not evacuate.

3. Families that evacuated were more likely to have been "advised or mandated" to evacuate, and more often accessed web-based information about the storm, than families who did not evacuate.

4. Sixty percent of evacuating families, and 27 percent of non-evacuating families had received a mandatory evacuation order during Sandy. However, there was no difference between evacuating and non-evacuating families in stating they would follow a mandatory evacuation order in the future.

The ultimate aim of this research is to increase our current understanding of the various intricacies of family decision-making processes and to examine the roles that adolescents play in those processes. This research could benefit public health and public safety by assisting in the development of future strategies for disaster educational programs that are based on a scientific understanding of individual and group decision-making processes and their coordination. It also holds the promise of empowering adolescents and young adults to have more relevant roles in family decisions. CPEG plans to share the research findings with our end-user education partners who will use them to produce curricula and tangible educational materials that will enhance disaster preparedness by including important human-factor aspects of decision and negotiation style into these programs, and, importantly, by helping personalize the education by making learners aware of their individual and family decisional styles, and how this affects their outcomes.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Lane Smith lane.smith@stonybrook.edu, Research Program Coordinator, New York Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Lane Smith at (631) 632-9780. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Dr. Clifford W. Scherer, Cornell University and Dr. Laura N. Rickard, SUNY, College of Environmental Science and Forestry, Dr. Gina Eosco, Cornell University.

Date of Report submission: June 1, 2015

Project #: R/CSAP-4-NY

Project Title: Measuring public responses to a surge of information: How individuals understand, react, and respond to storm surge media messages

Principal Investigator(s) and Affiliation(s):

1. Dr. Clifford W. Scherer, Cornell University

2. Dr. Laura N. Rickard, SUNY College of Environmental Science and Forestry

A. PROJECT GOALS AND OBJECTIVES:

The overall goal of this research is to better understand how coastal audiences obtain, understand and utilize storm risk information in deciding the nature of the risk to their safety and property and whether or not to evacuate.

The goal is to develop guidelines for improving the communication of complex storm risk to coastal audiences. More specifically, the project has five research questions.

RQ1: How do participants perceive (a) hurricane-related and (b) storm surge-related risk? To what extent do they perceive these risks as under their control?

RQ2: Controlling for knowledge, trust, channel reliance/beliefs, strength of social network, and past hurricane experience, how does visual type (i.e., iconic or indexical) relate to perceived (a) hurricane-related and (b) storm surge-related risk?

RQ3: Controlling for knowledge, trust, channel reliance/beliefs, strength of social network, and past hurricane experience, how does visual type (i.e., iconic or indexical) relate to hurricane-related behavioral intentions (i.e., to evacuate or not)?

RQ4: How do participants attribute responsibility for the cause of and the response to a given hurricane event?

RQ5: Does attribution of responsibility mediate past hurricane experience and present perceived (a) hurricane-related and (b) storm surge-related risk?

B. **RESULTS:**

This project involved three different methods: (1) A survey of coastal residents using a panel design implemented by GfK (n=619 respondents) (2) An experimental study examining visual effects on risk perception of storm warnings. This panel study was implemented by Qualtrics (n=1,052 respondents) and (3) Seven focus groups of coastal Connecticut residents (n=72 participants). Each of these three data collection methods provided unique views into the decision-making processes of coastal residents, their perception of risk and their decisions to evacuate or not.

Method #1: Survey of Coastal Residents

To test our major theoretical model RISP (Risk Information Seeking and Processing) we cooperated with the project "Forecasting Evacuation Behaviors of Coastal Communities in Response to Storm Hazard Information," with PI Ricardo Daziano. This was a panel study of 619 Coastal residents in NY, NJ and Ct. Incorporated into this study were variables which allowed us to test the appropriateness of the RISP model for predicting information seeking by coastal residents during a severe storm. Preliminary results of this study are reported later.

Method #2: Experimental study

Originally we had planned a central component of our project to be working with the National Hurricane Center (NHC); we had proposed to work with the NHC on testing audience perceptions of their newly created storm surge inundation map graphic by using an experimental broadcast video. In Progress Report #2, we describe our challenges and ultimately, our inability to work with NHC or with The Weather Channel to produce a video stimulus.

Without a video to use as a stimulus in the experiments, we were challenged to re-think our plan for using the real-time-response methods. As described in our Progress Report #2, in order to test our hypotheses we instead developed an online experiment, administered by the survey company Qualtrics and distributed to their panel members in CT, NY, and NJ in April 2015. The experiment employed a written broadcast (formatted to look similar to a post on a weather blog) describing a hypothetical "Hurricane Pat" and followed a 3 (visual type – photo of storm surge, map of projected storm surge, or no image) x 2 (acknowledging the shared responsibility of evacuation vs. not acknowledging the shared responsibility) factorial design. In addition to

questions gauging participants' perceptions of the broadcast, this questionnaire also included questions taken from our previous survey to residents of NY, CT, and NJ (administered by GfK between September 2014 and February 2015), including: (a) previous experience with hurricanes; and (b) individual characteristics, including sex, education level, and race/ethnicity, and home ownership. Data collection was complete on April 20, 2015 with $n = 1,052$ responses.

Although the Qualtrics survey allowed us to explore our visual hypotheses, we were not able to gather real-time response data – i.e., measuring change in risk perception on a moment-by-moment basis with respect to a dynamic weather-related video. Therefore, in planning our upcoming focus groups with residents affected by Hurricane Sandy, we decided to incorporate use of the dials as an aspect of the discussion format. (Note: Although we reached out to Sea Grant contacts in NY, CT, and NJ for help recruiting community groups for focus group discussions, we received an overwhelming response from our contacts in CT, and so focused our efforts exclusively on recruiting CT groups.) Focus groups took place between April 22-26 in the towns of Fairfield, Stonington, Groton, Old Saybrook, and Greenwich, CT, and involved 72 participants. Upon convening these groups of coastal CT residents, however, we soon discovered that the quantity and richness of the discussion generated by our discussion questions alone made asking an *additional* set of questions based on the RTR method impossible given time restrictions. As a contingency plan, we had discussed having PI Scherer recruit undergraduate students at Cornell to use the dials to react to video clips of weather broadcasts. Unfortunately, co-PI Rickard was unable to attend the focus groups due to family issues, and so plans to run the dial experiment at Cornell concurrently with the focus groups in CT had to be abandoned when PI Scherer took Co-PI Rickard's place in facilitating the focus groups (along with postdoc Gina Esoco and MS student Dave Haase.)

Method #3: Focus group study

Surveys and experiments are important tools for understanding how individuals and groups respond to different conditions and information. However, both of these methods require that the researcher have some level of pre-conceived idea of how residents understand, obtain and utilize information in their decision-making. Focus groups are an excellent tool for hearing how the individual and community think about the issues, where they get information and what that information means to them in a crisis situation. To gain a broad understanding of how individuals think about what happened before and during Sandy, we conducted seven focus groups along the coast of Connecticut.

Participant Recruitment

Connecticut Sea Grant played an instrumental role in connecting us to community gatekeepers. We provided an invitation email and a corresponding PDF explaining what our project was about, which was disseminated to their community leaders.   Interested community leaders then corresponded with us directly.

Each community leader had a different way of contacting the members of their area. For example, Fairfield used sign-up sheets from Sandy aftermath public meetings. Fenwick and Greenwich primarily used homeowner's association list serves. The community of Groton

contacted numerous individuals including city planners and emergency personnel. Each focus group was a little different marking the uniqueness of all the communities.

Focus Group locations and # of Participants

	# of Females	# of Males
Fairfield:	4	9
Stonington:	5	8
Groton #1:	2	8
Groton #2:	1	2
Fenwick/Old Saybrook:	1	8
Greenwich 1:	6	8
Greenwich 2:	6	4
	2	+ 47 = 72 total participants

Participant Characteristics

One important factor to consider, however, is that the participants were self-selected. That is, the focus groups were entirely voluntary, and by the nature of how individuals were invited, many others were not. Using invitation lists from past public meetings will inevitably target citizens who are already interested in participating in such discussions. This does not discredit the findings, but it's important to reflect on all those participants who were not present.

Additionally, although we did not objectively collect age information, participants noted that the neighbors they saw around the table were not "the younger folks." Those who decided to participate tended toward retirement age. We did, however, have a few participants with younger children. But, there was a frustration among the older generation that the younger generation did not make time for such discussions.

Format and Length of Focus Groups

The majority of the focus groups were around 2 hours in length with one or two nearing the 2.5-hour mark. Participants were eager to stay and continue discussions. One session had to end at 2 hours simply because another one was taking place in the same location. There was a longing to discuss Sandy. Once the recorders were off numerous participants thanked us for listening. One woman expressed to me that she had no idea how much she was holding in until she had the opportunity to share it. Others saw the focus group as a great way to have a community discussion. In fact, 3 of the communities asked for a summary report of what was discussed for their community. They saw it as an action plan.

Findings:

Below, we review each of our objectives and follow with a brief summary of the relevant findings from each applicable method: (a) GfK survey (administered to a representative sample of NY, CT, and NJ residents living in zip codes affected by Hurricane Sandy); (b) Qualtrics

survey (administered to a non-representative sample of NY, CT, and NJ residents who may or may not have been affected by Sandy); (c) focus groups with residents of coastal CT affected by Hurricane Sandy. Please note that we are in the beginning stages of analyzing our data, and so we present just a surface-level overview of our findings.

OBJECTIVE 1: To better understand the way(s) in which residents of coastal New York (NY), New Jersey (NJ), and Connecticut (CT) communities perceive (a) hurricane-related and (b) storm surge-related risk.

Findings: Initial results from the GfK survey data suggest various statistically significant differences in hurricane-related risk perception based on both demographic characteristics and past hurricane experience.

We found differences in risk perception between:

- Individuals who reported that they evacuated during Hurricane Sandy ($M = 20.9$) and those who did not ($M = 15.29$), $t(47.48) = 3.69$, $p = .01$.
- Individuals who reported at least some general hurricane experience (e.g., having been in a hurricane, having some property damage from a hurricane) ($M = 15.63$) and those who did not have any experience ($M = 12.10$), $t(552) = 3.69$, $p = .00$.
- Individuals who reported at least some specific Hurricane Sandy experience (e.g., experiencing storm surge in one's neighborhood, experiencing personal loss) ($M = 15.88$) and those who did not ($M = 10.70$), $t(84.64) = 6.24$, $p = .00$.
- Non-Hispanic Whites ($M = 15.59$) and all other races/ethnicities ($M = 14.23$), $t(606) = -2.10$, $p = .04$.
- Residents of the three states ($F_{2, 605} = 6.82$, $p = .001$). A Bonferroni post hoc test found significant difference between the mean risk perception of NJ and NY residents ($p = .001$), with NJ residents' risk perceptions higher than those of NY residents.
- Individuals living in houses ($M = 15.73$) and those living in apartments/other types of housing ($M = 14.53$), $t(606) = -2.01$, $p = .04$.
- Individuals who own homes ($M = 15.71$) and those who don't ($M = 14.28$), $t(606) = -2.34$, $p = .02$.
- Individuals who are currently employed ($M = 15.70$) and those who aren't ($M = 14.42$), $t(606) = -2.12$, $p = .04$.
-

Moreover, risk perception was positively related to likelihood to evacuate in the case of a future hurricane with the same intensity as Sandy ($r = .24$, $p = .000$, $n = 608$).

Summary: *This, of course, suggests that in may be that storm communication should concentrate on increasing the perception of individual risk. This is not the exaggeration of risk the media often does. This exaggeration may boomerang—since it may not be believable and residents tend to discount or ignore the actual risk as "hype'. What is needed is to help individual understand their individual specific risk. This was clearly articulated by respondents in the focus groups who responded to responders knocking on their door explaining the risk to "them" specifically. Every indication suggests that this increased individual risk perception which then contributed to their evacuation.*

In addition, focus groups data suggest that CT residents use recall heuristics as a cognitive short cut to make sense of the risk of hurricanes; however, this practice may also result in a boomerang effect (i.e., the opposite effect of that which is intended). Focus group participants spoke of using the 1938 hurricane as a marker, using the reasoning that, if their house weathered this major storm, then it could endure Sandy, ultimately deciding to stay put. (Research suggests that similar reasoning was used by New Orleans residents who perceived the risk of Hurricane Katrina in light of their experience during Hurricane Camille). Residents also recalled broadcasters reporting that the noon high tide would be around the height of the high tide during Hurricane Irene. When it wasn't, some residents' risk perceptions diminished, and they decided not to evacuate.

OBJECTIVE 2: To experimentally test the effect of varying the type of visual image that conveys storm-surge related risk on participants' (a) perceived hurricane-related and storm surge-related risk and (b) behavioral intentions (e.g., to evacuate or not), while controlling for variables known to contribute to perceived risk and behavioral intention (e.g., past experience, knowledge of hurricanes, trust in authority figures, etc.).

Findings: Results from the Qualtrics questionnaire suggest that differing visual type (i.e., no visual, map of storm surge, or photograph of storm surge) had a marginally significant effect on perceived concern about storm surge from hypothetical Hurricane Pat, but only within forecasts that did *not* acknowledge a "shared" responsibility for hurricane safety ($F_{3, 1048} = 2.44$, $p = .06$). Post hoc analysis (Games Howell, due to non-homogeneity of variance) suggested that individuals assigned to the condition 2B (photo of storm surge, individual responsibility) were more concerned than those in conditions 1A, 2A, or 3A (i.e., no visual, map of storm surge, or photo of storm surge, all with shared responsibility), $p = .07$. In addition, individuals in condition 2B were more concerned than those in condition 3B (map, individual responsibility), $p = .08$.

Moreover, we were able to experimentally test the effects of varying visual image on participants' perception of the risk of Hurricane Pat while controlling for past experience with hurricanes and other individual characteristics. A hierarchical OLS regression predicting risk perception (perceived seriousness of the risk of Hurricane Pat * perceived likelihood of harm) ($F_{14,741} = 20.66$, $p = .00$, adjusted $R^2 = .27$) suggested that being female ($B = .67$, $p = .10$), number of children ($B = .37$, $p = .02$) and perceiving the Hurricane Pat forecast as believable ($B = 4.18$, $p = .000$) were related to increased risk perception. (In the final model, experimental condition failed to reach significance.) In a regression predicting perceived concern about storm surge from Hurricane Pat ($F_{14,751} = 15.48$, $p = .00$, adjusted $R^2 = .21$) number of children ($B = .06$, $p = .02$), having experienced impacts from previous hurricanes ($B = .09$, $p = .00$), and perceiving the forecast as believable ($B = .60$, $p = .00$) were related to increased perceived harm. Identifying as White (as compared to non-White) ($B = -.26$, $p = .01$), and amount of general experience with hurricanes (e.g., having been in a hurricane, having evacuated) ($B = -.05$, $p = .03$) were related to decreased perception of storm surge harm from Hurricane Pat. Again, experimental condition failed to reach significance in the final model.

SUMMARY: *These findings suggest that how storm risk information is visualized and contextualized can influence how coastal residents respond. Much additional research needs to*

be done on how storm risk is and can be visualized to increase understanding and risk perception and thus influence appropriate evacuation. Currently, the mass media concentrate on either maps of the storm, radar, or the reporter standing out in the storm. None of these may be as helpful as an indexical photograph of what it may look like when the storm hits.

OBJECTIVE 3: To better understand how attribution of responsibility for the cause and/or the response to a given hurricane event relates to (a) perceived hurricane-related and storm surge-related risk and (b) behavioral intentions (e.g., to evacuate or not).

Findings: **How individuals perceive their responsibility for their own safety or the responsibility of authorities or others for maintain their safety influences individual intentions to evacuate.** Initial results from the GfK survey data suggest that perceiving individual-level responsibility for hurricane-related storm preparedness/response is negatively related to intention to evacuate during a future hurricane with the same intensity as Sandy ($r = -.12$, $p = .00$, $n = 608$). In other words, the more survey respondents saw individuals as responsible for their safety during Hurricane Sandy (e.g., agreeing that "People who did not heed the evacuation orders are responsible for what happened to them"), the less likely they were to report that they would evacuate during a future storm. Moreover, individual-level responsibility was also positively related to risk perception ($r = .08$, $p = .05$, $n = 601$) – that is, the more respondents perceived individuals as responsible during Hurricane Sandy, the more risk they perceived with respect to hurricanes. Interestingly, respondents' satisfaction with the actions of "external" actors (e.g., police, first responders, government officials, etc.) during Hurricane Sandy (e.g., agreeing that "The federal government did as good a job as it could in responding to Hurricane Sandy") was also negatively related to evacuation intention ($r = -.09$, $p = .04$, $n = 611$). (We used these measures as representing "external" responsibility.)

The GfK survey data also suggest several positive statistically significant correlations between attribution of responsibility, past hurricane experience, and individual characteristics. In particular, we found correlations between individual-level attribution of responsibility and:
- General hurricane experience ($r = .09$, $p = .03$, $n = 556$)
- Age ($r = .09$, $p = .04$, $n = 608$)
- Household income ($r = .15$, $p = .00$, $n = 608$)
- Education ($r = .09$, $p = .03$, $n = 608$)

In addition, we found positive correlations between satisfaction with the behavior of external actors during Sandy and:
- Individuals' degree of social support ($r = .15$, $p = .02$, $n = 257$)
- Household income ($r = .12$, $p = .00$, $n = 611$)

Interestingly, we also found a positive correlation between attributing Hurricane Sandy to the effects of climate change and likelihood of evacuating in the event of a hurricane similar to Sandy ($r = .15$, $p = .00$, $n = 609$).

In an OLS regression model predicting likelihood of evacuating in the event of a hurricane similar to Sandy ($F_{12, 463} = 14.90$, $p = .000$, adjusted $R^2 = .26$, $N = 476$), neither individual attribution of responsibility nor external attribution of responsibility reached significance in the

model; however, attributing Sandy to climate change did ($B = .14$, $p = .004$). Other significant variables in the model included: length of residence in current state ($B = -.62$, $p = .001$); satisfaction with evacuation decision ($B = -.26$, $p = .000$); having evacuated during Sandy ($B = 1.87$, $p = .000$); risk perception ($B = .04$, $p = .000$); protective action perception (perception that taking certain actions will reduce financial consequences of a storm) ($B = .21$, $p = .006$); and hurricane-related information gathering capacity ($B = -.20$, $p = .012$).

Almost all focus group participants seemed to acknowledge their individual responsibility to secure their home, as well as accept the consequences of their decision to stay (rather than evacuate). Participants expressed that they understand that first responders could not rescue them if they chose to remain in their homes; however, it remains unclear whether this stated acceptance of the consequences of one's decisions changes when faced with impending physical risk, such as having water fill their home.

Summary: These findings can be important in how storm risk messages are framed in the future. If messages are framed to transfer responsibility for their safety to the individual rather than first responders or other authorities, the decision to evacuate of not may be greatly influenced.

OBJECTIVE 4: To contribute to the development of visual communication theory in the context of risk issues, and to apply a novel methodological approach to quantifying dynamic risk perceptions and behavioral intentions in real time.

Findings: Although we were able to explore how visual type influences perception of risk via the Qualtrics survey, we were not able to do so with a novel methodological approach (i.e., Real-Time-Response technology) as described earlier in this report. Results are discussed as a part of Objective 2 above.

OBJECTIVE 5: To develop best practices for practitioners for how to convey visual information about hurricane and storm surge to public audiences in order to encourage risk perceptions and behaviors aligned with experts' recommendations.

The focus groups provided an interesting approach to answering thie objective. Below is a brief overview of how respondents described their understandings and need for information.

Sandy as a false alarm? What the media shared compared to what people heard.

Tropical storm. Monster. Superstorm. These are all phrases that Connecticut coastal residents heard as Sandy was approaching their coastline. Not all of these words resonated with each resident the same way. Nor did everyone interpret the impending risk the same way. There were many storm details communicated to them by many sources, which led to vastly different risk perceptions.

Sources. All focus group participants mentioned local TV stations or The Weather Channel as one of their primary "weather watching" sources. There was at least one participant of every location that specifically mentioned the National Oceanic and Atmospheric Administration (NOAA) or the National Hurricane Center as their primary source of hurricane information. But, despite these sources to gather weather information, it was local sources that influenced their decisions to stay or go. Coastal residents who were under mandatory evacuations remarked about fire and police officials knocking on their doors. They received 911 robo calls. Their neighbors came to check on them. Family members from out of state started calling. It was more local sources that influenced their final decisions.

As residents who live on the coast, it is their responsibility to stay weather aware, they all proclaimed. They begin gathering hurricane information days before landfall. But, because hurricanes are a long fuse event compared to a severe thunderstorm warning with 20 minutes notice, the participants stated they feel "hurricane news fatigue" by the time action is required.

Tone and Hype. Further, all coastal residents mentioned the hype about Irene, and how "forecasters tend to exaggerate." Interestingly, the residents did not describe Irene as a false alarm. Indeed, western CT communities noted that Irene brought significant, but not major, flooding and erosion to their area. They described, however, that they felt the media coverage did not warrant the hype compared to the impacts.

With Sandy, however, they said that they did feel the tone was different. Some more weather savvy participants noted that the "What do we call this storm" dialogue - hurricane, nor'easter, superstorm? - but forecasters provided a sense that this storm was unique. One Fairfield resident noted that they just "thought the predictions were wrong."

Why? All of the focus group participants expressed a general sentiment that the news does not provide a coastal forecast. For western CT residents, the news is focused on the impacts of New York City. For central CT coastal residents who have Hartford news stations, they simply feel left out. And the eastern CT residents say they are forgotten – not close enough to New York City or Boston to receive attention. The media did cover coastal risks and impacts for Sandy, but perhaps the residents feel that what is covered is too general. It is not relatable to them.

For this reason, residents emphasized the role of local sources, or forecast translators to tell them if they should take the storm seriously. After all, "It was only a tropical storm," proclaimed one resident. Yet many participants excitedly stated that local officials *did* express the severity of the storm knocking on doors, driving through neighborhoods making announcements via a loud speaker.

Despite all of these actions and messages, what was shared compared to what was heard is a tale of two stories. As residents continued to explain what they heard, it became apparent that the problem was not a single source, but the combination of hearing many.

- **Timing of the "worst" tide -** As residents who live on the coast, the participants noted how important the timing of high tide is. As such, all of the participants said they were

listening for the worst high tide. There were two versions of the highest high tide. About half heard that the evening high tide was forecast as the highest tide, and the second half heard that the noon high tide was forecast as the highest high tide. Both groups noted Hurricane Irene as their anchor for hearing this.

- **Success and Failure: Irene as a recall device** – Using Hurricane Irene as a recall device was both a success and failure. According to the participants, many broadcasters used Irene to describe how high the tide forecast was at noon the day Sandy hit. Those who heard that the highest high tide was in the evening described their fear when the water reached Irene levels by early afternoon. This convinced many who decided not to evacuate to evacuate, as they noted that the tide never receded. For those participants who heard that noon was the highest high tide, their fear was relieved when the tide *only* reached Irene levels. They thought they were in the clear. "They had missed the worst."

- **Surge Time as Fear** – Participants noted that storm surge is frightening, but only if you cannot see it. "If a surge comes in at night, it's much more frightening. You can see it during the day." Many participants noted the importance of seeing and observing the surge first hand. Hearing a prediction is not the same as experiencing it.

- **What do you call rising water?** – The participants shared that many media outlets, emergency personnel and local officials all used different descriptions of the surge, which ultimately led to confusion. The following is a list of descriptions the participants described:
  - 7 feet above normal
  - 7 feet above high tide
  - 18-20 feet of surge
  - 18-20 feet of storm surge

  Although a meteorologist may see similarities in these descriptions, to the coastal residents, all of these terms meant distinctly different impacts. In fact, Greenwich residents originally heard "7 feet above normal." They all remarked that this resonated with them. However, when police knocked on their doors to urge evacuation compliance, the police said it was an 18-20 foot storm surge. For many, this caused confusion and fear.

  Further, additional residents said some police and fire officials were describing the surge as "engulfing" them. Residents thought, then, that surge was a big wave like a tsunami. Listening to many media outlets and local officials led to the use of many words to describe surge. Engulf sparked images of large waves, not an inundation of ocean water, where as above normal resonated with many residents. Participants from Fenwick also suggested "extra high tide" or a "super high tide" for future surge communication.

- **No precipitation with Sandy** – The residents described their perceived notions of hurricanes in combination with what they heard on the media. They listed rain, wind and surge as the main weather ingredients of the storm. In the days leading to Sandy, they heard so many messages about the monster storm that they were expecting a deluge of

rain on that Monday. But, Monday's weather confused them further and actually led many to decide not to evacuate. They explain:

> *"The day Sandy hit it was beautiful. It didn't feel like a monster storm was coming."*

> *"Not much rain so we thought the worst was over."*

> *"Weather conditions prior to the storm were so nice, so many people didn't make preparations."*

Expecting to experience all three hazards, residents were caught by surprise when the rain did not fall. This led many to believe that they had missed the worst of the storm. It also made many residents feel that the forecast was simply wrong.

Should I stay or should I go?

Women and Wives. Those who did evacuate were mostly women or wives who made their family evacuate. The women described themselves as "rule followers." One family explained that they have a child with a disability and always evacuate for the safety of their child (they did not disclose the type of disability). Another elderly woman said her adult children kept calling and "pestering" her, and she finally caved and evacuated to "keep them quiet."
Weather Sport. One gentleman remarked that he stayed, as not evacuating was akin to a sport, a "weather sport." He explained that some people sky dive or mountain climb, but for coastal residents staying home and watching a storm is a sport to them. It's one of the reasons they live there. It excites them.

FEMA Compliant Homes. Many individuals stated that they stayed because their homes were "FEMA compliant." Perception of home safety is an increasingly important factor when deciding to evacuate or not. Residents may want to stay, but if they are concerned about the structure of their home, they may decide to evacuate. As described by the residents, having a FEMA compliant home is analogous with a safety stamp of approval from FEMA. With this focus group sample, this compliance has an association with non-compliance of evacuation orders. Those who are now rebuilding to FEMA compliant levels also indicated that they may not evacuate due to their increased safety. Many, however, indicated that their Sandy experience was so scary that they will never stay again.

Hurricane of 1938 survivor. Another marker of perceived home safety was survival from the 1938 hurricane. Many residents have historical data on their homes and knew whether or not their home had flooded during the 1938 hurricane. For many, this information was a deciding factor to stay or evacuate. If their home did not flood during the 1938 hurricane, then Sandy was no match.

The use of reverse 911. Many residents noted their appreciation of their towns and municipalities using reverse 911 to inform their residents of the storm. They noted, however, that the message never changed in language or tone as Sandy neared. Receiving a repeat message did not increase their risk perception. Participants in Greenwich said that if a new voice had been recorded that conveyed a more serious tone, they may have taken it more seriously.

False Loyalty. Many residents noted that their decision to stay was to protect their home. One female resident captured it well, "We have a false loyalty to our home." She explained that it does not make sense. The home will not take care of them, and in the end, they really cannot prevent the surge from taking their home either.

Evacuation Discomfort. Many residents noted their discomfort with evacuating. Collectively, there were 3 main reasons.

- **An Evacuation Sardine** – Although *none* of the residents voluntarily evacuated to a shelter, there is a perception that shelters treat people like sardines. Their impressions are in part influenced by their memories of media coverage from Hurricane Katrina.

- **Not Enough Hotels** – All of the participants proclaimed that there are not enough hotels. Some residents did look for a hotel further north, but all hotels were booked. Additionally, hotels raised their rates discouraging residents from staying. Because of this, many felt more comfortable at home.

- **A fear of wind and trees** – A common theme among all of the focus group participants was that evacuating north meant an increased likelihood of a tree falling on them or their evacuated location. Compared to other hurricane regions such as the Gulf Coast, New England does have an abundance of trees. Storm surge, however, is still the leading cause of hurricane deaths, not falling trees. This perceived risk of falling trees played a large role in the non-evacuation decisions for many residents.

Summary: As we continue to analyze the data collected in their study, we will be able to more completely address each of the specific objectives. In addition,   we specifically plan to prepare a "best practices" for media practitioners for how to convey visual information about hurricane and storm surge to public audiences in order to encourage risk perceptions and behaviors aligned with experts' recommendations.

C. **COLLABORATORS, PARTNERS, and INTERACTIONS:**
Ricardo Daziano and Jonathan Schuldt, Cornell University (cooperation on GfK survey)

Juliana Barrett, Nancy Balcom, and Bruce Hyde from Connecticut Sea Grant played an instrumental role in connecting us with community groups, leaders, and local officials. We provided a draft email and PDF to send to the groups, but they did the hard work of emailing it out. Once individuals indicated their interest, our group took over the dialogue.

The following individuals were our point of contact for each community.

Rick Grauer, City of Fairfield, CT.
Beth Sullivan, Borrough of Stonington, CT.
Marian Galbraith, Mayor of Groton, CT.
Ethel Davis, Warden of Old Saybrook, CT.
Denise Savageau, Greenwich, CT.

D. **PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS**:
   (Abstracts attached at the end of report)

Conference Papers:

Title: *Do I stay or do I go? Exploring predictors of behavioral decision-making during Hurricane Sandy.*
Society for Risk Analysis: Denver Co. 2014 Rickard, LN*; Eosco, GM; Scherer, CW;

Title: *A flood of information: Exploring the influence of visual type on hurricane risk perception*. Society for Risk Analysis, December 2015, L. Rickard*, Gina Eosco, and C.W. Scherer

Presentations and Posters:

Title: *Emerging issues from discussions with coastal residents about information, evacuation and perceived risks.* Society for Risk Analysis, December 2015, Gina Eosco*, L. Rickard, C.W. Scherer and Dave Haase.

E. **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

F. **STUDENTS:**

Total number of **new** undergraduates: 6
Total number of **new** Masters degree candidates: 1

Total number of **continuing** undergraduates: 1
Total number of **continuing** Ph.D. candidates: 1

G. **VOLUNTEER HOURS:**
H. **PICTORIAL:**
I. **HONORS AND AWARDS**:

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*
       For those living directly on the coast, storm surge is the most dangerous and potentially deadly risk. During Sandy, 40 deaths were directly attributed to flooding that occurred due to a dramatic slow rise of ocean surge. Beyond Sandy, storm surge has easily been one of the most challenging risks to communicate over the last decade. Hurricanes Katrina (Knabb, Rhome, &

Brown, 2005), Ike (Berg, 2009) and Isaac (Berg, 2013) all brought high surge amounts that differed from their categorical strength. In response to this disparity, after Hurricane Ike in 2008, the National Hurricane Center (NHC) started separating storm surge from hurricane wind category (NOAA, 2010), because biophysical scientists realized that wind strength was not the sole cause of a dramatic storm surge. Rather, many contributing factors such as wind, wave action, astronomical tide, bathymetry of the coastline, and many others, contribute to the height of the surge. NHC determined that hurricane category, which is used to describe wind strength, was confusing public audiences' understanding of storm surge, as the surge amount is not solely associated with the category number (NHC, 2012; NOAA, 2010). Based on this re-categorization, two challenges face those tasked with communicating hurricane-related risk[1]. First, communicators must ensure that public audiences consider storm surge as a risk *distinct from*—and not explicitly communicated by—hurricane category. Second, and fundamental to the proposed research, communicators must determine *how* to convey storm surge risk so that the impacted populations will understand the nature of the new rule and their personal risk.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

Surveys of public audiences' information seeking during weather events provide a clearer picture of the complex media environment in which a weather graphic, such as the storm surge inundation map, circulates. Although Internet use during hurricane events is high, television weather reporting—particularly, on local channels—remains the primary source of information during a storm (Lazo & Morrow, 2013). Further, although NHC's website includes storm-specific information, the majority of respondents in a recent study (61%) reported never using the resource to obtain information about storm events (Lazo & Morrow, 2013). In the span of a limited television forecast, broadcast meteorologists present many visuals to convey the numerous and varied risks associated with hurricane events; the storm surge inundation graphic may represent only 30 seconds out of a 3-minute forecast.[2] As such, individuals are exposed to an array of weather information in a short amount of time.

This research explored how individuals get, utilize, and understand storm surge information from various sources. The study used three methods to better understand how individuals make decisions concerning the level of risk they face, and whether or not they should evacuate: (1) a survey of 619 coastal residents ((2) and experimental study of visualization of storm surge involving 1,052 coastal respondents and (3) Focus groups in seven communities involving 72 individuals.

RESULTS:

      Impacts. Within the meteorological and forecasting realms, risk is primarily conveyed through visuals, as much of the information is spatial in nature, or simply consists of visual data (e.g., radar, satellite, etc.) In the case of hurricanes, visual communication of risk becomes even more critical, as track maps, wind estimates, and now, storm surge inundation maps, provide both scientific experts and general audiences with time-sensitive information about a developing storm. Practitioners often seek assistance in designing visuals, hoping to find evidence of "best practices" for incorporating visuals into risk messaging. To date, research in visual communication has provided only limited direction, as the nascent discipline currently offers more questions than answers.

This research has started exploratory research in better understanding how the visualization of risky weather events can change how individuals understand and react to weather information. As our analysis of the data collected continues during the next year, we will be able to begin to answer practical questions regarding visual design and placement in the context of risk-based messages delivered to large audiences through mass media channels.

Ultimately, the goal of this research is to design a visual message that prompts storm surge risk assessments in line with ambient conditions, and subsequently, increases the likelihood of evacuation if appropriate.

The results from this study shed light on audience perceptions, and, as we continue to analyze the data, will provide recommendations for improving hurricane risk communication given a complex media environment. We anticipate that our results will be especially applicable to broadcast meteorologists, whom many audiences turn to first for information about local weather, and thus are important communicators of weather-related risk. More broadly, this project will also provide recommendations for how the weather community communicates complex information visually. Although the proposed research focuses on hurricanes and storm surge-related risk, we anticipate that the findings and recommendations will be generalizable to a broader suite of weather and natural hazard-related issues.

K. Stakeholder Summary

Deciding whether an approaching hurricane poses a serious threat to our safety and to our property is a complex process. We know that how information is presented can change our perceptions of the seriousness of an approaching storm. Broadcast media generally use maps, radar or a newscaster standing out in the storm to try to convey the seriousness of a storm. Yet, we know that past experience (the last storm or the most serious one in memory), how neighbors and friends are responding (boarding up windows or going about things as usual) , how local authorities communicate (knocking on doors with warnings or business as usual) or how broadcast media mention a specific area or ignore it, all influence how we as individuals respond. Findings from this research project suggest that how serious storm warnings are communicated can be significantly improved. For example, a photo showing how the results of

the storm surge and wind may impact a local neighborhood may be more effective than a radar or storm track map.

Results of this research project promise to offer a number of significant findings about how to improve storm risk communication.

Papers/Poster Abstracts presented or to be presented.

Title: *Do I stay or do I go? Exploring predictors of behavioral decision-making during Hurricane Sandy.* Society for Risk Analysis: Denver Co. 2014 Rickard, LN*; Eosco, GM; Scherer, CW;

For those living on the coast, storm surge is the most potentially deadly risk. During Hurricane Sandy, in October 2012, 40 deaths were directly attributed to flooding that occurred due to a dramatic slow rise of ocean surge. While scientists and coastal managers continue to characterize "objective" storm surge risk, less is known about how coastal residents perceive such risks, and how these perceptions—in addition to other factors—may influence behavioral decision-making. Within the natural hazards literature, researchers have proposed comprehensive models to predict preventive action and decision-making during severe weather events, integrating social psychological concepts such as efficacy, with sociological concepts, such as institutional trust.

Risk communication researchers have forwarded models to predict information seeking and processing with respect to risk issues, introducing concepts such as information sufficiency and informational subjective norms. Drawing upon two models that exemplify these approaches, the Protective Action Decision Model (Lindell & Perry, 2012) and the Risk Information Seeking & Processing Model (Griffin, Dunwoody, & Yang, 2012), the present study proposes an expanded model to understand communication and decision-making during a hurricane. Using a random sample of residents of New Jersey, New York, and Connecticut affected by Hurricane Sandy, we employ a web-based survey to explore, among other variables: (a) perceptions of hurricane and storm surge risk; (b) trusted information sources; (c) preferred communication channels; (d) strength of social networks; (e) previous hurricane experience; and (f) attribution of responsibility for preventing and responding to hurricanes. By asking about survey respondents' (non)evacuation and information-seeking behavior during Sandy, we explore the applicability of the expanded model to a real-life case.

Title: *Emerging issues from discussions with coastal residents about information, evacuation and perceived risks.* Laura Rickard *, Gina Eosco , Cliff Scherer and Dave Haase.   Society for Risk Analysis, December 2015.

For those living directly on the coast, storm surge is the most dangerous and potentially deadly risk. During Sandy, 40 deaths were directly attributed to flooding that occurred due to a dramatic slow rise of ocean surge. Beyond Sandy, storm surge has easily been one of the most challenging risks to communicate over the last decade. How individuals make decisions about whether or not to evacuate is explored in this study of 75 individuals living within a few feet or blocks of the coast in Connecticut. These individuals participated in a 90 to 120 minute focus g4roup exploring their use of information sources during Sandy and the decisions they made about whether or not to evacuate. One significant finding coming from these discussions suggests that the more "storm proof" they perceive their house, the less likely they are to evacuate. This may be counter to prevailing policy requiring coastal homes to make modifications in elevation to protect property from storm damage.   If individuals perceive their homes as safer, and they are less likely to evacuate, is the policy to protect property from damage running

counter to protection of human life and injury. In other words the information they are receiving suggests that they are in danger and should evacuate, but their perception of their homes is that they have been modified to be FEMA compliant and are safe.   And is this likely to put first responders in greater danger when individuals need to be rescued during the storm?   This poster will explore this and other important issues emerging from the Connecticut residents.

Title: *A flood of information: Exploring the influence of visual type on hurricane risk perception*. Gina Eosco*, Laura Rickard and Cliff Scherer,   Society for Risk Analysis, December 2-15.

Whether a graphic of a hurricane path, a photograph of a flooded neighborhood, or a radar image, visual representations of severe weather range from the "iconic" to the "indexical" (Messaris, 1997). Whereas iconic visual representations, such as maps, serve as an analogy between an object and its signifier, indexical visual representations, such as photographs, are considered physical traces: "proof" that some object exists. Past research suggests that iconic visuals implicitly convey uncertainty, including in relation to the timing of the event, the amount of risk to a location, or if the event will even occur. Indexical visuals, on the other hand, tend to prompt increased certainty and perceived risk. In the case of severe weather, however, providing indexical images may be impossible, as often these events have yet to occur. Building on this foundation, the present study explores the influence of visual type on perceived risk related to a hurricane forecast. In a between-subjects factorial design, we present residents of New York, New Jersey, and Connecticut ($N = 1,052$) with a forecast describing hypothetical Hurricane Pat accompanied by either a map showing predicted storm surge amounts, a photograph of storm surge impacting a neighborhood, or no visual. In addition, half of the forecasts contained information characterizing evacuation decision-making as a shared responsibility between forecasters, emergency personnel, and individual citizens. Results suggest that the condition *with* a photo but *without* shared responsibility information elicited more concern about storm surge than any other condition. Moreover, when predicting risk judgment (perceived likelihood of hurricane impacts multiplied by perceived severity), experimental condition, perceptions of the visual (i.e., its believability), and individual characteristics (i.e., education, number of children at home) were significant predictors, whereas past experience with hurricanes was not. Theoretical and practical implications will be presented.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Lane Smith lane.smith@stonybrook.edu, Research Program Coordinator, New York Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Lane Smith at (631) 632-9780. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Ricardo Daziano

Date of Report submission: 6/1/15

Project #: R/CSAP-5-NY

Project Title: Forecasting evacuation behaviors of coastal communities in response to storm hazard information

Principal Investigator(s) and Affiliation(s):

1. Ricardo A. Daziano, School of Civil and Environmental Engineering, Cornell University

2. Jonathon Schuldt, Department of Communication, Cornell University

3. Phil Liu, School of Civil and Environmental Engineering, Cornell University

4. Linda Nozick, School of Civil and Environmental Engineering, Cornell University

A. PROJECT GOALS AND OBJECTIVES:

This project seeks to collect, analyze, and model microdata on informed evacuation behavior within coastal communities in the tri-state areas impacted by Hurricane Sandy.

Our main hypothesis is that there is an efficient mix of warnings – type of information and media – that will encourage people to quickly enact their evacuation plans. Thus, the goal of this project is to enhance our knowledge about the opportunity to exploit social media to support evacuation, while addressing heterogeneity in the processes of making and updating evacuation decisions. We basically expect to identify the best tools for enacting safe and effective evacuation plans, including the opportunities associated with the use of social media.

More specifically, we will design a web-based survey instrument to collect detailed information about awareness, preparedness, evacuation, and survival to weather hazards from households in coastal communities of New Jersey, New York, and Connecticut to achieve the following research objectives:

1. Build novel methods for both presenting and generating new data using discrete choice experiments of behavioral response to storm hazards. Hypothetical storms and preventive information need to be presented in a way that is realistic to the individual. An additional challenge is to account for events that present an uncertain evolution in time. The media used to convey and visualize information is key for addressing the dynamics of weather hazards. Thus, we will control for different media in a web-based, customized survey. We will also combine intended actions with actual evacuation behavior during hurricane Sandy.
2. Construct stochastic models of evacuation behavior. We will identify the causal relationship between probabilistic measures of evacuation behaviors (when, where, and how to evacuate) and a complete set of explanatory variables such as attributes of the dynamic predictions of weather conditions (e.g. storm intensity) and coastal impacts (e.g. flood risks), risk measures and attitudes toward risk (e.g. evacuation orders), network effects (e.g. evacuation behavior by neighbors and friends, social media reports), and socioeconomic characteristics of the household (e.g. region, distance to shoreline, demographics, and lifestyle and values).
3. Derive robust estimates of evacuation probabilities for heterogeneous individuals as a concrete measurement of the impact of differing types of storm-related risk information and information outlets (social media) on evacuation behavior. Credible sets will be used to account for uncertainty in the determination and prediction of the probabilistic measures of evacuation behaviors.
4. Design effective evacuation communication tools and policies accounting for the differing, uncertain response of coastal communities. Using the evacuation predictors, behavioral forecasts, and empirical evidence we expect to elucidate the factors that will encourage safe evacuation. We also expect to determine the mix of most effective information tools and outlets for better-informed decisions in response to storm hazards.

B. **RESULTS:** **(**_Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)_

Milestones
- **Pretest**: _N = 158 adult individuals living in the New York City Metropolitan Area. Started in June 19, 2014; Completed in June 21, 2015._

- **Final survey design**: _Based on the results of the pretest, the original survey was revised. The final version of the survey was completed in early October, 2014._

- **Final data collection**: _N = 619 adults living in the coastal tri-state area (New York, New Jersey, and Connecticut). Started in October 28, 104; Completed in March 2, 2015_

Questionnaire Format

The questionnaire consisted of two main parts. Part one included questions broadly related to participants' experiences during Hurricane Sandy and general perceptions of hurricanes, including impacts they may have experienced, social support they received, risk perceptions, attitudes toward hurricane-related information, and perceptions of responsibility of various social actors (see below for specific measures). Part two consisted of an experimental section in which participants were presented information about a hypothetical hurricane, including its intensity and predicted path, and asked a series of questions about their intended behavior. A final section of the questionnaire included basic demographic measures and questions about other individual characteristics.

Measures. Most measures in part one of the questionnaire came from existing literature in risk communication and natural hazard decision-making; specifically, several items were adapted from recent applications of the Protective Action Decision Model (PADM) (Lindell & Perry, 2012) and the Risk Information Seeking and Processing model (RISP) (Griffin, Dunwoody, & Yang, 2012; Griffin, Yang, ter Huurne, Boerner, Ortiz, & Dunwoody, 2008).

Individual characteristics. Demographic characteristics measured included age, sex, and race/ethnicity [White/Non-White?]. In addition, we measured other individual characteristics often associated with natural hazard-related preventive behavior, including: (1) length of time in current home; (2) whether the participant or a close other (e.g., family member) had a disability or; (3) the obligation to care for pets; (4) the primary language spoken (English, Spanish, or other); (5) level of education; (6) employment status; (7) relationship status; (8) homeownership; (9) political orientation; and (10) whether the participant had children.

Pretest

In the summer of 2014, we surveyed a diverse sample of *N* = 158 residents living in areas that were directly impacted by Sandy and its devastating storm surge (the greater New York metropolitan area). In the 25-minute survey, cognitive, emotional, and behavioral responses to information about extreme weather events was collected. In fact, the instrument was designed to cover a thorough set of dimensions that we identified as critical to evacuation decisions, including pre-awareness, experience, behavioral influence, risk perceptions, affect, evacuation intentions, preventive actions, channel beliefs, source credibility, attribution of responsibility, and social networks. In particular, information about a hypothetical storm was conveyed using NOAA Track Forecast Cones. 3-day Track Forecast Cones represent the probable track of the center of a storm. Information on the maps also includes time to landfall and maximum sustained winds. Respondents were asked a set of questions for four maps randomly chosen from Track Forecast Cones for 84, 72, 57, 48, 36, 30, and 6 hours to landfall. We note that 48 hours is a standard threshold for beginning evacuation; 36 hours is considered optimal clearance time; 30 hours coincides with the first evacuation order for Sandy; and 6 hours is considered the last safe possible evacuation time. For each map respondents were asked to rate on a Likert scale the perceived harm and threat that the depicted forecast could cause to him or her, his or her family, and his or her local community. To take into account social norms, respondents were also asked about their beliefs regarding their family or friends wanting them to evacuate to safer area given the information provided in each map. Perceived capability of evacuating was also asked. Finally, given the information on each map we asked the respondents about their concrete plans to evacuate to a safer area.

Risk communication scholars are increasingly interested in the message factors that shape the public's response to severe storm warnings. Only recently, however, have scientists begun to study the influence of the name given to the storm itself, as when female-named storms are perceived as less risky than their male-named counterparts (Jung et al., 2014). In this vein, we conducted an experiment to assess whether describing a severe storm as a "hurricane" or "superstorm"—monikers that were commonly employed in news coverage of Sandy—might similarly shape risk perceptions among the storm-vulnerable public. Depending on condition, respondents were asked to recall how severe they believed "Hurricane Sandy" or "Superstorm Sandy" was going to be before the storm hit. Greater severity judgments were reported when Sandy was described as a "superstorm" rather than a "hurricane" among individuals who were more directly impacted by the actual event (e.g., who experienced a personal loss or storm surge during Sandy) (interaction $F(3,152)=4.97$, $p = .03$). Overall, results reiterate the importance of attending to storm message factors that are seemingly innocuous and driven largely by aesthetic considerations, such as the name of a storm, which may nevertheless sway risk perceptions and possibly impact important downstream behaviors (e.g., the decision to evacuate).

Final Survey Design

After analyzing the results of the pretest, some changes to survey were made. Some of the questions were revisited, while keeping the basic structure covering the same dimensions of pre-awareness, experience, behavioral influence, risk perceptions, affect, evacuation intentions, preventive actions, channel beliefs, source credibility, attribution of responsibility, and social networks. The most important change was the addition of a new experimental design.

The new experiment was based on a **time-dependent discrete choice experiment**. In this discrete choice experiment, we used the following attributes: category of the storm (1,2, or 3), storm surge hazard (moderate, high, extreme), and evacuation order (none, voluntary, mandatory). A full factorial design was considered, which was then divided in two blocks (Tables 1 and 2). Scenarios from each block of the full factorial design were randomly chosen to describe the dynamic evolution of two hypothetical storms at 5 different times before expected landing, namely 48, 36, 24, 12, and 6 hours to the expected landfall. For a given storm and random scenario at time *t*, the respondent was asked about his or her evacuation likelihood. The experiment for that hypothetical storm stopped as soon as the responded chose to evacuate. The experiment otherwise continued with another random scenario (without repetition) at the following time. If a respondent chose to evacuate at time 48 for the two hypothetical storms presented, a third hypothetical storm was created from the second block.

Scenario ID	Category	Storm Surge	Evacuation Order
HS1.1	1	Moderate	None
HS1.2	1	High	None
HS1.3	1	Extreme	None
HS1.4	1	Moderate	Voluntary
HS1.5	1	High	Voluntary
HS1.6	1	Extreme	Voluntary
HS1.7	1	Moderate	Mandatory
HS1.8	1	High	Mandatory
HS1.9	1	Extreme	Mandatory
HS1.10	2	High	None
HS1.11	2	Extreme	None
HS1.12	2	High	Voluntary
HS1.13	2	Extreme	Voluntary
HS1.14	2	Extreme	Mandatory

Table 1: First block of the full factorial design of the discrete choice experiment

Scenario ID	Category	Storm Surge	Evacuation Order

HS2.1	2	Moderate	None
HS2.2	2	Moderate	Voluntary
HS2.3	2	Moderate	Mandatory
HS2.4	2	High	Mandatory
HS2.5	3	Moderate	None
HS2.6	3	High	None
HS2.7	3	Extreme	None
HS2.8	3	Moderate	Voluntary
HS2.9	3	High	Voluntary
HS2.10	3	Extreme	Voluntary
HS2.11	3	Moderate	Mandatory
HS2.12	3	High	Mandatory
HS2.13	3	Extreme	Mandatory

Table 2: Second block of the full factorial design of the discrete choice experiment

Each storm was introduced with the following text: "Suppose now that a new storm has formed. Suppose that you have subscribed to a hurricane text alert service. The text alert will provide information about the **hurricane category**, **storm surge hazard**, and whether a **voluntary or mandatory evacuation order** has been issued."

The texts alerts mimicked a text message received in a smartphone. Figure 1 shows two examples of the experimental scenarios as seen by the respondents.

Figure 1: Evolution of a hypothetical storm in discrete time intervals, presented as a text alert in a smartphone

Final Data Collection

Below we present summary statistics of the final survey.

Age.
    $M = 53.6$ ($SD = 16.0$) (Range: 18–89)

Gender.	*f*	*%*
Males	267	43.1
Females	352	56.9

Educational attainment.	*f*	*%*
< H.S. diploma	15	2.4
H.S. graduate	83	13.4
Some college	135	21.8
Associate degree	52	8.4
Bachelors degree	185	29.9
Masters degree	117	18.9
Professional/ Doctorate	32	5.2

Race/ethnicity.	_f_	%
White, non-Hisp.	434	70.1
Black, non-Hisp.	54	8.7
Other, non-Hisp.	23	3.7
Hispanic	91	14.7
2+Races, non-Hisp.	17	2.7

State of residence.	_f_	%
CT	83	13.4
NY	332	53.6
NJ	204	33.0

Homeownership status.	_f_	%
Owned	388	62.7
Rented for cash	216	34.9
Occupied without payment	15	2.4

Did you evacuate during Sandy? [Q4]	_f_	%
Yes	43	7.4
No	334	57.2
Was not in an evacuation zone	207	35.2
Missing	35	5.7

Impacts from Sandy [Q7].

Personal loss?	_f_	%
Yes	135	23.1
No	441	71.2
Don't know	5	0.8
Refused	3	0.5
Missing	35	5.7

Know someone with loss?	_f_	%
Yes	390	63.0
No	176	28.4
Don't know	17	2.7
Refused	1	0.2
Missing	35	5.7

Home experience surge?	_f_	%
Yes	91	14.7
No	488	78.8
Don't know	3	0.5
Refused	2	0.3
Missing	35	5.7

Neighborhood experience surge?	_f_	%
Yes	208	33.6
No	348	56.2
Don't know	25	4.0
Refused	3	0.5
Missing	35	5.7

Previous experience with hurricanes [Q8].

Previous hurricane count	f	%
0	68	11.0
1–2	190	30.7
3–4	154	24.9
5–6	64	10.3
7 or more	89	14.4
Refused	3	0.5
Missing	51	8.2

Previous evacuation count	f	%
0	477	77.1
1–2	76	12.3
3–4	7	1.1
5–6	2	0.3
7 or more	2	0.3
Refused	4	0.6
Missing	51	8.2

Figure 2 shows the households of the sample are located in the tri-state area. Stars are the respondents who evacuated, and dots are those who did not.
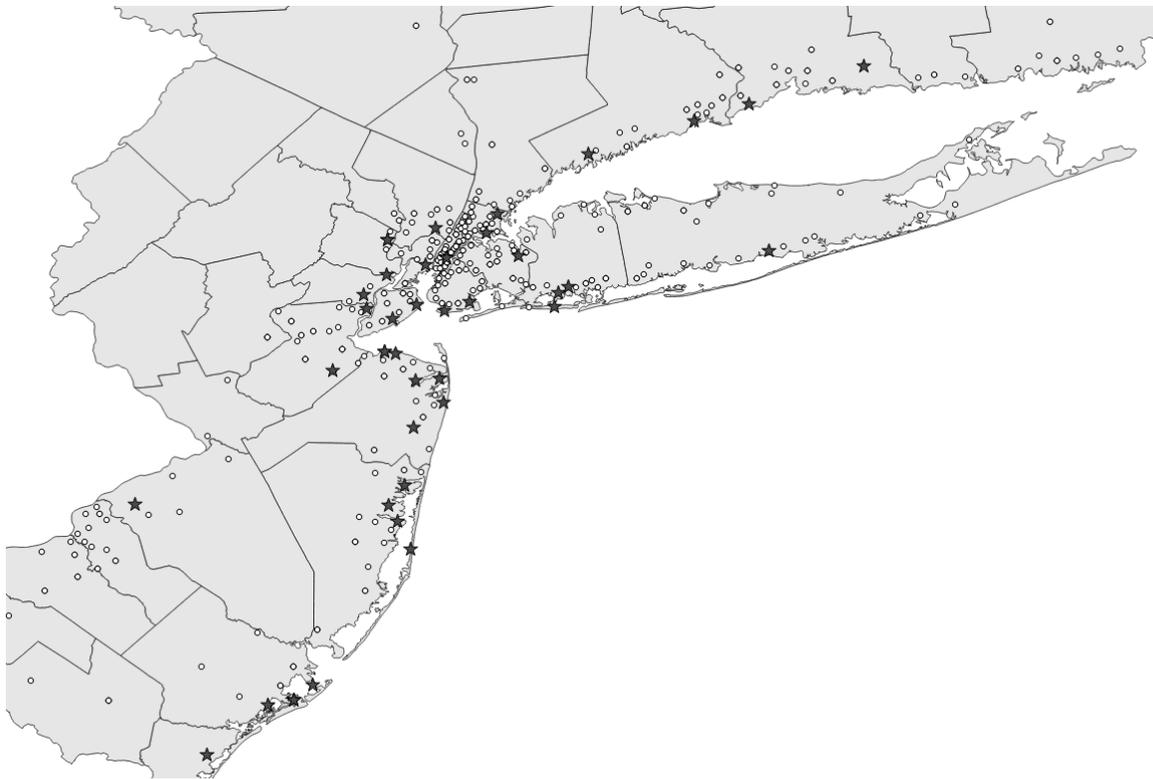
Figure 2: Final Sample

Figure 3 presents the location of respondents in NY.
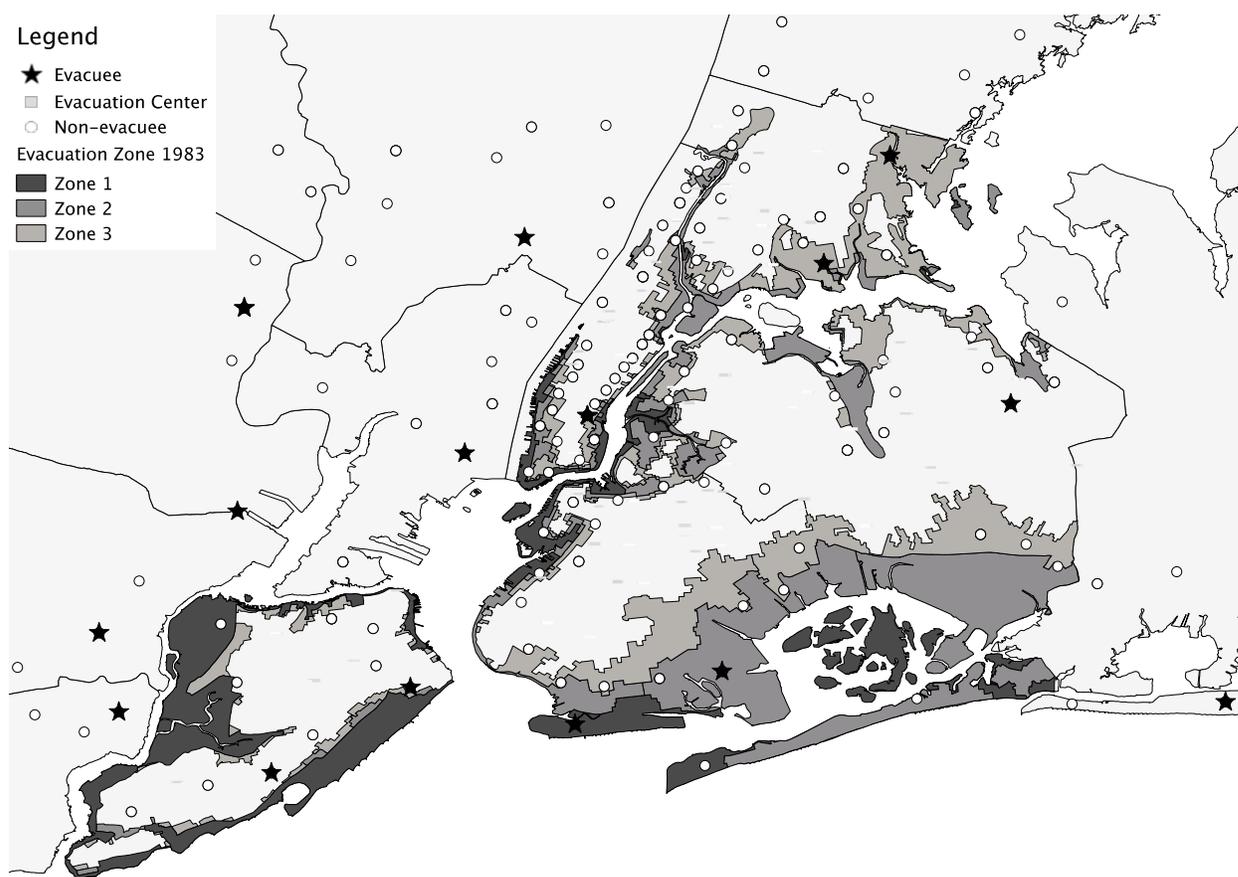
Figure 3: Location of respondents in the NYC Metro Area.

Below we summarize the different measures that were collected in the survey. We also show a table that summarizes the results of these measures.

Protective action perception. We measured protective action perception through both *hazard-related attributes* (i.e., the extent to which an individual perceives a particular response as effective in mitigating a hazard) and *resource-related attributes* (i.e., the perceived cost, time, skills, etc. needed to enact a given response) (Lindell & Perry, 2012; Terpstra & Lindell, 2012). In particular, we gauged hazard-related attributes with three questions (e.g., "Thinking about a future hurricane event, how effective would the following preparations be for ensuring your own safety?"), with each question asked in relation to a series of six actions (e.g., "purchasing flood insurance"); response categories, which were slightly different based on the wording of each question, were measured on 5-point scales and ranged from (1) not at all useful (effective) to (5) extremely useful (effective). Resource-related attributes were measured with three questions (e.g., "Given your income and personal expenses, how affordable would the following preparations be?") using the same series of six actions, measured on 5-point scales ranging from (1) not at all (able, affordable, difficult) to (5) extremely (able, affordable, difficult). A fourth question gauging the amount

of help the participant perceived s/he would need to enact each action used a 4-point scale, ranging from (1) none to (4) a lot.

Risk judgment. Risk judgment consisted of two sets of measures: (1) the perceived likelihood that "a storm like Sandy" will harm various groups ranging from "you and your family" to "the U.S. East Coast" (4-point scales ranging from (1) very unlikely to (6) extremely likely), and (2) the perceived severity of the threat to these groups (6-point scales ranging from (1) not at all serious to (6) extremely serious) (Zhao, Leiserowitz, Maibach, & Roser-Renouf, 2011). Product terms were created based on these two dimensions and averaged into an index to assess risk judgment.

Affect. Following Terpstra (2011), we used an open-ended question to ask participants to describe the feelings that come to mind when thinking about "a storm like Sandy."

Information sufficiency. Based on applications of the RISP model (Griffin et al., 2008), we measured *perceived knowledge* about storm surge using a scale from 0-100, where 0 meant knowing nothing and 100 meant knowing everything the participant could possibly know about storm surge. Using the same scale, we measured *information sufficiency threshold*, where 0 meant the participant believed s/he did not need to know anything about storm surge and 100 meant the participant needed to know everything s/he could possibly know.

Informational subjective norms. Following Yang and Kahlor (2013), we measured informational subjective norms with three items on 6-point scales from strongly disagree (1) to strongly agree (6) depicting perceptions of others' expectations about one's own level of hurricane knowledge (e.g., "My friends expect me to know something about hurricanes").

Information gathering capacity. Participants' perceived ability to collect and interpret information about hurricanes was measured with four items on 6-point scales ranging from strongly disagree (1) to strongly agree (6) (e.g., "I can't make sense of information about hurricanes").

Attitude toward learning about hurricanes. Adapting Kahlor (2007), we assessed participants' attitude toward learning about hurricanes by asking them to indicate on a 6-point scale from 1 (strongly disagree) to 6 (strongly agree) the extent to which "understanding the risks posed by hurricanes" is seen as useful, beneficial, wise, and/or valuable.

Source credibility. Following Trumbo and McComas (2003), we gauged participants' perceived credibility of seven sources/channels for information about hurricane evacuation, ranging from "friends, relatives, and neighbors" to "The Weather Channel." For each source/channel, participants responded to a series of four items using 6-point semantic differential scales (e.g., "can be trusted/cannot be trusted"). An additional item measured the extent to which the source/channel influenced (or did not influence) the participant's evacuation decision during Hurricane Sandy (Arlikatti, Lindell, Prater, & Zhang, 2006).

Hurricane experience. One question targeted participants' past experience with hurricanes other than Sandy, including three items adapted from Trumbo, Lueck, Marlatt, and Peek (2011) (e.g., "how many hurricanes have you been in?"). Additionally, seven questions asked specifically about experience during Hurricane Sandy, including: where the individual lived during the storm (e.g., whether an evacuation order was in place), evacuation decision and satisfaction with this decision [CITE], personal losses, and recollections about the storm (e.g., meteorologists' predictions about storm surge).

Social support. Perceived relationship satisfaction with a series of six actors (e.g., spouse, extended family) was measured on six-point scales from 1 (very dissatisfied) to 6 (very satisfied), including a "not applicable" category. Additionally, we measured the amount of support received during Hurricane Sandy from each of these six actors on a scale of 1 (none) to 4 (a lot), including "not applicable" (Glass, Flory, Hankin, Kloos, & Turecki, 2009).

Attribution of responsibility. To provide a realistic scenario to which participants could react, we presented a brief narrative describing the experience of Joe and Janice Perkins, a hypothetical Staten Island couple, during Hurricane Sandy. The story was constructed based on a review of media coverage of New York, New Jersey, and Connecticut residents' post-Sandy experiences. After reading the narrative, participants rated the importance of ten potential causal factors (e.g., decisions or actions of local officials, environmental conditions) for determining what happened to Joe and Janice using five-point scales ranging from (1) not at all responsible to (5) extremely responsible. An accompanying free-response question asked participants to describe why they answered the way they did.

Two additional questions, with items adapted from Ben-Porath and Shaker (2010) and measured on 6-point scales from (1) strongly disagree to (6) strongly agree, further gauged participants' attribution of responsibility for the impacts of Hurricane Sandy. Specifically, seven items measured perception of government and other institutions' responsibility (e.g., "The federal government did as good a job as it could in responding to Hurricane Sandy") and six items measured perception of individuals' responsibility with respect to the storm and its aftermath (e.g., "People who did not heed the evacuation orders are responsible for what happened to them").

Behavioral intention. On a 7-point scale from (1) very unlikely to (7) very likely, where (4) meant "undecided," participants indicated the extent to which they would be likely to evacuate if a storm with the same intensity as Hurricane Sandy were predicted to impact their area next week.

Summary Statistics: Key Concepts

Concept	Measures	*M*	*SD*
External (Societal) Responsibility (1-6 scale) α = .64	The federal government did as good a job as it could in responding to Hurricane Sandy.	3.59	1.40
	My state government should have done more to help evacuate people from Hurricane Sandy **(reverse coded).**	3.55	1.33
	No level of government should be held accountable for what happened to the people affected by Hurricane Sandy in your state.	3.23	1.43
	All levels of government did all they could to aid the Hurricane Sandy relief efforts in your state.	3.47	1.39
	First responders (fire, police, and EMS personnel) did all they could to save people from rising floodwaters during Hurricane Sandy.	4.98	1.06
	My local and state government did not convey to me the severity of the risks posed by Hurricane Sandy **(reverse coded).**	4.16	1.34
	TV media conveyed to me the severity of the risks posed by Hurricane Sandy	4.42	1.17
Individual Responsibility (1-6 scale) α = .75	People who did not heed the evacuation orders are responsible for what happened to them.	4.46	1.20
	Most people who remained in an evacuation zone after the evacuation orders did so because they could not leave on their own **(reverse coded).**	3.95	1.23
	The people who remained in an evacuation zone after the evacuation order acted irresponsibly.	4.45	1.30
	The people who remained in an evacuation zone after the evacuation order could have left the area if they tried hard enough.	4.13	1.26
	Most people who stayed in an evacuation zone chose to do so.	4.71	1.06
	People were responsible for seeking information about the risks posed to them and their property.	4.55	1.06
Social Support (relationship satisfaction * level of support)	*How satisfied are you with the following relationships?* (1-6 scale)		
	Spouse	5.36	1.22
	Extended family	4.98	1.17
	Friends	5.21	.97
	Neighbors	4.60	1.22
	Co-worker(s)	4.72	1.09
	Employer(s)	4.49	1.18
	How much support did you receive from the following individuals during Hurricane Sandy? (1-4 scale)		

	Spouse	3.35	1.06
	Extended family	2.47	1.18
	Friends	2.59	1.11
	Neighbors	2.29	1.11
	Co-worker(s)	1.98	1.08
	Employer(s)	2.06	1.12
General Hurricane Experience (additive index) (1-5 scale)	How many hurricanes have you been in?	2.85	1.24
	How many times have you evacuation from a hurricane?	1.18	.49
	How many times have you had property damage from a hurricane?	1.4	.61
Risk Judgment (susceptibility * severity)	**Perceived susceptibility** (1-6 scale)*:* *In the event of a storm like Sandy, how likely is it that the following would be harmed:*		
	Your home/apartment	3.18	1.35
	You and your family	3.01	1.29
	Your local community	3.94	1.35
	Your neighbor's home/apartment	3.26	1.38
	The U.S. East Coast	4.99	1.12
	Perceived severity (1-6 scale): *In the event of a storm like Sandy, how serious would the threat be to the following:*		
	Your home/apartment	3.10	1.42
	You and your family	3.10	1.43
	Your local community	3.89	1.40
	Your neighbor's home/apartment	3.21	1.45
	The U.S. East Coast	4.94	1.19
Trust in Government (1-5 scale) $\alpha = .94$	*In your opinion, how trustworthy are the following:*		
	City government	2.67	.92
	State government	2.57	.93
	County government	2.61	.92
	Federal government	2.47	.98
Informational Subjective Norms (1-6 scale) $\alpha = .95$	My friends expect me to know something about hurricanes.	3.70	1.42
	Most people who are important to me think I should know something about hurricanes.	3.81	1.42
	My family expects me to know something about hurricanes.	3.89	1.42
	I can't make sense of information about hurricanes **(reverse coded)**.	4.94	1.04

Information Gathering Capacity (1-6 scale) α = .91	When it comes to information about hurricanes, I don't know how to separate facts from fiction **(reverse coded).**	4.77	1.15
	Most information about hurricanes is too technical for me to understand **(reverse coded).**	4.91	1.04
	I can't understand information about hurricanes even if I make an effort **(reverse coded).**	5.14	.94
Attitude toward Learning about Hurricanes (1-6 scale) α = .95	*Understanding the risks posed by hurricanes is:* Wise	5.24	.89
	Useful	5.24	.88
	Valuable	5.19	.91
	Beneficial	5.22	.89

Concept	Measures	*M*	*SD*
Source Credibility: Local Authorities (1-6 scale) α = .86	Cannot be trusted **(reverse coded)**	4.32	1.28
	Is not accurate **(reverse coded)**	4.11	1.22
	Does not tell the whole story **(reverse coded)**	3.85	1.34
Source Credibility: Public Access Local TV Channel (1-6 scale) α = .91	Cannot be trusted **(reverse coded)**	4.17	1.30
	Is not accurate **(reverse coded)**	4.05	1.23
	Does not tell the whole story **(reverse coded)**	3.97	1.30
Source Credibility: Local Media (1-6 scale) α = .92	Cannot be trusted **(reverse coded)**	4.10	1.29
	Is not accurate **(reverse coded)**	4.02	1.22
	Does not tell the whole story **(reverse coded)**	3.86	1.34
Source Credibility: National Media (1-6 scale) α = .93	Cannot be trusted **(reverse coded)**	3.96	1.28
	Is not accurate **(reverse coded)**	3.95	1.23
	Does not tell the whole story **(reverse coded)**	3.79	1.34
Source Credibility: The Weather Channel (1-6 scale) α = .92	Cannot be trusted **(reverse coded)**	4.61	1.27
	Is not accurate **(reverse coded)**	4.50	1.28
	Does not tell the whole story **(reverse coded)**	4.42	1.31

		M	SD
Source Credibility: Friends, Relatives, Neighbors (1-6 scale) α = .87	Cannot be trusted (**reverse coded**)	3.90	1.36
	Is not accurate (**reverse coded**)	3.48	1.24
	Does not tell the whole story (**reverse coded**)	3.34	1.35
Source Credibility: Employers, Co-Workers (1-6 scale) α = .92	Cannot be trusted (**reverse coded**)	3.61	1.31
	Is not accurate (**reverse coded**)	3.43	1.22
	Does not tell the whole story (**reverse coded**)	3.33	1.28

Concept	Measures	*M*	*SD*
External (Societal) Responsibility – Narrative (1-5 scale) α = .82	*How responsible are the following factors for determining what happened to Joe and Janice?*		
	Media reporting on the storm (e.g., issuing of hurricane watches or warnings)	2.57	1.27
	Laws or policies in place (e.g., zoning laws)	2.69	1.24
	Decisions or actions of local officials (e.g., mayor, emergency manager)	2.75	1.25
	Decisions or actions of state or federal officials (e.g., governor, Congress)	2.63	1.22
Individual Responsibility – Narrative (1-5 scale) α = .80	*How responsible are the following factors for determining what happened to Joe and Janice?*		
	Joe and Janice's decisions or actions	3.78	1.33
	Joe and Janice's level of preparedness	3.48	1.37
Protective Action Perception – Personal Safety (1-5 scale) α = .81	*Thinking about a future hurricane event, how effective would the following preparations be for ensuring your own safety?*		
	Having an emergency kit (including food, water, battery-powered radio, etc.)	4.09	.97
	Seeking information about flooding consequences (e.g., depth), evacuation routes, safe/high places in the neighborhood	3.41	1.23
	Creating a list of what to do in the case of an evacuation or flood (i.e., household emergency plan)	3.64	1.17
	Making agreements with family, friends, and neighbors about how to help each other during an evacuation or flood	3.67	1.12
	Having sandbags and/or plywood	2.40	1.30
	Purchasing flood insurance	2.42	1.43

Protective Action Perception – Financial Consequences (1-5 scale) α = .83	*Thinking about a future hurricane event, how effective would the following preparations be for limiting damage and financial consequences to your property and belongings?*		
	Having an emergency kit (including food, water, battery-powered radio, etc.)	3.46	1.37
	Seeking information about flooding consequences (e.g., depth), evacuation routes, safe/high places in the neighborhood	3.13	1.32
	Creating a list of what to do in the case of an evacuation or flood (i.e., household emergency plan)	3.35	1.27
	Making agreements with family, friends, and neighbors about how to help each other during an evacuation or flood	3.23	1.29
	Having sandbags and/or plywood	2.54	1.34
	Purchasing flood insurance	2.75	1.49
Protective Action Perception – Other Uses (1-5 scale) α = .84	*How useful would the following preparations be for situations other than hurricanes?*		
	Having an emergency kit (including food, water, battery-powered radio, etc.)	3.96	1.0
	Seeking information about flooding consequences (e.g., depth), evacuation routes, safe/high places in the neighborhood	3.10	1.29
	Creating a list of what to do in the case of an evacuation or flood (i.e., household emergency plan)	3.58	1.19
	Making agreements with family, friends, and neighbors about how to help each other during an evacuation or flood	3.57	1.14
	Having sandbags and/or plywood	2.27	1.28
	Purchasing flood insurance	2.28	1.35
Protective Perception – Help Needed[1] (1-4 scale) α = .76	*How much help would you need from others (family, friends, neighbors, or the government) to implement the following preparations?*		
	Having an emergency kit (including food, water, battery-powered radio, etc.)	1.45	.78
	Seeking information about flooding consequences (e.g., depth), evacuation routes, safe/high places in the neighborhood	1.90	.92
	Creating a list of what to do in the case of an evacuation or flood (i.e., household emergency plan)	1.61	.81

	2.07	.99
Making agreements with family, friends, and neighbors about how to help each other during an evacuation or flood	2.07	.99
Having sandbags and/or plywood	2.05	1.06
Purchasing flood insurance	1.85	1.05

[1]Items for other resource-related attribute questions (affordability, time needed, skills needed) had ~ 50% missing data

Behavioral Models

Using the responses to the time-dependent discrete choice model, we fitted logit models of evacuation behavior. We analyzed not only standard logit models with fixed parameters, but also logit models with random effects – using the maximum simulated likelihood estimator – to account for both unobserved heterogeneity and correlation among respondents. The results of a logit model with random effects are presented below.

```
Random-effects logistic regression          Number of obs    =      3,197
Group variable: ID                          Number of groups =        619

Random effects u_i ~ Gaussian               Obs per group:
                                                         min =          2
                                                         avg =        5.2
                                                         max =         10

Integration method: mvaghermite             Integration pts. =         12

                                            Wald chi2(20)    =     438.42
Log pseudolikelihood  = -1457.8827          Prob > chi2      =     0.0000

                                  (Std. Err. adjusted for 619 clusters in ID)
-----------------------------------------------------------------------------
              |               Robust
         Evac |        OR   Std. Err.      z    P>|z|     [95% Conf. Interval]
--------------+--------------------------------------------------------------
        TTL36 |  .6684143   .1037638    -2.60   0.009     .4930674    .9061189
        TTL24 |  .9538106    .184099    -0.25   0.806     .6533835    1.392375
        TTL12 |   1.72156   .4124571     2.27   0.023     1.076436    2.753315
         TTL6 |  1.122802   .3442846     0.38   0.706     .6156009    2.047891
         Cat2 |   1.31241   .2072079     1.72   0.085     .9631164    1.788382
         Cat3 |  3.379828   .5484032     7.51   0.000     2.459125    4.645245
      EvacVol |  1.079562   .1749923     0.47   0.637     .7857267    1.483282
     EvacMand |  24.29126   5.117812    15.14   0.000     16.07364    36.71011
    SurgeHigh |  2.600859   .4193944     5.93   0.000     1.896088     3.56759
     SurgeExt |  3.811357   .5912696     8.62   0.000     2.812093    5.165705
        black |  3.135057   1.502297     2.38   0.017     1.225619    8.019277
      hispanic |  1.501824   .5665377     1.08   0.281     .7169974    3.145722
     noevacexp |  .4219913    .132437    -2.75   0.006     .2281202    .7806263
     homesurge |  1.759124   .6249005     1.59   0.112     .8768409    3.529166
       smartph |  1.631911   .4319273     1.85   0.064     .9714132    2.741504
       hhinc75 |  .8240267   .1939536    -0.82   0.411      .519507    1.307047
      housedet |  .4303807   .1046362    -3.47   0.001     .2672419    .6931082
        PPT01 |  3.368977   2.182681     1.87   0.061     .9462905    11.99421
        PPT25 |  1.589938    .958034     0.77   0.442     .4880673    5.179415
  tenmorefive |  .7387072   .2132619    -1.05   0.294     .4195017    1.300801
         _cons |  .1567537   .0793234    -3.66   0.000     .0581402    .4226285
--------------+--------------------------------------------------------------
     /lnsig2u |  1.755891   .1482375                       1.465351    2.046431
--------------+--------------------------------------------------------------
      sigma_u |  2.405951   .1783261                        2.08064    2.782126
          rho |  .6376187   .0342519                       .5681981    .7017371
-----------------------------------------------------------------------------
```

Parameters of the logit model are interpreted as the effect on the likelihood of evacuating. According to the model estimates, both **category of the storm** and **risk of storm surge** affect evacuation decisions. However, the main determinant to increase the likelihood of evacuation is a **mandatory evacuation order**, informed by **local media** or **the Weather Channel**. The models also provide evidence of the need to revisit evacuation instructions that are labeled as being **voluntary**. **Voluntary evacuation** orders are perceived as **ambiguous**, and they may even **reduce the likelihood of evacuation** compared to not having any order at all. Below there is a summary of the quantitative results of the effect on increasing the likelihood of evacuation.

The likelihood of evacuation is:

> **62% lower** for **men**
> **54% lower** if the individual has **no previous evacuation** experience
> **62% lower** for **household heads**
> **66% higher** if **house is detached**
> **1% higher** for every additional year of age
> **172% higher** for **African Americans**
> 63% higher for Hispanics
> **1.3 times higher** if the storm is of **category 2** (reference: cat 1)
> **2.4 times higher** if the storm is of **category 3**
> **1.6 times higher** if **storm surge** is **high** (reference: moderate)
> **2.8 times higher** if **storm surge** is **extreme**
> 33% lower, 36 hours before expected landfall (reference: 48 hours before landfall)
> 5% lower, 24 hours before expected landfall
> **72% higher, 12 hours before expected landfall**
> **6% higher, 6 hours before expected landfall**

Finally, for **mandatory evacuation** orders the likelihood of evacuation is **24 times higher.** In the base model, voluntary evacuation order seems to have no effect on the likelihood of evacuation. In fact, in a model with a random parameter for the voluntary evacuation effect, on average people are **41% less likely to evacuate** if there is a **voluntary evacuation** order in effect (compared to not having any order at all). As shown in Fig. 4, **57%** of people **are less likely to evacuate if a <u>voluntary</u> evacuation order is in place** (compared to not having any order in effect).

Conditional Distribution for Evac.Vol
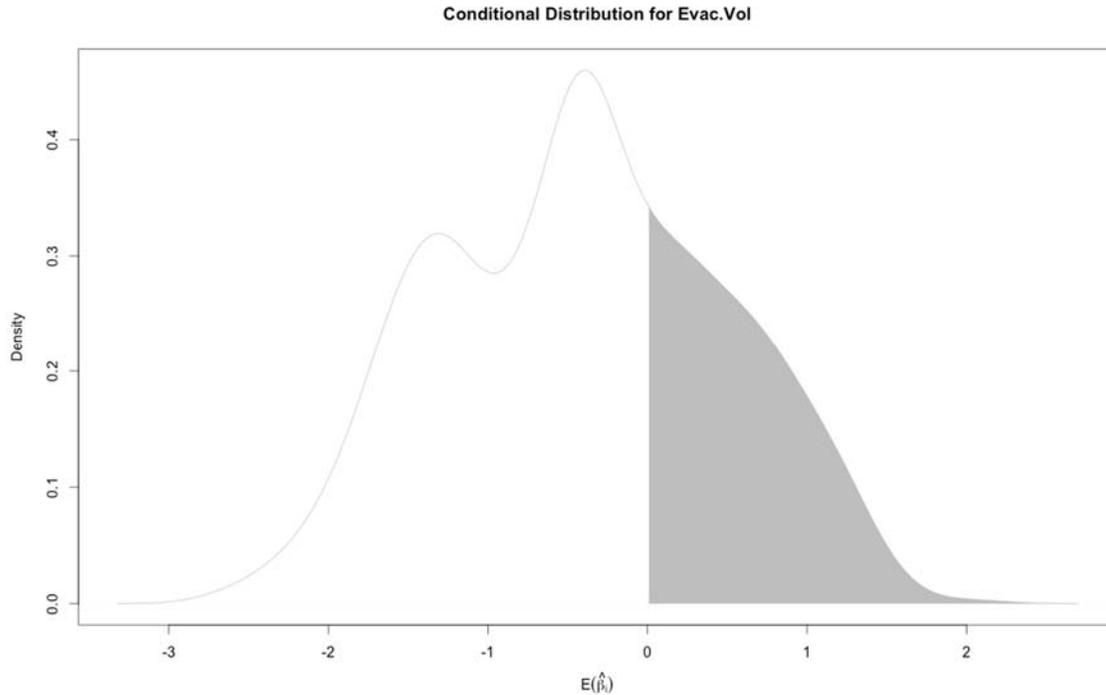
Figure 4: conditional distribution of the individual estimates of the effect of a voluntary evacuation order.

C. **COLLABORATORS, PARTNERS, and INTERACTIONS:** *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

For the design of the survey (and its pretest and final forms) we have been collaborating with the members of the CSAP Project "**Measuring Public Responses to a Surge of Information: How Individuals Understand, React, and Respond to Storm Surge Media Messages**" *Principal Investigators: Dr. Clifford W. Scherer and Dr. Laura N. Rickard*

D. **PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS**: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers: 1

Motoaki, Y., Daziano, R.A., Schuldt, J.P., Eosco, G.M., Rickard, L.N. & Scherer, C.W. (2015) Response to Hurricane Forecasts: an examination of attributes that trigger risk perceptions

and evacuation intentions. Paper accepted for presentation at the Fourth International Choice Modelling Conference, May, Austin, TX.

Other articles, such as proceedings or book chapters: 1

Daziano, RA. 2014. Behavioral response to extreme-weather hazards: from evacuation decisions to supporting resilience investments. Proceeding of the 1st International Workshop on the Resilience and Safety of Modern Social Systems. National Graduate Institute for Policy Studies, Tokyo, Japan.

Web sites, Software, etc.: NA

Technical Reports / Other Publications: NA

Other Products (including popular articles): NA

Planned Publications:

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *1*
Schuldt, J.P., Eosco, G.M., Rickard, L.N., **Daziano, R**., & Scherer, C.W. (December, 2014). A tale of two storms: Recalling the risk of "Hurricane" versus "Superstorm" Sandy. Poster presented at the annual meeting of the Society for Risk Analysis, Denver, CO.

E. **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

F. **STUDENTS:** *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "New" students are those who **have not** worked on this project previously. "Continuing" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

Total number of **new** K-12 students: 0
Total number of **new** undergraduates: 0
Total number of **new** Master's degree candidates: 0
Total number of **new** Ph.D. candidates: 2

Total number of **continuing** K-12 students: 0
Total number of **continuing** undergraduates: 0
Total number of **continuing** Master's degree candidates: 0
Total number of **continuing** Ph.D. candidates: 0

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name: Yutaka Motoaki
Degree Sought: PhD in Civil and Environmental Engineering
Thesis or Dissertation Title: TBD
Date of thesis <u>completion: NA</u>
Expected date of graduation: Spring 2016

Student Name: Chen Wang
Degree Sought: PhD in Civil and Environmental Engineering
Thesis or Dissertation Title: TBD
Date of thesis <u>completion: NA</u>
Expected date of graduation: Spring 2016

G. <u>VOLUNTEER HOURS:</u>
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)
NA

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.)*

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.*)
Specify:
a) Name of person or group receiving recognition: NA
b) Name of award or honor: NA
c) Group or individual bestowing the award or honor: NA
d) What it was for: NA
e) Date: NA

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

Existing research in the field of evacuation behavior has examined what different factors influence evacuation decisions and how they do so. Five of the most important factors include characteristics of the storm, risk perception, housing type, authorities' actions, and the hazard level of the area. Socio-demographic factors related to evacuation behavior are gender, age, household size, income, race and ethnicity, and level of education. Physical disability, proximity to evacuation routes, previous experience with extreme weather events, the presence of pets, and media reports also affect the decision of whether or not to evacuate in the case of an extreme weather event. In the existing literature, however, little attention has been devoted to the problem of how storm information triggers evacuation actions.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

Behavioral models were specified, estimated, and tested to investigate the factors that trigger evacuation intentions. The models were fitted to the answers of the questions of an online survey by 619 individuals living in areas hit by storm surge in the tri-state area. In terms of methodology, we analyzed not only ordered logit models with fixed parameters, but also with random parameters – using the maximum simulated likelihood estimator – to account for both unobserved heterogeneity and correlation among respondents. In addition, we analyzed estimates of an ordered logit model with endogenous, latent explanatory variables (measuring uncertainty, preparedness, and potential loss), in the form of a simultaneous system of ordered logit models (cf. hybrid choice modeling).

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

In the Northeast, damaging hurricanes occur but less frequently than in other areas. As a result, communities at risk rely on official sources to make evacuation decisions for them. In particular, people are not really expecting to be able to interpret storm characteristics. In fact, people expect to be told what to do in a very precise and succinct message (such as **mandatory evacuation**). Additionally, our models show that the media (local media/the Weather Channel) plays a larger role in influencing the respondents' evacuation decisions during Sandy than the local authority, friends, and neighbors did.

According to the estimated evacuation behavior models, both **category of the storm** and **risk of storm surge** affect evacuation decisions. However, the main determinant to increase the likelihood of evacuation is a **mandatory evacuation order**, informed by **local media** or **the**

Weather Channel. The models also provide evidence of the need to revisit evacuation instructions that are labeled as being **voluntary**. **Voluntary evacuation** orders are perceived as **ambiguous**, and they may even **reduce the likelihood of evacuation** compared to not having any order at all. Below there is a summary of the quantitative results of the effect on increasing the likelihood of evacuation.

The likelihood of evacuation is:
> **62% lower** for **men**
> **54% lower** if the individual has **no previous evacuation** experience
> **62% lower** for **household heads**
> **66% higher** if **house is detached**
> **1% higher** for every additional year of age
> **172% higher** for **African Americans**
> 63% higher for Hispanics
> **1.3 times higher** if the storm is of **category 2** (reference: cat 1)
> **2.4 times higher** if the storm is of **category 3**
> **1.6 times higher** if **storm surge** is **high** (reference: moderate)
> **2.8 times higher** if **storm surge** is **extreme**
> 33% lower, 36 hours before landfall (reference: 48 hours before landfall)
> 5% lower, 24 hours before landfall
> **72% higher, 12 hours before landfall**
> **6% higher, 6 hours before landfall**

Finally, for **mandatory evacuation** orders the likelihood of evacuation is **24 times higher.** In fact, in a model with a random parameter for the voluntary evacuation effect, on average people are **41% less likely to evacuate** if there is a **voluntary evacuation** order in effect (compared to not having any order at all).

Consider the following as they apply to your research and any related outreach/education.
· What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?
 In this research we implemented a novel time-dependent discrete choice experiment. The answers to the experiment were the used to fit logit models with random effects of evacuation behavior. While the methodology of using random-parameter logit models already existed, this research contributes by adapting the estimator to analyze evacuation intentions.

· What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?
 NA

· What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?

One of the main conclusions is the use of the word **mandatory** for evacuation orders to increase the likelihood of people evacuating when ordered. Sometimes emergency managers are limited in the use of the mandatory label, but we believe that that policy should change to make sure that the community responds to evacuation orders. In addition, using the word **voluntary** should be omitted as it induces ambiguity that can actually reduce the likelihood of evacuation. No policies have been changed yet, but we also recommend creating official ties with local media as in our models, media appears as the main source that has an influence on evacuation decisions.

· What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated? NA

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

Between October 28th and November 29th, 2012, Hurricane Sandy in New York, New Jersey, and nearby areas caused 117 fatalities. A number of these fatalities could have been prevented if residents had evacuated when mandated to; 45% of drowning deaths occurred in Evacuation Zone A, which had been identified as being at risk of flooding from any category of hurricane. This fact illustrates the key motivation behind studying evacuation behavior.

Existing research in the field of evacuation behavior has examined what different factors influence evacuation decisions and how they do so. Five of the most important factors include characteristics of the storm, risk perception, housing type, authorities' actions, and the hazard level of the area. Socio-demographic factors related to evacuation behavior are gender, age, household size, income, race and ethnicity, and level of education. Physical disability, proximity to evacuation routes, previous experience with extreme weather events, the presence of pets, and media reports also affect the decision of whether or not to evacuate in the case of an extreme weather event. In the existing literature, however, little attention has been devoted to the problem of how storm information impacts evacuation actions.

In this project we analyzed data collected in the spring of 2015 among 619 respondents in the tri-state area impacted by Sandy, using a unique instrument. In the on-line survey, cognitive, emotional, and behavioral responses to information about extreme weather events was collected. In fact, the instrument was designed to cover a thorough set of dimensions that we identified as critical to evacuation decisions, including pre-awareness, experience, behavioral influence, risk perceptions, affect, evacuation intentions, preventive actions, channel beliefs, source credibility, attribution of responsibility, and social networks.

One of the main results obtained in this research is that communities at risk rely on official sources to make evacuation decisions for them. This dependence seems to rely on the fact that

in the Northeast damaging hurricanes occur but less frequently than in other areas. In fact, the community expects to be told what to do and when to do so in a very precise, simple, and succinct message. Additionally, the media (local media/the Weather Channel) plays a larger role in influencing the respondents' evacuation decisions during Sandy than the local authority, friends, and neighbors did.

Finally, according to the estimated evacuation behavior models, the main determinant to increase the likelihood of evacuation is a **mandatory evacuation order**, informed by **local media** or **the Weather Channel**. **Voluntary evacuation** orders are perceived as **ambiguous**, and they may even **reduce the likelihood of evacuation** compared to not having any order at all.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Syma Ebbin syma.ebbin@uconn.edu, Research Coordinator, Connecticut Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Syma Ebbin at (860) 405-9278. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Jennifer R. Marlon

Date of Report submission: June 1, 2015

Project #: __ R/CSAP-7-CT_Final Report _____

Dates of the project: From [Jan 4, 2014   ] to   [June 15, 2015   ].

Project Title: An audience segmentation analysis of Connecticut coastal residents to support storm preparedness

Principal Investigator(s) and Affiliation(s):

1. Jennifer R. Marlon / School of Forestry & Environmental Studies, Yale University, 195 Prospect Street, New Haven, CT 06511
2. Anthony Leiserowitz / School of Forestry & Environmental Studies, Yale University, 195 Prospect Street, New Haven, CT 06511

A. PROJECT GOALS AND OBJECTIVES:

The four project goals are:

1) Conduct a representative telephone survey of 1,000 to 1,200 coastal residents of Connecticut regarding their storm-related beliefs, risk perceptions, vulnerabilities, information sources, communication patterns, and preparedness and evacuation behaviors and barriers.

2) Provide topline descriptive results on coastal residents' storm-related beliefs, risk perceptions, vulnerabilities, information sources, communication patterns, and preparedness and evacuation behaviors and barriers, along with their demographic and socio-cultural characteristics.

3) Conduct a segmentation analysis of coastal residents' to identify diverse target audiences within the public requiring tailored communication and engagement strategies. This typology will help coastal storm risk communicators understand the different types and needs of these different audiences, as well as their specific abilities and vulnerabilities, understandings and misconceptions, and likely responses to future threats.

4) Share the results with the coastal storm preparedness and response community in Connecticut to inform their communication strategies.

B. **RESULTS:** **(***Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*

As of May 31, 2015 the first three of the four goals are complete. The fourth goal will be complete within the next 8 weeks.

Goal #1 – Conduct a representative survey of coastal Connecticut residents

We designed a 12-page mail-out/mail-back questinonnaire for household decision-makers located in Connecticut coastal evacuation zones A and B (as defined by the Army Corp or Engineers). The survey was conducted in October, 2014 among 1,130 adults (18+) with a completion rate of 31.3%. The average margin of error for the total sample is +/- 3 percentage points at the 95% confidence level. Data from the surveys were cleaned, analyzed, and summarized.

Goal #2 – Present survey toplines

A public report presenting the topline results was issued on March 20, 2015. Highlights from the report include:

- Only 21% of coastal CT residents in Zone A say they would evacuate in the event of a Category 2 hurricane if they did NOT receive an official notice; about six in ten (58%) say they would evacuate if advised to by an official.
- About one third (34%) of coastal CT residents believe it would be safer to stay at home during a Category 2 hurricane; slightly less (31%) believe it would be safer to evacuate, and a final third (35%) say it's about 50/50.

- Coastal CT residents generally underestimate storm impacts: about half (52%) say damage from past storms was more than they had expected, whereas 19% say past damage was less than they had expected.
- Only about one third (31%) of coastal CT residents have evacuated at least once to avoid a storm in the past six years (since the beginning of 2009).
- About 22% of coastal CT residents evacuated for Superstorm Sandy. In Zone A (closest to the shoreline), 27% of coastal CT residents evacuated, whereas 11% in Zone B did so. Of the Zone A evacuees, 82% left before the storm arrived or just as it was arriving.
- Zone A residents, on average, tend to be older, Caucasian, have higher household incomes, higher educational attainment levels, and have made more storm preparations than Zone B residents.
- 70% of coastal CT residents are either unsure or unaware that their home is in an evacuation zone (as defined by the Army Corps of Engineers).
- Three quarters of coastal CT residents (74%) have never seen a local evacuation map.

Because vulnerability to environmental threats is increased when awareness of that threat is low or non-existent, our research shows that CT coastal residents need basic information about their physical vulnerability (e.g., that they live in an evacuation zone, that some evacuation routes may be better than others, and that a hurricane is very likely to occur in the next 50 years), as well as their social vulnerability (e.g., that elderly people and those with health issues are at greater risk of injury and death during a hurricane).

Goal #3 – Conduct a segmentation analysis

We used a statistical technique based on *k-means* cluster analyses and Monte Carlo simulations to identify five different audience groups among coastal CT residents based on 49 risk perceptions, behavioral, knowledge-based, and communication survey items. The "First Out" (21% of the population) are anxious about any severe storm and are eager to leave if a hurricane is in the forecast. The "Constrained" (14%) are aware of the risks and willing to evacuate but feel that significant barriers restrict their options. The "Surprised" (16%) doubt that a hurricane will occur, but say they are willing evacuate if one does. As a result, however, the Surprised are the least prepared of all the groups and perceive barriers to leaving if they must go. The "Reluctant" generally feel safe but say they would evacuate if they were ordered to by an official authority (especially local police or firemen). Finally, the "Diehards" believe it is safer to stay at home than to evacuate during a hurricane. As a result, they tend to be the most prepared, and generally do not intend to evacuate.

Goal #4 – Share the results with stakeholders

Our primary mechanism for dissemination of our results is by producing and widely publicizing our reports both to our email listserv (Yale Project on Climate Change Communication: http://yale.us2.list-manage.com/subscribe?u=78464048a89f4b58b97123336&id=de6cdfce82). Our first public report presenting the topline results was issued on March 20, 2015 (URL: http://environment.yale.edu/climate-communication/article/hurricane-perceptions-of-coastal-ct-residents/). The report was covered in local media, including:

- NBC Connecticut (March 26, 2015) – Shoreline Residents Underestimate Storm Threat: Study (http://www.nbcconnecticut.com/news/local/Shoreline-Residents-Underestimate-Storm-Threat-Study-297719281.html)
- Yale Daily News (April 2, 2015) – CT residents underestimate hurricane risks, report reveals (http://yaledailynews.com/blog/2015/04/02/ct-residents-underestimate-hurricane-risks-report-reveals/)
- The Day (March 26, 2015) – Survey shows gap in public awareness of coastal storm risk (http://www.theday.com/local/20150326/survey-shows-gaps-in-public-awareness-of-coastal-storm-risk-)
- Fox CT (Channel 3, Hartford) – forthcoming (http://foxct.com/)
- CoastalCT magazine – forthcoming (http://www.coastalconnecticut.com/)

We also delivered the report to all of our stakeholders in local and state government and offered to provide in-person presentations of the key findings to any interested groups after the second report is released.

Our second report presenting the segmentation analysis is nearing completion and will be released before the project end date of June 15, 2015. The Audience Segmentation report is likely to generate broader media attention than the first report and will likely be of greater interested to emergency managers and anyone interested in public outreach and communication relating to storms.

C. **COLLABORATORS, PARTNERS, and INTERACTIONS:** *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

Throughout the project we worked with a variety of collaborators in Sea Grant, NOAA and the Connecticut State Government. Most of the interactions focused on survey development and design; although outreach is just beginning now that the final report is about to issued. As a result, we expect many more interactions with state and local government officials even after the project has technically concluded.

Peg Van Patten (Sea Grant) has been very helpful throughout, providing comments on the survey, reviewing results, and in developing and managing outreach efforts. We have

interacted with the following people to ensure a high quality survey instrument that meets their needs: William P. Shea, Deputy Commissioner, Department of Emergency Services & Public Protection; John Gustafson, Emergency Telecommunications Manager, Division of Emergency Management and Homeland Security and Department of Emergency Services and Public Protection; William J. Hackett, State Emergency Management Director, State of Connecticut, Division of Emergency Management and Homeland Security, Department of Emergency Services and Public Protection; Robert F. Kenny, Jr., Emergency Management Area Coordinator, Connecticut Department of Emergency Services and Public Protection, Division of Emergency Management and Homeland Security, Region 1 Office.

Phone conversations with Scott Devico, DEMHS Public Information Officer, Peter Sandgren, Radiological Emergency Preparedness, DESPP Division of Emergency Management and Homeland Security, Matthew Walsh of the Army Corps of Engineers, and Elizabeth Ban, Director of Communication, NOAA Sea Grant College Program, were also extremely helpful in designing the survey. Jay Baker provided valuable information about a recent survey on hurricane evacuation behavior that greatly improved the overall study.

D. <u>PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS</u>: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers:

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.:

Technical Reports / Other Publications:

- Marlon, J., Rosenthal, S., Feinberg, G., Pal, S. and Leiserowitz, A. (2015). Hurricane Perceptions of Coastal Connecticut Residents: October, 2014. Yale University. New Haven, CT: Yale Project on Climate Change Communication.
URL: http://environment.yale.edu/climate-communication/article/hurricane-perceptions-of-coastal-ct-residents/

Other Products (including popular articles):

Planned Publications:

- EOS Workshop Report

- Scientific paper presenting the topline results for *Environment Magazine*

- Scientific paper presenting the audience segmentation results, journal to be determined

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

E. **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

n/a

F. **STUDENTS:** *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "__New__" students are those who **have __not__** worked on this project previously. "__Continuing__" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

n/a

Total number of **new** K-12 students:
Total number of **new** undergraduates:
Total number of **new** Masters degree candidates:
Total number of **new** Ph.D. candidates:

Total number of **continuing** K-12 students:
Total number of **continuing** undergraduates:
Total number of **continuing** Masters degree candidates:
Total number of **continuing** Ph.D. candidates:

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name:
Degree Sought:
Thesis or Dissertation Title:
Date of thesis completion:
Expected date of graduation:

G. **VOLUNTEER HOURS:**
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

n/a

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.*)

Report website:
http://environment.yale.edu/climate-communication/article/hurricane-perceptions-of-coastal-ct-residents/

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.)*
Specify:
a) Name of person or group receiving recognition:
b) Name of award or honor:
c) Group or individual bestowing the award or honor:
d) What it was for:
e) Date:

n/a

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

Hurricane/Post-Tropical Cyclone Sandy was the largest hurricane on record in the U.S.; it affected an area home to over 100 million people, killed 147 (over half of which were elderly or with health issues), cut power to 8.5 million customers, and caused over $60 billion in economic damages. Despite the enormous threat, the advance notice, and the remarkably accurate forecasts, confusion and poor choices were widespread among the public. As a result, NOAA and Sea Grant funded ten research projects designed to understand the communication failures and identify ways to address them.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

Our study focused on developing our understanding of coastal residents' hurricane risk perceptions and behaviors, because decades of social science research shows that effective communication requires a strong focus on the needs of the audience rather than on the needs of the communicators. In particular, we designed a study to identify the primary groups among

the public who interpret and respond to coastal storms in similar ways, so that specific messages can be developed in the future to address the unique needs of each group.

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

Consider the following as they apply to your research and any related outreach/education.
·   What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?

·   What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?

·   What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?

·   What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?

 Our results provide insights into coastal Connecticut storm perceptions, their storm readiness, and the past as well as intended evacuation behaviors. Overall, we find that most Connecticut (CT) coastal residents are ill-prepared for the significant safety and economic threats posed by severe coastal storms. Highlights include:
- Only 21% of coastal CT residents in Zone A say they would evacuate in the event of a Category 2 hurricane if they did NOT receive an official notice; about six in ten (58%) say they would evacuate if advised to by an official.
- About one third (34%) of coastal CT residents believe it would be safer to stay at home during a Category 2 hurricane; slightly less (31%) believe it would be safer to evacuate, and a final third (35%) say it's about 50/50.
- Coastal CT residents generally underestimate storm impacts: about half (52%) say damage from past storms was more than they had expected, whereas 19% say past damage was less than they had expected.
- Only about one third (31%) of coastal CT residents have evacuated at least once to avoid a storm in the past six years (since the beginning of 2009).
- About 22% of coastal CT residents evacuated for Superstorm Sandy. In Zone A (closest to the shoreline), 27% of coastal CT residents evacuated, whereas 11% in Zone B did so. Of the Zone A evacuees, 82% left before the storm arrived or just as it was arriving.

- Zone A residents, on average, tend to be older, Caucasian, have higher household incomes, higher educational attainment levels, and have made more storm preparations than Zone B residents.
- 70% of coastal CT residents are either unsure or unaware that their home is in an evacuation zone (as defined by the Army Corps of Engineers).
- Three quarters of coastal CT residents (74%) have never seen a local evacuation map.

In addition, highlights from our segmentation analysis show that:
- The First Out perceive the greatest risk from hurricanes and tropical storms. Of those residents in the First Out group who experienced Superstorm Sandy, 55% evacuated.
- At the other end of the spectrum, the Diehards have very low risk perceptions and are the least likely to evacuate. Of the Diehards who experienced Superstorm Sandy, only 6% evacuated. The primary reasons that the Diehards give for staying is to protect their home. Pets, however, are also a barrier to leaving for 25% of the Diehards.
- After the Diehards, the Constrained are the least likely to evacuate for any storm, but their reasons are different; the Constrained know the risks but they perceive significant barriers to leaving, such as pets and the poor health or disability of a family member, which make evacuating difficult.
- The Surprised are unique among the audience segments in that they have lower expectations that a hurricane of any strength will occur in the next 50 years. The Surprised are also the least prepared for a hurricane, and the least confident that they can keep themselves and their family safe if one did occur.
- The First Out, Constrained and the Diehards are the most likely to live in Zone A. The Surprised and Reluctant groups have higher proportions of residents in Zone B, which partly explains their lower risk perceptions of hurricanes.
- Notification to evacuate from local officials, whether police, fire, or other government workers, carries the most weight with all groups, as compared with announcements from weather broadcasters or other sources on the TV or Radio.

Our results will be used to inform public communication about hurricane risks from state and local officials, as well as from interested non-profit groups and industry (e.g., insurance companies). Our results have also received local media attention, which points to the broader interest in hurricane risks and preparedness among Connecticut residents, local businesses, and others living and working along the coast. Finally, the segmentation approach used in our study has proven very useful to outreach specialists and educators when conducted for other domains, and we anticipate that our results will be similarly effective once our stakeholders have had some time to reflect on and incorporate our findings into their own communication efforts.

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

> Social scientists who conduct post-disaster studies have long understood that people are often surprised by and unprepared for the severity or extent of natural hazards. Such results are found

even despite major advances in the technical accuracy and advance warning of storm forecasts. Research also shows that surprise among the public could be reduced with more effective communication, informed by the specific and diverse needs of different audiences. Here we present the results from a representative survey and segmentation analysis on hurricane attitudes of coastal Connecticut residents. We find that 70% of coastal residents do not know they live in an evacuation zone, 74% have never seen an evacuation route map, and only 31% believe it would be safer to evacuate than to stay home during a Category 2 hurricane, suggesting that awareness of hurricane risks in general is quite low. We also identify five distinct audiences that range from the "First Out" (of which 55% evacuated for Superstorm Sandy), who feel the most anxious and are the most likely to leave prior to a storm making landfall, to the "Diehards" (of which only 6% evacuated for Superstorm Sandy), who feel the most prepared and are the most unlikely to respond to official evacuation notices. Three middle segments (the "Constrained", "Surprised", and "Reluctant") are differentiated by their storm expectations and readiness, as well as by different evacuation barriers. Based on these results, Connecticut coastal residents need basic information about their vulnerability, especially to storm surge. In addition, communications should be tailored to meet the unique needs of these different audiences.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Syma Ebbin syma.ebbin@uconn.edu, Research Coordinator, Connecticut Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Syma Ebbin at (860) 405-9278. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Dr. John F. Edwards

Date of Report submission: 06/03/2015

Project #: R/CSAP-8-CT

Dates of the reporting period: From [04/2014] to [06/2015].

Project Title: Assessment of social media usage during severe weather events and the development of a Twitter-based model for improved communication of storm-related information

Principal Investigator(s) and Affiliation(s):

1. Dr. John F. Edwards, Social Science Research Center, Mississippi State University
2. Dr. Somya Mohanty, Social Science Research Center, Mississippi State University
3. Dr. Patrick Fitzpatrick, Geo-systems Research Institute, Mississippi State University

A. PROJECT GOALS AND OBJECTIVES:

1) Survey residents from coastal areas affected by Hurricane Sandy to better understand the sources and quality of information received.

2) Identify key impact factors affecting the dissemination of weather-related information during Hurricane Sandy.

3) Identify and codify weather-related Twitter messages sent before, during, and after Hurricane Sandy.

4) Design and develop a novel software application that provides emergency managers with a real-time, Twitter-based, bidirectional communication system for capturing and disseminating weather-related information.

B. RESULTS:

The key findings and results of this research effort are as follows:

1) Survey of the general population from the coastal counties affected by Hurricane Sandy
    a) Among the full sample of respondents, television was the most frequently reported medium for receiving storm-related information. Upon the loss of electrical power, there was an increase in the use of Twitter and other social media platforms to send and receive storm-related information.
    b) Twitter users obtained more information from family, friends, and government agencies than non-Twitter users.
    c) In seeking to better understand the type of information that Twitter users shared via Twitter during Hurricane Sandy, it was found that photographs were the most frequently shared form of storm-related information, followed by personal experiences with the storm, information about storm damage, and storm warnings. This set of findings suggests that Twitter provides a useful platform through which users can share various forms of storm-related information, and through which researchers and emergency managers can retrieve information to help identify storm damage and plan relief efforts.

2) Social-media data analysis of Twitter messages during Hurricane Sandy
    a) There was a significant increase in the number of Twitter messages and users participating in weather-related discussions during the peak of Hurricane Sandy.
    b) During the peak of Hurricane Sandy, the social-mood of the users was negative. The majority of Twitter messages where of negative context.
    c) Several key influencers from disparate domains (politics, news agencies, relief organizations, and weather services) and their Twitter followers participated in close proximity discussions related to Hurricane Sandy.
    d) Twitter messages and images proved to be a valuable source of information during weather-related events.

3) Development of a Twitter-based, bi-directional software application to capture real-time images shared during Hurricane Sandy
    a) Using state-of-art computing technologies, a web-based application was created to enable real-time curation of weather-related images shared across social-media.
    b) Using the interfaces provided in the software, human coders can verify the location of a given image (using Google-street view) and the type of image that is being shared.
    c) The software also provides an interface for emergency managers to engage in bi-directional communication with specific Twitter users and take decisive action on the information collected.

C. COLLABORATORS:

For the web-based survey component of this research, it was critical for the research team to gain the cooperation of Twitter, Inc. Since the web-based survey methodology called for the recruitment of survey participants through Twitter's social media platform, the Twitter-based requests for participation in the survey could have easily been misinterpreted as spam. Had a representative from Twitter not been informed of the research team's intentions prior to sending messages to 20,000 Twitter users, the project server's IP address would have likely been blacklisted. Such action by Twitter would have effectively ended our opportunity to conduct the web-based survey. Twitter

has been very helpful in guiding the research team through the process of sending a large volume of tweets through their platform without being automatically flagged as spam. Twitter, Inc. has expressed strong interest in this research and has requested a brief overview of the findings in exchange for helping recruit survey participants through their company's platform.

D. PROJECT PUBLICATIONS:

Pellegrine, S. E., Gochanour, A., Edwards, J. F. & Mohanty, S. D. (2015). Using Twitter as a Means of Soliciting Participation in Survey Research. *In preparation.*

Gochanour, A., Pellegrine, S. E., Edwards, J. F., Mohanty, S. D, & Fitzpatrick, P. (2015) Communication Utilization and Reliability during Hurricane Sandy: A Multi-Modal Approach. *In preparation.*

Edwards, J. F., Mohanty, S. D., Gaylor, J., & Buffington, J. G. (2015). A Twitter-based Bi-directional Communication System for Weather-Related Disaster Response. *In preparation.*

Stubbs-Richardson, M., Gochanour, A., Mohanty, S. D., Edwards, J. F., & Fitzpatrick, P. (2015). Understanding the Utility of Twitter Use during Weather-Related Emergencies: A Case Study of Hurricane Sandy. *In preparation.*

Mohanty, S. D., Edwards, J. F., Stubbs-Richardson, M., & Fitzpatrick, P. (2015). Tweeting During Hurricane Sandy: A Network Analysis of Disaster Related Topics and Online Social Influence on Twitter. *In preparation.*

E. FUNDS LEVERAGED: None

F. STUDENTS:

Student Name: Amanda Gochanour
Degree Sought: Ph.D. Sociology
Expected date of graduation: May 2016

Student Name: Megan Stubbs-Richardson
Degree Sought: Ph.D. Sociology
Expected date of graduation: May 2017

Student Name: Sarah E. Pellegrine
Degree Sought: Masters in Sociology
Expected date of graduation: May 2016

G. VOLUNTEER HOURS: None

H. PICTORIAL: See Appendix C for screen captures of the software application.

I.   HONORS AND AWARDS: None

J.   PROJECT OUTCOMES AND IMPACTS

PROJECT RELEVANCE:
For storm hazard information, the classical linear communication model (Source → Message → Receivers) is being challenged by a nonlinear Communication Network Model consisting of an original source, multiple categories of intermediate receivers (internet sources, electronic media, print media, various government agencies), and ultimate receivers (individuals, households, and businesses). In addition, since warnings alone do not prompt evacuations and preparations, information must be parsed in a way that triggers risk perceptions for proper responses. This research provides a better understanding of a widely used social networking platform – Twitter – for proactive, decision-making processes. The proposed research also examines how the NOAA and local/federal emergency management agencies (sources) receive feedback and potential use information obtained from "receivers" to fill data-gaps.

RESPONSE AND RESULTS:

Research Objective 1: Survey residents from coastal areas affected by Hurricane Sandy to better understand the sources and quality of information received.

Survey Research Questions:
The survey instrument focused on the use of Twitter as a communication platform during Hurricane Sandy (See Appendix A). Analysis of respondent data addressed the following three research questions:

1) How did people obtain information during Hurricane Sandy?

2) From whom did people obtain information during Hurricane Sandy and how did these sources differ between Twitter users and non-Twitter users?

3) What type of information did Twitter users share over Twitter during Hurricane Sandy?

To answer the above research questions, researchers conducted a two-part survey of respondents who lived in coastal counties in Connecticut, New Jersey, and New York at the time of Hurricane Sandy, which made landfall in New Jersey on October 29, 2012. The first phase of data collection involved the use of a telephone-based survey. Since the researchers were highly interested in the ways respondents used Twitter during Hurricane Sandy, the telephone-based survey was supplemented with a web-based survey of respondents recruited via Twitter. The web-based survey of Twitter users also helped ensure a large enough sample of Twitter users to make useful comparisons between Twitter users and non-Twitter users (see Figure 1).

Figure 1

Sampling Frames
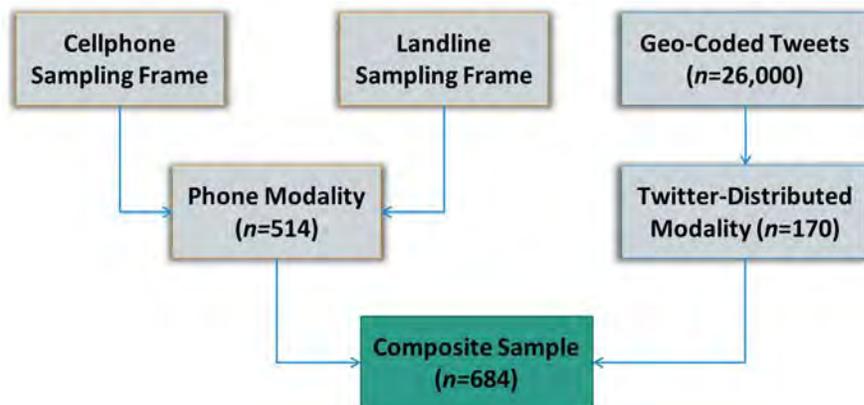
Telephone-based Survey:
The first phase of data collection involved a telephone-based survey of a representative sample of residents from 23 counties (see Figure 2) in Connecticut (Fairfield, Middlesex, New Haven, New London), New Jersey (Atlantic, Bergen, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, Somerset, Union), and New York (Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, Westchester). Respondents were screened to ensure that they were residents of one of the appropriate states and counties at the time Hurricane Sandy made landfall.

Figure 2

Survey Catchment Area

The sample was constructed using a dual frame approach – telephone numbers were selected for inclusion from the total frame of available landline numbers and the total frame of available cellphone numbers for the counties in the catchment area. The final sample size for those recruited

and surveyed via telephone was 514, with a cooperation rate of 12.4%. The researchers suspect that the relatively low cooperation rate is likely due to the length of time that passed between Hurricane Sandy and the data collection period (approximately 2 ½ years). The low cooperation rate might have also been influenced by respondent fatigue, considering the large number of research projects that have attempted to survey the local population in the years following Hurricane Sandy.

Regarding the sample of respondents recruited via telephone, the demographic characteristics were evenly split according to gender, with the sample comprised of 49.2 percent men and 49.8 percent women. The racial composition of the sample was comprised of 51.6 percent white, 18.9 percent black, 5.1 percent Asian, 12.5 percent "other," and 3.7 percent multiracial. With regard to level of education, the respondents were above average compared to the national population, with about half of the sample holding a bachelor's degree or a graduate degree.

Web-Based Survey
In the second phase of data collection, participants were recruited through Twitter. The researchers began by capturing all geo-coded tweets sent from the previously specified catchment area (see Figure 2 above) prior to, during, and directly following Hurricane Sandy's landfall. From this data, approximately 26,000 unique Twitter users were identified, 20,000 of which were randomly selected for inclusion in the web-based survey sample. To solicit participation in the survey, a Twitter message was sent as an "@ reply" to each Twitter user. When participants clicked a link embedded in the solicitation tweet, they were directed to a web-based survey which was virtually identical to the telephone survey (see Appendix A).

The 20,000 solicitation tweets generated 207 click-throughs for a total of 170 completed surveys, resulting in a response rate of slightly less than one percent. Much like the telephone sample, this low response rate is likely attributable to the length of time between the event and the data collection period, and to respondent fatigue. Furthermore, Twitter-based survey recruitment is a relatively novel approach and users may have been less willing to consider surveying a legitimate use of Twitter's platform.

Regarding the sample of respondents recruited via Twitter, the demographic characteristics are as follows: The modal category for gender is men, with men making up 57.0 percent of the sample and women comprising 43.0 percent of the sample. Regarding race, the vast majority of the sample was white 57.3%, followed by 6.8 percent Asian, 5.3 percent multi-racial, 3.9 percent black, and 3.9 percent "other." For level of education, the respondents were above average compared to the national population, with about half of the sample holding a bachelor's degree or a graduate degree.

Telephone and Web-based Survey Results
Survey Research Question 1: How did people obtain information during Hurricane Sandy?
The first research question sought a better understanding of how individuals received information during Hurricane Sandy. In both the telephone- and web-based surveys, individuals were asked whether or not they sought information through ten different mediums. There were statistically significant differences between Twitter users and non-Twitter users on four of the ten mediums for receiving information, with Twitter users receiving information via cellphone and the Internet at higher rates than non-Twitter users. In the full sample (including both Twitter users and non-Twitter users), there exists an interesting difference in ways of receiving information when taking into account the loss of electrical power. Figure 3 shows how the sample of respondents who did not lose power during Hurricane Sandy reported receiving storm-related information. Figure 4 shows how respondents who lost power during Hurricane Sandy reported having received storm-related information. Clearly there are significant differences between the groups.

Figure 3

Information Sources for Respondents with Power (*n*=205)

Figure 4
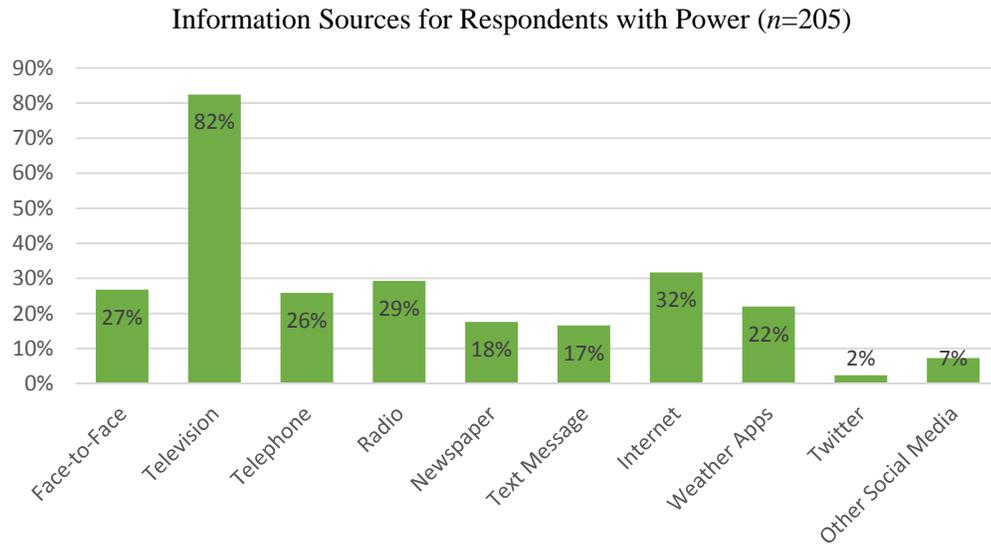
Information Sources for Respondents without Power (*n*=414)
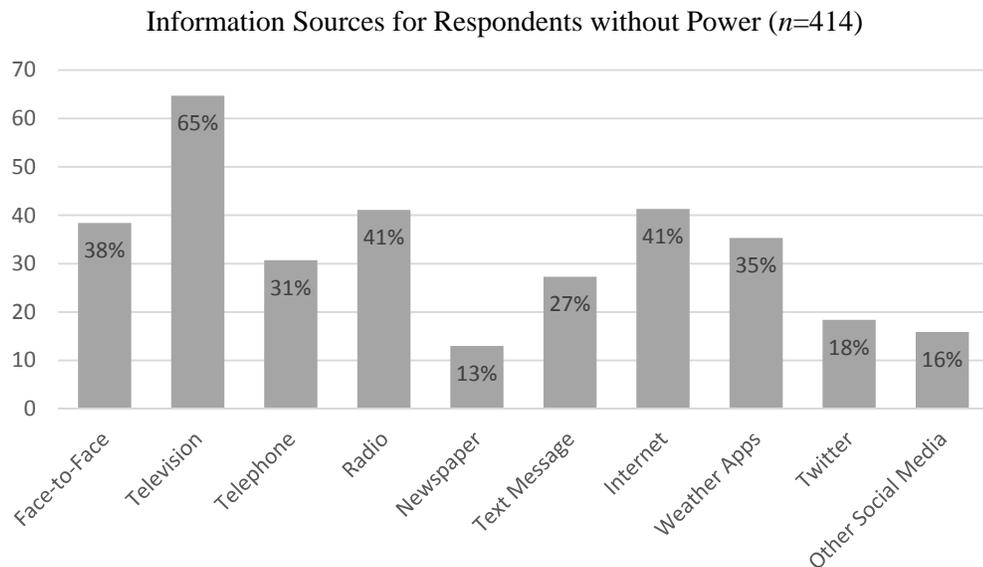
The most obvious discernable differences between Figures 3 and 4 are as follows: Individuals who lost access to electrical power, moved away from their reliance on television for receiving weather-related information and toward a reliance on radio, telephone, cellphones (through both text messages and weather apps), and the Internet, including social media. A move toward social media as a useful source of weather-related information when losing electrical power is among the clearest patterns in this analysis.

Survey Research Question 2: From whom did people obtain information during Hurricane Sandy and did these sources differ between Twitter users and non-Twitter users?
The second research question asked from whom respondents received information during Hurricane Sandy. Of particular interest was the way Twitter users differed from non-Twitter users

regarding their sources of information. Respondents were asked whether or not they received information from any of seven different sources. Figures 5 and 6 represent the sources of weather-related information for Twitter users and non-Twitter users, respectively.

Figure 5

From Whom Did Twitter Users Receive
Weather-Related Information (*n*=266)
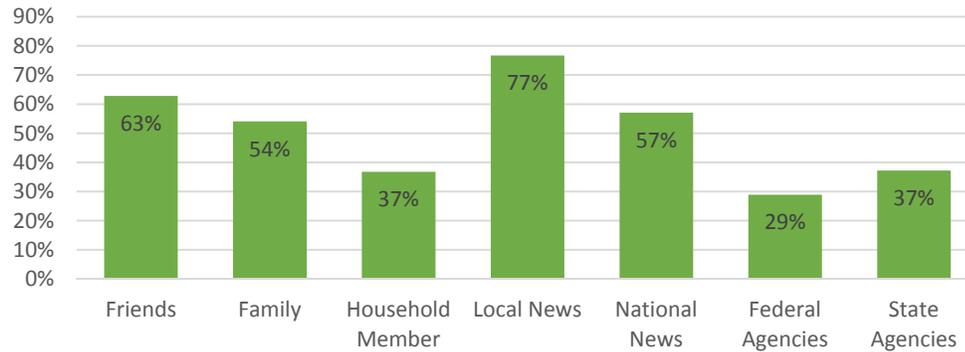
Figure 6

From Whom Did Non-Twitter Users Receive
Weather-Related Information (*n*=420)
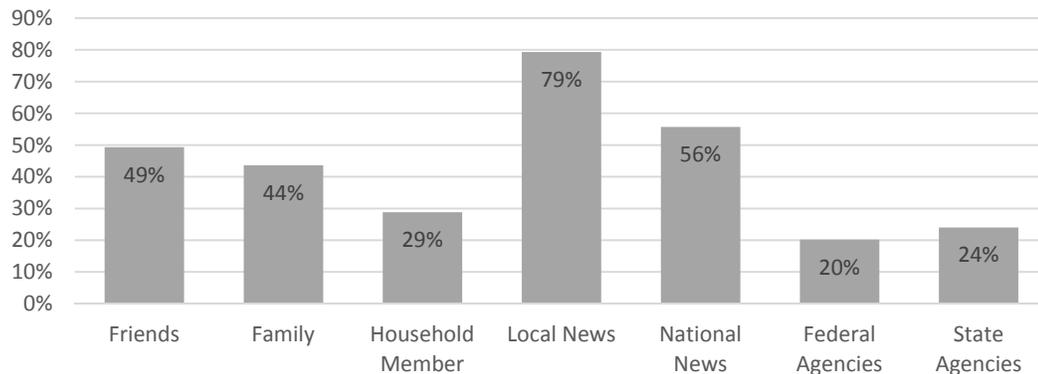
The above figures suggest that, while both Twitter users and non-Twitter users relied on local and national news at about the same frequency, Twitter users reported having received information from family, friends, and government agencies at higher rate than non-Twitter users. This suggests an issue of access. Through Twitter, users have more access to family, friends, and government agencies than non-Twitter users. One potentially actionable finding that stems from these data is that government agencies can utilize Twitter during emergency situations and, by doing so, reach at least a subset of the population most at risk during weather-related emergencies.

A secondary analysis relating to this research question examined what sources the Twitter-user respondents reported following on Twitter. Figure 7 illustrates which weather-related Twitter accounts respondents followed.

Figure 7

Weather-related Twitter Accounts Followed by Survey Respondents (*n*=266)
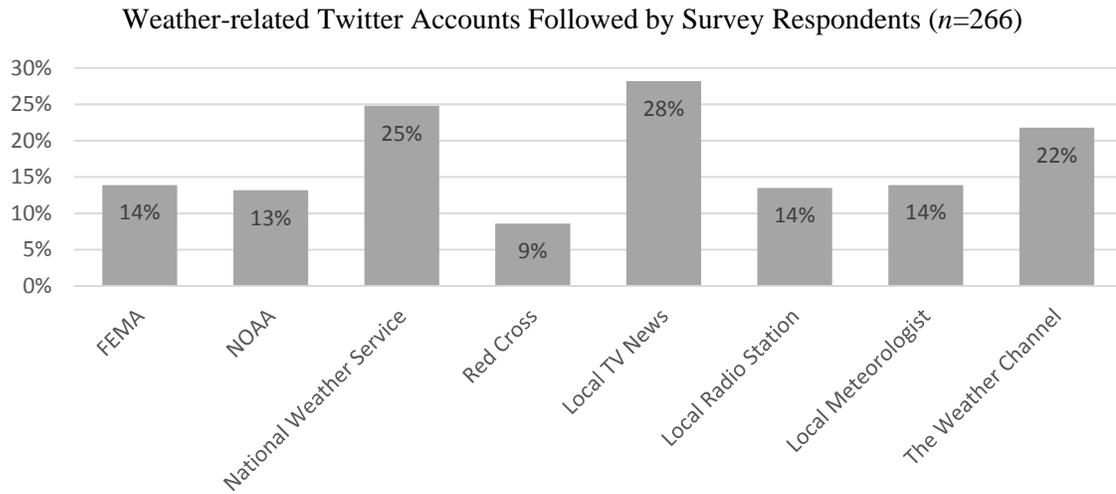
While Figure 7 clearly indicates that Twitter users follow a myriad of weather-related sources, the three top sources were: The National Weather Service, The Weather Channel, and respondents' local television news stations.

Survey Research Question 3:
What type of information did Twitter users share over Twitter during Hurricane Sandy?
The third research question seeks to better understand the types of information Twitter users shared via Twitter during Hurricane Sandy. Twitter users were asked whether or not they shared weather-related information during the hurricane. If they reported that they had, they were asked what types of information they had shared. Approximately 59 percent of Twitter users reported that they shared weather-related information via Twitter during Hurricane Sandy. Figure 8 illustrates the types of information those users shared.

Figure 8

Types of Information Twitter Users Share During Hurricane Sandy (*n*=156)
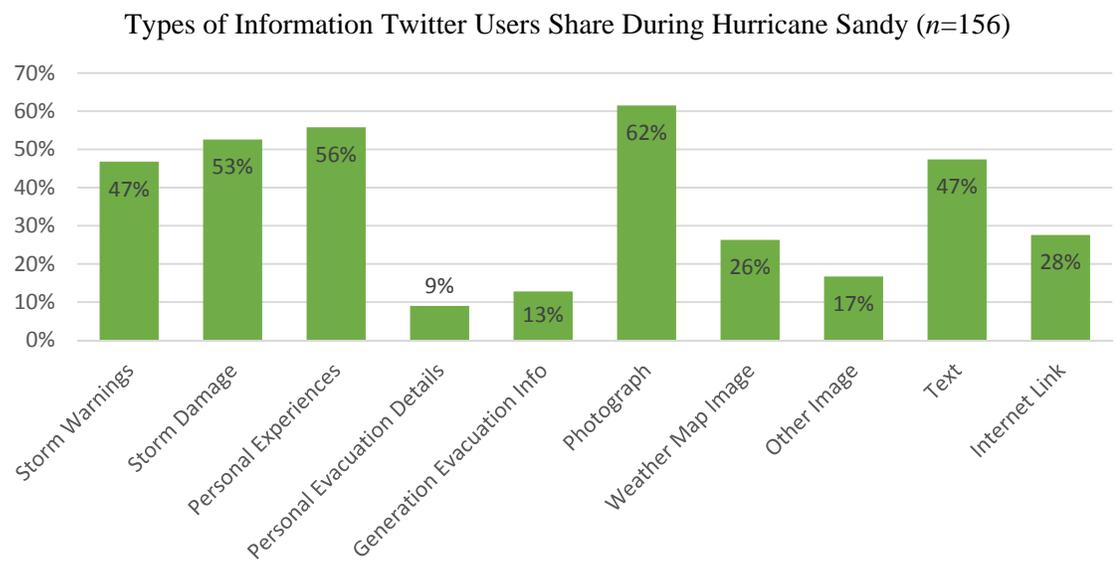
The data indicate that photographs were the most frequently shared form of information by users of Twitter. Photographs are followed in frequency by personal experiences with Hurricane Sandy and information about storm damage. It is not necessarily the case that the categories of information Twitter users shared are mutually exclusive, meaning respondents may have posted a tweet sharing their personal experiences with the storm and attached an image to that tweet. Regardless, these findings illustrate Twitter's utility as an image-sharing platform and lend support to the development of a software application designed to identify images relevant for disaster response efforts.

Overview of Survey Findings
The findings indicate that Twitter can serve as a valuable medium for communication during weather-related emergencies. During power outages, respondents reported using Twitter and other social media at higher rates. This suggests that during power outages, individuals can use Twitter and other social media platforms as a back-up source of weather-related information. In addition, Twitter users reported receiving information from various sources at higher rates than non-Twitter users. This suggests that Twitter provides users with access to individuals, organizations, and agencies that are sharing weather-related information.

Taken cumulatively, the findings indicate that Twitter can be a useful medium through which individuals can communicate during weather-related emergencies; a useful source for researchers to better understand how individuals communicate during weather-related emergencies; and a useful way for agencies responsible for providing assistance to communicate with individuals at risk.

Research Objective 2 & 3: Identify key impact factors affecting the dissemination of weather-related information during Hurricane Sandy and identify and codify weather-related Twitter messages sent before, during, and after Hurricane Sandy.

To achieve the project objectives, a total of 13.7 million Twitter messages were collected from Oct. 22 to Nov. 7, 2012. The raw data were indexed and inserted into a distributed NoSQL (MongoDB) database for storage. This database serves as the central repository of data for all subsequent analyses.

Internal to the database, the data are divided into two datasets (see Table 1):

1) Keyword – Twitter messages matching a set of collection terms comprised of keywords, hashtags, and user names (see Appendix B). This dataset helped the researchers better understand the discussions and the impact factors in Hurricane Sandy related messages within the Twitter network (4.4 million Twitter messages).

2) Geo-coded – Twitter messages from New York, New Jersey, and Connecticut. This dataset helped the researchers gain additional information (images of damage and flooding, evacuation notifications, development of codification mechanism) from the geo-coded messages posted during Hurricane Sandy from the affected coastal counties (9.3 million Twitter messages).

Table 1

Total Count of Twitter

Dataset	Rules Matched	Tweet Count
Geo-coded	Initial Bounding Box	4,254,642
	New Jersey Bounding Box	223,715
	Total Unique Tweets	**4,478, 357**
Keyword	Body content terms	9,039,065
	Hashtags	1,066,273
	Users	373,309
	Total Unique Tweets	**9,386,824**

To better understand the impact factors and the content of the messages shared across Twitter, both the datasets (Keyword and Geo-coded) were further divided into three temporal phases:

1) Pre-Hurricane   (10/22/2012 – 10/28/2012)
2) During-Hurricane (10/29/2012 – 10/31/2012)
3) Post-hurricane   (11/01/2012 – 11/07/2012)

The following describes the analytical methodology and the key inferences gained from the data:

i) Traffic Analysis:
Methodology: The collected datasets contained metadata attributes of the time at which the messages were posted on the Twitter network. The time-stamp attribute has a resolution of milliseconds in relation to the GMT time zone. Analysis on the keyword and the geo-coded datasets were conducted to illustrate the *peaks* and *valleys* in the data in order to better understand the involvement of Twitter users in discussions about Hurricane Sandy. The data were aggregated by number of messages per-hour and the number of unique users per-hour to visualize the resulting peaks in the temporal zones.

Insights: The analyses of the traffic statistics for the keyword and the geo-coded datasets provide some valuable insights. For the keyword dataset (see Figure 9), during the hurricane, there was a substantial increase in the number of messages that were being sent across the network and the number of unique users contributing to the discussion. The discussion started increasing on Oct 26, 2012 with the highest peak occurring on Oct 29, 2012 (approximately 237 K unique messages being shared per hour) at 6:00pm EST. At the time Hurricane Sandy made landfall (8:00pm EST in Atlantic City), approximately 223 K unique messages were being shared across the network by 187 K users participating in the discussion per hour. In the following days, both during and post-hurricane Sandy the number Twitter messages along with the number of users decreased over time. The post-hurricane phase revealed a larger number of messages being shared across the network in comparison to the pre-hurricane period.

Figure 9

Traffic Statistics of Keyword Dataset Aggregated by Hour
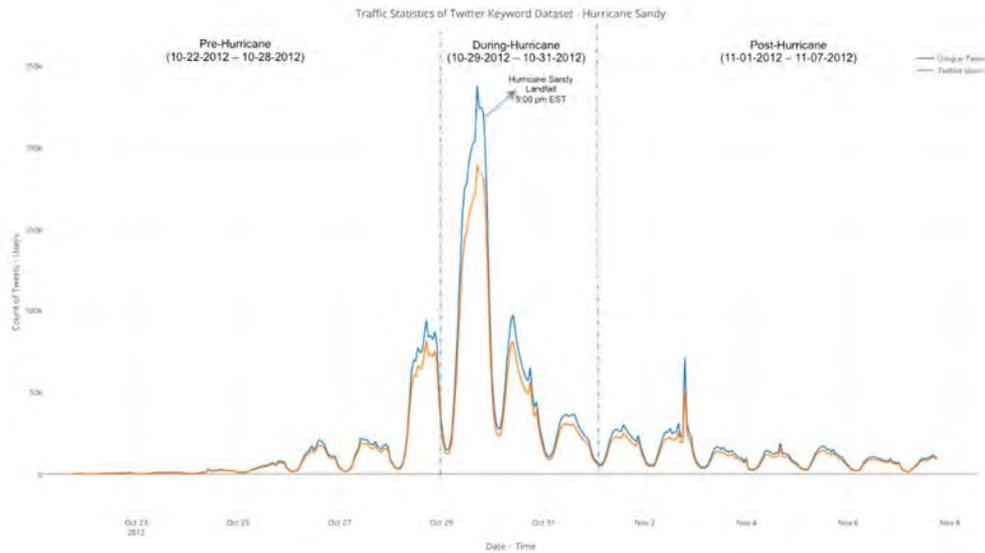
Figure 10 shows the traffic statistics of the geo-coded messages and their corresponding users collected from the New York, New Jersey and Connecticut area. In comparison to the keyword dataset, the geo-coded traffic shows a large number of peaks in all three phases of the hurricane. During the pre-hurricane phase, the number of Twitter messages shared from the location decreased Oct. 28 and then gradually rose to the peak during landfall at 8:00pm EST on Oct. 29. The traffic then gradually decreased over the following days and peaked again on Nov. 7, which was a result of President Obama's re-election.

Figure 10

Traffic Statistics of Geo-Coded Dataset Aggregated by Hour
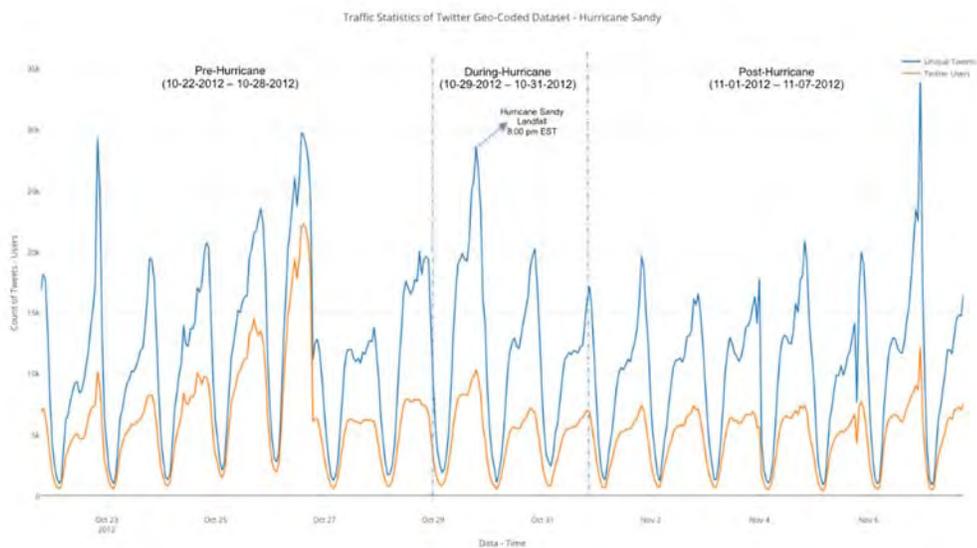
During the hurricane, approximately 10 K users sent more than 28 K geo-coded messages per hour across the network. These messages provide valuable information from individuals residing in the hurricane-affected areas. More specifically, the messages contain firsthand information about the hurricane, along with disaster related images taken in real-time. The data are utilized for the real-time information codification pertaining to Objective 4 of this research project.

ii) Klout Analysis:

Methodology: Each user captured by the data, contains the metadata attribute of Klout score. This score for a Twitter user is a numerical value from 1 to 100. It is based on the size of user's social network (friends, followers, and their social influence) and correlates with the reactions to the user's posting by other Twitter users. In this research, the scores pertaining to individual users were aggregated by hour to understand the involvement of influential users in the discussions about Hurricane Sandy. The data were then compared across the temporal zones for both the keyword and the geo-coded datasets.

Insights: The analysis of the aggregated Klout scores shows a decrease in the average score per hour nearing landfall (see Figures 11 & 12). This indicates an increase in participation of the general population (lower Klout Scores in comparison to influential users) in the discussions leading up to, and following, Hurricane Sandy. While influential users with high Klout scores also participated in the discussions, the general population was more active in sending messages that were being shared across the network. The analysis also shows that the geo-coded users have a much lower average Klout score than the keyword dataset users. This may indicate that the majority of the general population have their geo-location services enabled on their mobile devices.

Figure 11

Average Klout Scores Keyword Dataset Aggregated by Hour
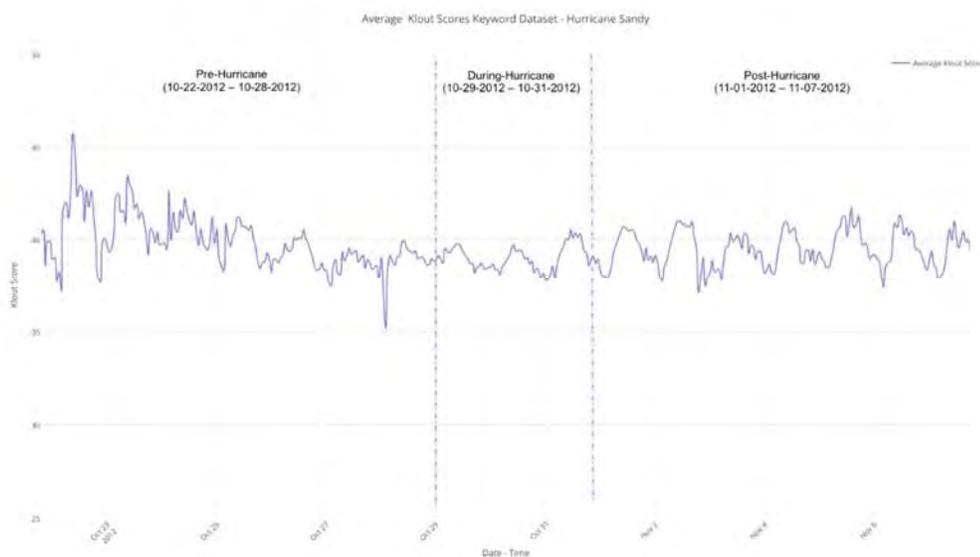
Figure 12

Average Klout Scores Geo-coded Dataset Aggregated by Hour
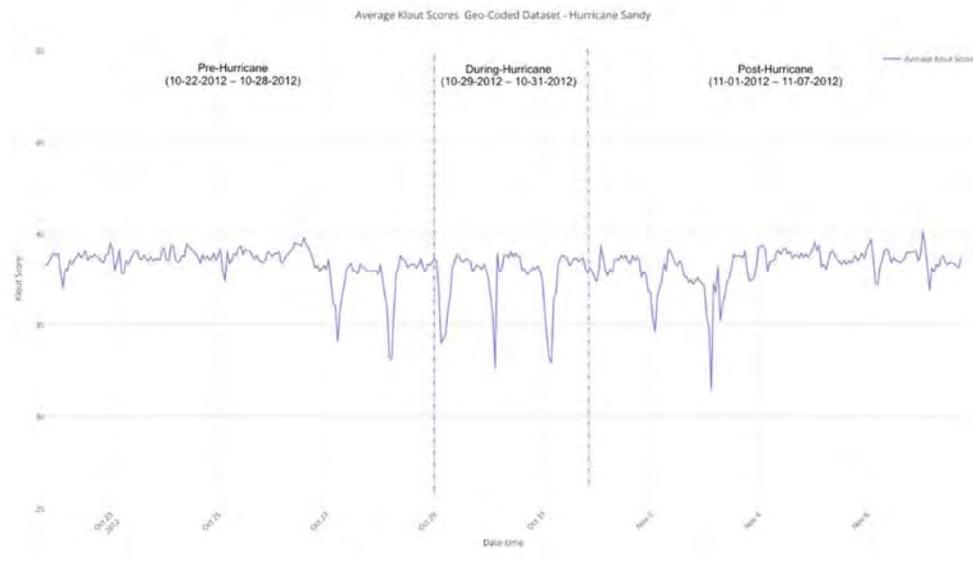
iii) User Network Analysis:

Methodology: The user-network analysis is based on the metadata of user mentions in Twitter messages. Twitter users can mention other users by posting a message using the format of '@username' to reference a particular user or reply to another user's tweet. The research team utilized the data to analyze and visualize the interconnectivity of Twitter users and to further understand the influence of prominent users in the network. A graph-based data structure was created for each mention of the user and edges were added from the originating user to the mentioned user. As shown in Figures 13 and 14, the nodes represent Twitter users and the lines between the nodes represent the connectivity by the attribute of mention.

Figure 13

User-Network Analysis Keyword Dataset - Pre-Hurricane Phase
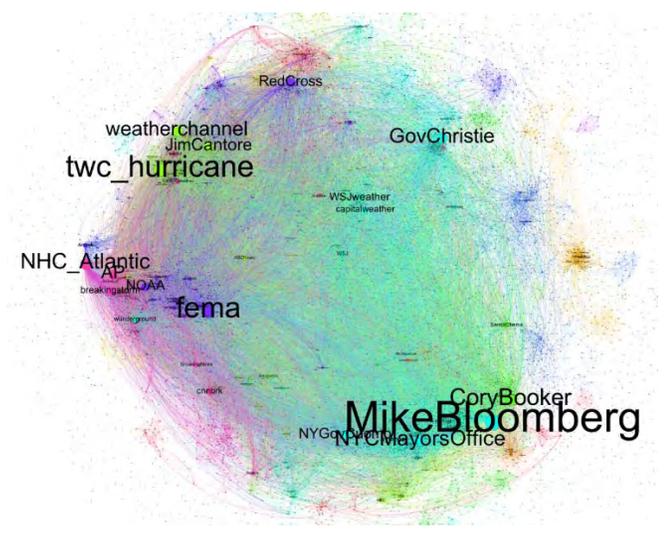
The size of the nodes (and the size of username) represents the number of times a particular user was mentioned. Modularity index (clustering parameter) was used to divide the graph into groups of users who are well connected or clustered together in the graph. The varying colors of the nodes and the edges represent the various clusters, which form in the graph. A Force-Directed algorithm was utilized to visualize the different clusters, where each nodes acts as a planet and the edge between them acts as the gravitational pull between the nodes (or planets).

Figure 14

User-Network Analysis Keyword Dataset - During-Hurricane Phase
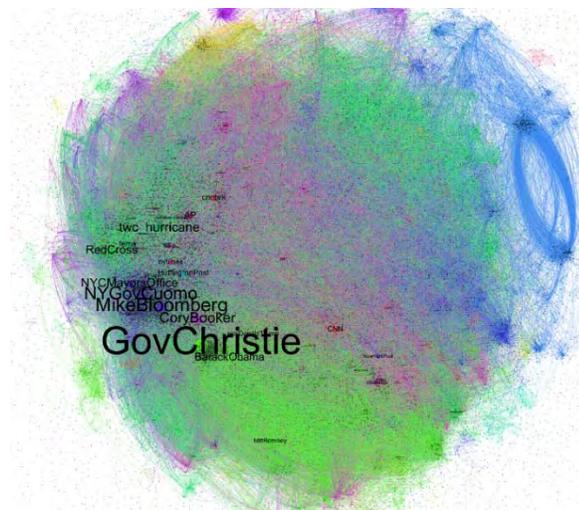
Insights: The user-network analysis identifies prominent users that were mentioned during the time of the hurricane and their closely associated Twitter users. In the pre-hurricane phase (Figure 13), politically related Twitter users such as, MikeBloomberg, NYGoverner, NYCMayorsOffice, CoryBooker cluster together, where as news agencies (NHC_Atlantic, breakingstorm, wunderground, twc_hurricane, weather_channel, ABCnews) and federal agencies (FEMA, NOAA) each form separate clusters. RedCross and GovChristie have their own influence groups, which are separate from the other clusters. In the during-hurricane phase (Figure 14), most of the users clustered together. This suggests that there was an abundance of information being commonly shared across the prominent users. GovChristie achieved the highest number of mentions, followed by other politically related Twitter users (BarakObama, NYCMayorsOffice, NYGovCuomo, MikeBloomberg, CoryBooker). FEMA and RedCross gravitated closer to news agencies such as HuffingtonPost, nytimes, AP, cnbrk.

The formation of a blue circular cluster (on the right side of the data structure) proved to be noise unrelated to the hurricane. This cluster represents a high volume of communication between two United Kingdom musical bands and their producers' discussions about a song titled "Sandy."

In the post-phase of the hurricane (Figure 15), users clustered near the center of the graph, suggesting that most of the centroid users where highly connected to other users in the network. RedCross becomes highly mentioned as a result of its involvement in the relief efforts.

Figure 15

User-Network Analysis Keyword Dataset - Post-Hurricane Phase
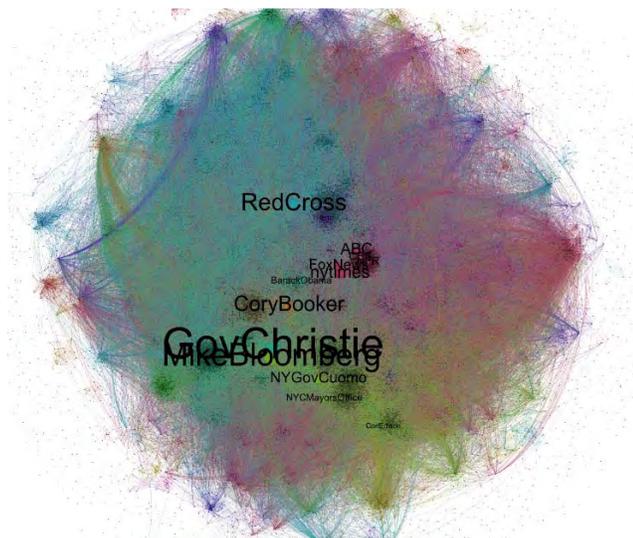
iv) Sentiment Analysis:

Methodology: Sentiment analysis of the tweets involves the utilization of a machine-learning model which examines the content of the tweet to determine polarity of the message (positive, negative, or neutral). The process utilizes various techniques such as text cleanup (stopword, url removal, emoticon filtering), feature-extraction (context features, natural language processing, rare word filter, stemming), and vectorization of text. The model used for the analysis of the present datasets is based on a trained dataset of approximately 4.2 million coded tweets in each category and is purpose-built for codifying short text messages such as tweets with an accuracy of 81% (10 fold cross-validation with 2.1 million codified tweets). The sentiment model assigns each tweet a value between -2.0 to +2.0, where -2.0 to -1.0 is codified as negative, -0.99 to +0.99 is codified as neutral and +1 to +2 is codified as positive. Both the keyword and geo-coded datasets were codified with sentiment values for each tweet and average sentiment values were aggregated by hour.

Insights: Analysis of the different phases of the study (see Figures 16 & 17) reveals the messages shared by Twitter users were more negative in the during-hurricane phase of the study. The pre-hurricane phase of the study in both datasets displayed a more positive sentiment, while gradually decreasing toward the mid-point of the during-hurricane study (lowest sentiment average scores) and then increasing in the post-hurricane period. This shows the dynamics of Twitter users who were posting messages with an increasingly negative attitude to Hurricane Sandy at the peak of the storm. The comparison of the keyword and geo-coded datasets also reveals that the sentiment of Twitter messages originating from the Hurricane Sandy areas (geo-coded dataset score range between -0.2 to +0.5) are more negative than the keyword dataset (score range between +0.1 to +0.5).

Figure 16

Average Sentiment Score Keyword Dataset Aggregated by Hour
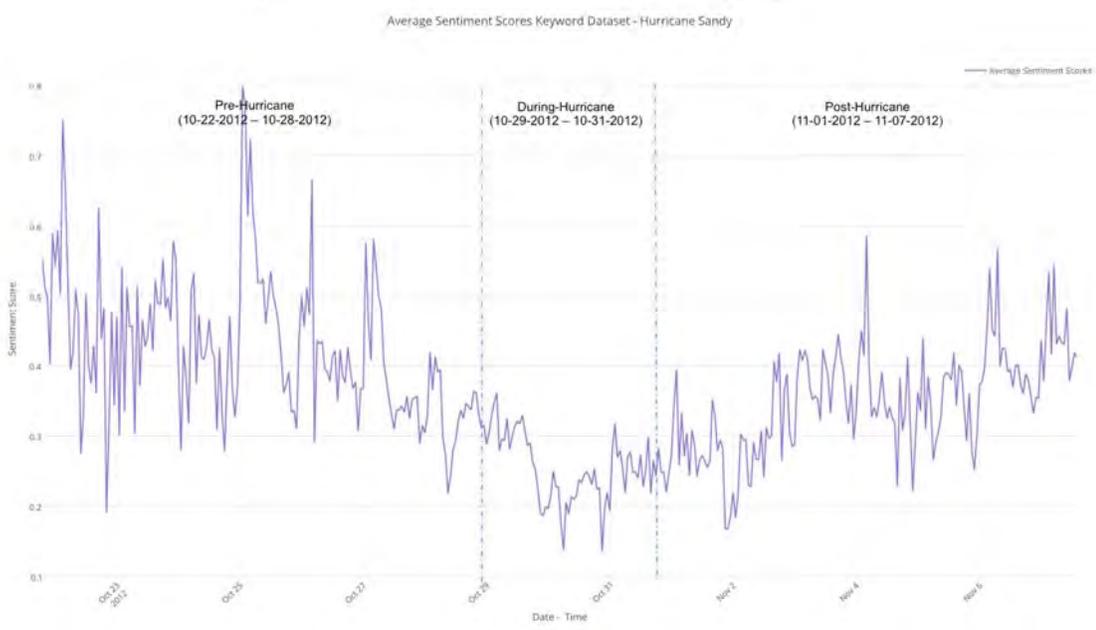
Figure 17

Average Sentiment Score Geo-Coded Dataset Aggregated by Hour
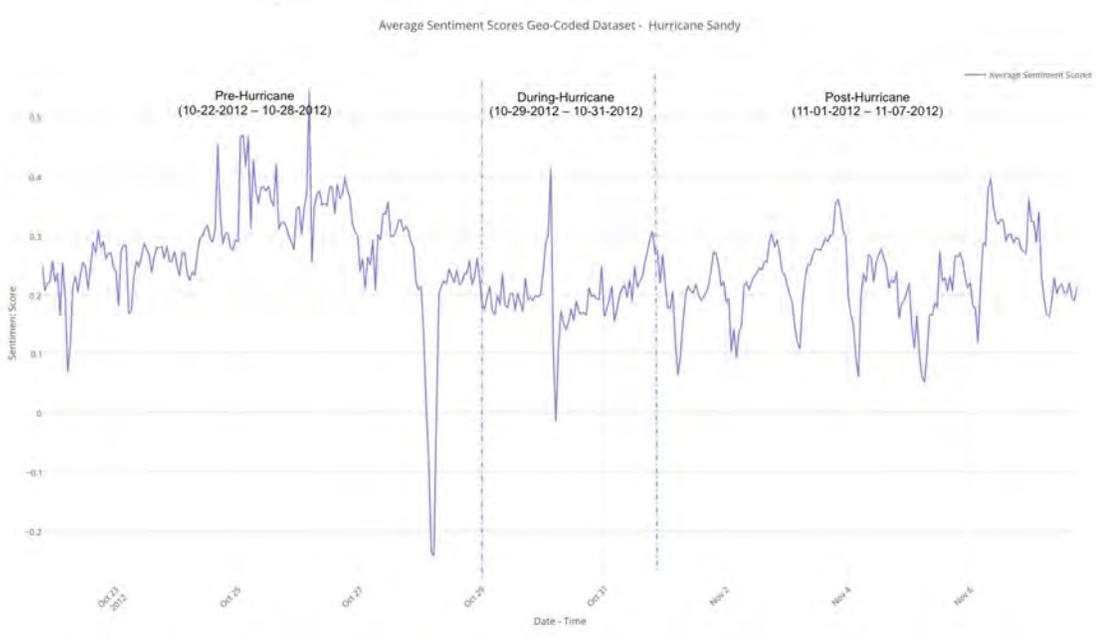
v) Word-Cloud Distribution Analysis:

Methodology: The content of the twitter messages can be analyzed for word-distribution in order to understand the key-topics that were discussed in the temporal phases of the study. The research team extracted the text content of the tweets for the different phases of the hurricane from both datasets. The text was then processed for cleanup and word frequencies were calculated. Stemming was utilized for abbreviations in the short messages and a term occurrence score was calculated using Term Frequency – Inverse Document Frequency. The resulting values were plotted using word clouds to understand the trends of key terms in both of datasets (see Figure 18).

Figure 18

Word Cloud Distributions (Keyword Dataset)

Pre-Hurricane Phase	During-Hurricane Phase	Post-Hurricane Phase

Insights: In the keyword dataset, analysis of the word distributions reveal that the most frequently occurring words in the pre-hurricane phase were: *Sandy, Hurricane, Frankenstorm, Storm, New York, Coming,* and *Tomorrow*. In comparison, the most frequently occurring words in the during-hurricane phase were: *Sandy, Hurricane, Power, HurricaneSandy, Safe, Stay Safe, East, Prayer,* and *Good*. In the post-hurricane phase, the most frequently occurring words were: *Help, Relief, Sandy, Hurricane, New York, SandyHelp, Aftermath,* and *Power*. The analysis shows the transition of discussion across the different phases of the hurricane from people advising and spreading the news of the hurricane, to Twitter users being concerned about the well-being of their friends and followers, to relief and rescue efforts in the aftermath of the hurricane. The discussion of power outages also occurs in the during- and post-phases of the hurricane.

The geo-coded dataset presents similar results with one key difference in the post-hurricane phase, where the discussion was more of an everyday social interaction along with some discussion on President Obama's re-election (see Figure 19).

Figure 19

Word Cloud Distributions (Geocoded Dataset)

Pre-Hurricane Phase	During-Hurricane Phase	Post-Hurricane Phase

vi) Word Collation Analysis:

Methodology: Using a similar methodology as the user-network analysis, word-collation analysis was performed on the keyword dataset. Individual Twitter messages were analyzed for words that co-existed and graph data structures were created for analyses of the pre, during, and post phases of the hurricane. The words formed the nodes in the graph and edges were added if any two words co-existed in a given tweet. The size of nodes represents the frequency of occurrence of the word in the dataset. Clustering algorithms were performed on the data structure to partition the graph based upon the inter-connectivity of the words.

Insights:

In the pre-phase (see Figure 20), the words *hurricane* and *sandy* were the top ranking words. They were connected by less occurring words such as *frankenstorm, storm, hurricanesandy, school,* and *monday.*

Figure 20

Word-Collation (Keyword Dataset): Pre-Hurricane Phase

The during-phase (see Figure 21) shows a substantial change in the words that were tweeted. Words that formed clusters included: [*stay, safe, strong*], [*friends, family, share*], [*New, York, Jersey, Atlantic*], [*prayers, thoughts*], and [*power, out, home*].

Figure 21

Word-Collation (Keyword Dataset): During-Hurricane Phase

In the post-phase (see Figure 22), clusters related to the aftermath [*power, still, out*], relief [*food, water*], [*help, relief , sandyhelp*] and donation [*redcross, donate*] formed the main topics of discussion.

Figure 22

Word-Collation (Keyword Dataset): Post-Hurricane Phase

Research Objective 4: Design and develop a novel software application that provides emergency managers with a real-time, Twitter-based, bidirectional communication system for capturing and disseminating weather-related information.

Development of Software for Codification of Emergency Weather-Related Messages:
A prototype of a web-based application named Social Crowd-based Visual Monitor (SoC-VM), was developed to provide emergency managers with a bi-directional communication system for identifying and responding to important Twitter-based messages and images sent by the general public during weather-related emergencies. Initial focus has been placed on the value of using geo-coded images sent by Twitter users during Hurricane Sandy. A significant number of images that depict both damage and flooding in the coastal areas of Connecticut, New York, and New Jersey during Hurricane Sandy were obtained from tweets sent during the event. Once a key set of such images are properly filtered from the vast amount of images unrelated to storm damage or flooding, critical inferences can be made regarding the extent of the damage and the depth of the floodwaters.

Since the science of machine-based image recognition has not progressed to the level of accurately identifying images of damage or depth of floodwater, the application relies on human judgment to codify the pertinent images. It is also critical for the human codifier to determine whether the exact location of the image, as indicated by its accompanying lat-lon coordinates, can be accurately identified. To this end, the web-based application has been designed to provide a team of human codifiers with a stream of real-time images obtained from Twitter, juxtaposed with an image from Google Street View that shares the same lat-lon coordinates as the Twitter image (see Figure 23).

Figure 23

Codifier Module
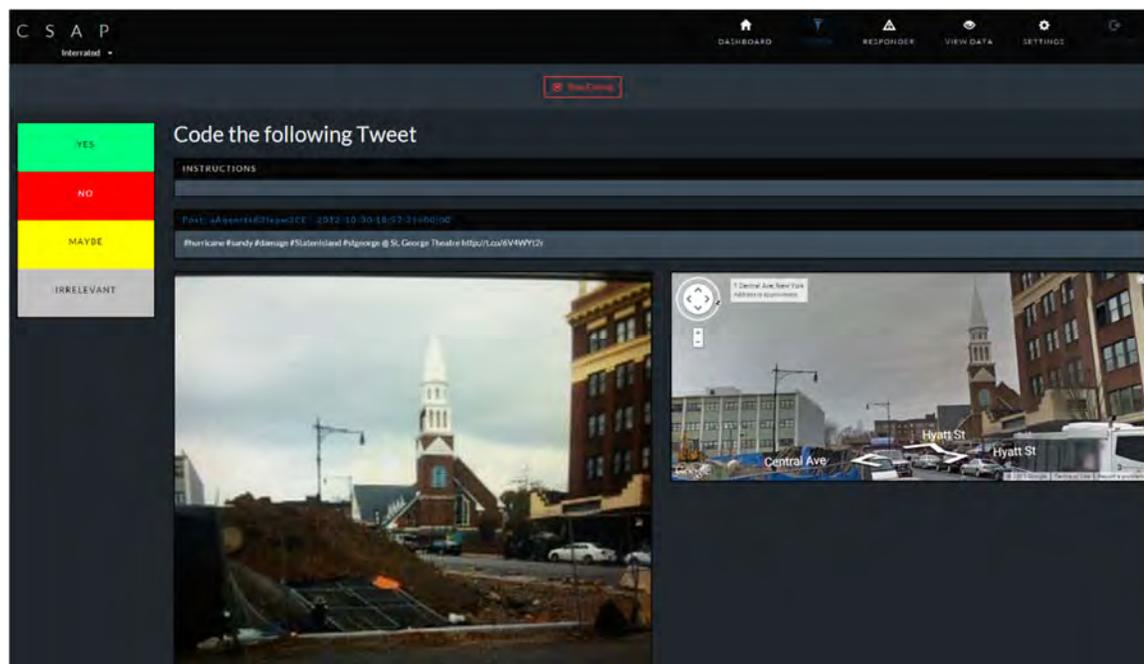
The codifier has four coding options: YES, NO, MAYBE, and IRRELEVANT. A Punnett-style square was devised to assist in coding the images. For each image the codifiers were instructed to answer two questions: 1) Is there visible damage or floodwater? and 2) Can the location be verified (using the Google street view pane)? The codifier used their answers to these two questions to correctly code the images according to the codification schema illustrated in Figure 24.

Figure 24

Codifying Schema

The graphical user interface (GUI) for the SoC-VM codifier module has been designed to maximize the efficiency of the filtering process with large color-coded response buttons that can be easily triggered by a finger tap on a touchscreen. For traditional workstations, the software also accepts the keyboard strokes of 1 through 4 as an alternative input method for coding the images. Preliminary data-entry speed tests of the GUI have shown that a traditional workstation with a number pad is the most efficient method for filtering the images.

As the visual data is filtered in real-time, all images that have been marked as pertinent for review by an emergency manager are queued for presentation through the Emergency Manager Module (see Figure 25). Again, the GUI has been designed to maximize efficiency of the decision-making process. Both the Twitter image and its corresponding Google Street View image are clearly presented. Additionally, a street address corresponding to the image's lat-lon coordinates is provided. This information is obtained through the "Latitude/Longitude Lookup" feature of Google's Geocoding API. To further facilitate the decision-making process of an emergency manager using this system, the text of the tweet from which the image was obtained is also provided.

Figure 25

Emergency Manager Module
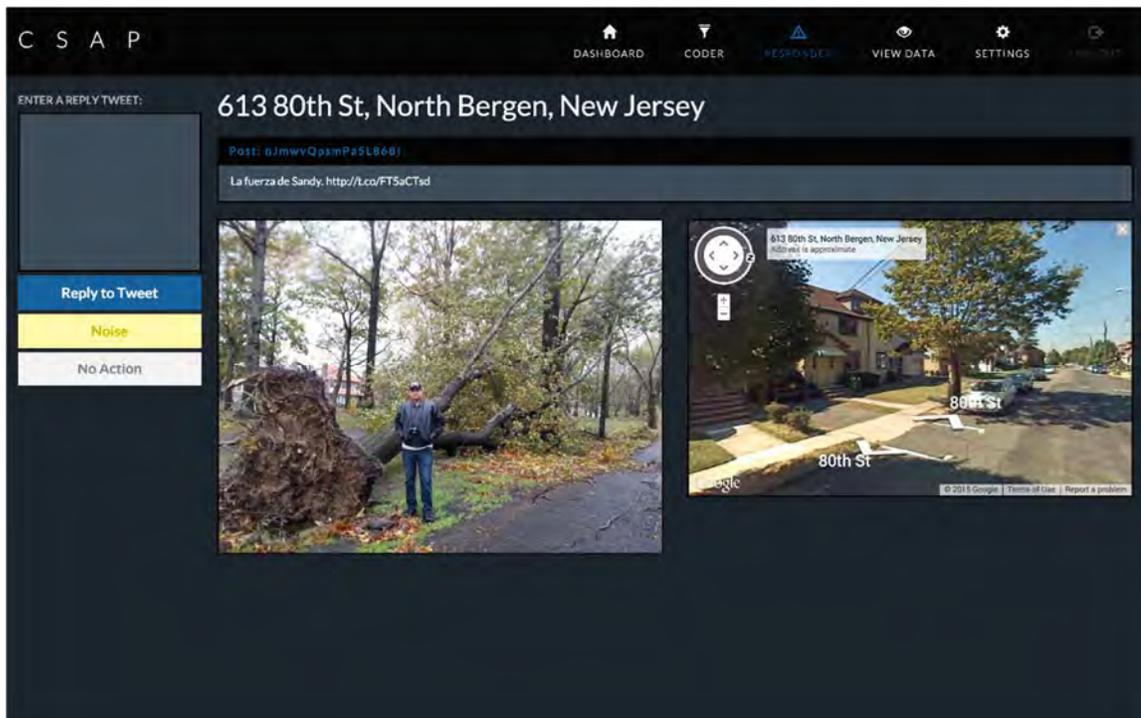
The street address, Twitter image, Google Street View image, and the text of the tweet associated with the image provide the critical information necessary for an emergency manager to make an informative decision of whether or not the social media-based communication warrants a response and/or other action, such as dispatching first responders to the location. The module allows the emergency manager to take one of several actions. The manager can type a response to the Twitter user who provided the information and directly send this response via Twitter as a "reply" to the original tweet. This will allow both the Twitter user and all of his or her followers to see the emergency manager's reply, thereby facilitating bi-directional communication between the emergency manager and the Twitter user who provided the valuable information. For example, the emergency manager can request that the Twitter user provide more information about the location by tweeting more descriptive text or sending more images. Essentially, the system has spawned a critical communication link between an emergency manger and a bystander in the field. The bystander can serve as a human sensor, continuously assessing the environmental conditions for a very specific location. Lastly, the module allows the emergency manager to mark the Twitter communication as relevant but not warranting any further action or irrelevant and to be taken out of the queue.

Additional monitoring of the system data can be viewed though the Data Collection Module (see Figure 26). This module provides an overview of the data stream, a map indicating where damage or flooding has been observed, and multiple measures of coding efficiency. The module indicates the total number of images that have been processed with a graphical representation of how many images fall into each of the four coding categories. Additional coding efficiency measures include: 1) Average time for coding each image; 2) Total number of images in queue; 3)

Estimated time for completion; 4) A signal to noise ratio; and 5) Total number of individuals actively codifying the data.

Figure 26

Data Collection Module
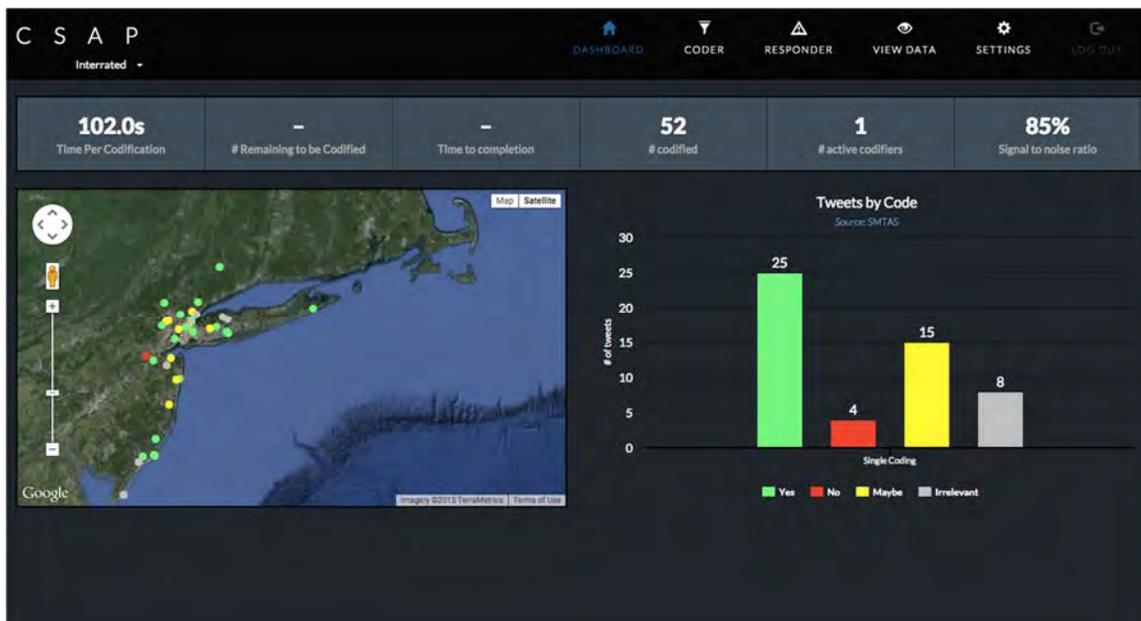
As the images are being coded, a real-time map of the data collection catchment area displays points where images indicate the presence of damage or flooding (green map points in Figure 26). Equally important, the map displays points where no damage or flooding has been observed (red map points in Figure 26). As the number of coded images increases, the map continuously populates with more indicators of damage/flooding versus non-damage/flooding. With enough data, the color-coded map points begin to cluster, providing a broad overview of large swaths of damaged structures or flooded land.

Technical Specifications:
The Social Crowd-based Visual Monitor (SoC-VM) is based on a real-time web-application model utilizing state-of-art frameworks. SoC-VM uses a structure-less, non-relational database (MongoDB) for the storage of the data. The utilization of a schema-less storage mechanism enables extensibility of the software to other social media datasets. The framework is based on Meteor, which enables the real-time data transfer and update using web-sockets. The real-time functionality of the software provides the time-critical reactivity needed for the data to be codified and examined by the emergency managers. The front end of the application is based on HTML5, CSS and node.js, enabling the web-application to be compatible with multiple web-browsers and accessible from any Internet connected machine. The application can be directly connected to the real-time *firehose* connection of Twitter's API (Application Program Interface), providing the necessary connectivity to the source data.

K. STAKEHOLDER SUMMARY

The goal of this research project was to better understand the sources, quality, and reliability of information received by individuals affected by Hurricane Sandy. To this end, the research team took a threefold approach to exploring the issues: A survey was conducted with individuals from New York, New Jersey, and Connecticut who experienced Hurricane Sandy; Social-media posts from Twitter were analyzed to identify the social-media users who were most responsible for contributing to the weather-related topics of discussion; A novel software application was developed for use by emergency managers to gather time-critical, social media information (photographs and messages) for coordinating disaster relief and assistance.

Responses to the survey helped answer three main questions: 1) How did people obtain weather-related information during Hurricane Sandy; 2) From whom did people obtain this information; and 3) What type of weather-related information did people share via Twitter? Television proved to be the most popular source of weather-related information, however, once people lost power, many shifted to using Twitter and other social media platforms to receive this information. In contrast to non-Twitter users, avid users of social media relied more on information that they received from friends, family, and government agencies. Twitter users possess a more comprehensive communication network than non-Twitter users. It was also found that during Hurricane Sandy, Twitter users more frequently shared storm-related photographs than any other information.

The analysis of social-media content showed that Twitter was a highly valuable source of information during the hurricane. There was a considerable increase in the number of users and the messages that were shared during the peak of the hurricane. A large number of posts contained weather-specific information that was being shared with photographs taken by the users that showed the intensity of the hurricane in real-time, along with images of damage and flooding. The analysis of social media also revealed a number of key influencers from different domains: 1) Political (GovChristie, MikeBloomberg, NYGoverner, NYCMayorsOffice, CoryBooker), 2) News and Weather (NOAA, NWS, NHC_Atlantic, breakingstorm, wunderground, twc_hurricane, weather_channel, ABCnews), and 3) Relief organizations (Red_Cross, Occupy_sandy). These key influencers and their followers participated in Twitter-based discussions related to Hurricane Sandy. The connectivity of the influencers and their followers on Twitter played a vital role in information sharing and dissemination throughout the hurricane.

The final result of this research was the design and development of a novel software application that provides emergency managers and first responders with real-time, exact-location, images chronicling the effects of a weather-related disaster (e.g. damage, flooding). Despite warnings to take shelter or evacuate from an impending disaster site, many people remain in place and share photographs of a given disaster using social media platforms such as Twitter. SoC-VM, the software application developed as part of this research project, allows emergency managers to have direct access to all images posted on Twitter from a given area in real-time, often hours before first responders can safely enter the disaster zone. Many of these images are geo-coded, meaning that the exact location (street address) of the damage or flooding can be geographically pinpointed and verified. Such images can help emergency managers better plan their rescue and relief efforts. This research showed that people are sharing thousands of photographs on social media during weather-related disasters. While the researchers do not condone this behavior, they chose to develop a software application that will allow emergency managers to use these images for the greater good.

Appendix A

Survey instrument and Response Frequency Percentages

Screening Question

When Hurricane Sandy occurred, was your primary residence in Connecticut, New Jersey, New York, or some other location?
- Connecticut
    - In which county? New London, Middlesex, New Haven, Fairfield, Other, DK, RF
      IF "OTHER/DK/RF" END SURVEY
- New Jersey
    - In which county? Middlesex, Monmouth, Ocean, Atlantic, Cape May, Hudson, Essex, Bergen, Union, Somerset, Other, DK, RF
      IF "OTHER/DK/RF" END SURVEY
- New York
    - In which county? Westchester, Bronx, New York, Richmond, Kings, Queens, Nassau, Suffolk, Rockland, Other, DK, RF
      IF "OTHER/DK/RF" END SURVEY
- Some other location   END SURVEY
- Don't Know   END SURVEY
- Refused   END SURVEY

1. During Hurricane Sandy, was the area where you lived under an evacuation order?
   - Yes   13.9%

2. During Hurricane Sandy, did you have a twitter account?
   - Yes   38.0%

3. Do you have a Twitter account now?
   - Yes   43.7%

4. How many times per week, on average, do you check Twitter to read tweets?   _____

5. How many times per week, on average, do you retweet someone else's tweet?   _____

6. How many times per week, on average, do you send your own tweets?   _____

7. During Hurricane Sandy, did you get any weather-related information from the following sources (Check all that apply)?

- Friends   55.1%
- Family   48.1%
- Household member   32.0%
- Local news stations   79.1%
- National news stations   57.0%
- Federal agencies   23.7%
- State agencies   29.2%
- Other sources   31.4%

How reliable would you rate the sources from which you received information?

- Friends
  - Very Reliable   43.3%
  - Somewhat Reliable   49.3%
  - Neither Reliable nor Unreliable   2.5%
  - Somewhat Unreliable   3.5%
  - Very Unreliable   1.4%

- Family
  - Very Reliable   49.4%
  - Somewhat Reliable   41.1%
  - Neither Reliable nor Unreliable   2.2%
  - Somewhat Unreliable   4.0%
  - Very Unreliable   0.3%

- Household member
  - Very Reliable   57.7%
  - Somewhat Reliable   36.3%
  - Neither Reliable nor Unreliable   1.4%
  - Somewhat Unreliable   3.7%
  - Very Unreliable   0.9%

- Local news stations
  - Very Reliable   63.8%
  - Somewhat Reliable   31.9%
  - Neither Reliable nor Unreliable   0.9%
  - Somewhat Unreliable   2.6%
  - Very Unreliable   0.8%

- National news stations
  - Very Reliable — 56.1%
  - Somewhat Reliable — 36.2%
  - Neither Reliable nor Unreliable — 1.6%
  - Somewhat Unreliable — 4.5%
  - Very Unreliable — 1.6%

- Federal agencies
  - Very Reliable — 62.7%
  - Somewhat Reliable — 29.7%
  - Neither Reliable nor Unreliable — 0.6%
  - Somewhat Unreliable — 5.1%
  - Very Unreliable — 1.9%

- State agencies
  - Very Reliable — 59.6%
  - Somewhat Reliable — 32.1%
  - Neither Reliable nor Unreliable — 1.0%
  - Somewhat Unreliable — 4.1%
  - Very Unreliable — 3.1%

- Other sources
  - Very Reliable — 67.9%
  - Somewhat Reliable — 27.0%
  - Neither Reliable nor Unreliable — 1.3%
  - Somewhat Unreliable — 3.8%
  - Very Unreliable — 0.0%

8. In what ways did you receive weather-related information?
   - Face-to-face — 35.1%
   - Television — 71.3%
   - Telephone — 29.2%
   - Radio — 37.3%
   - Newspaper — 14.9%
   - Text message — 25.1%
   - Internet (non-social media specific) — 39.9%
   - Cellphone weather apps — 34.1%
   - Twitter — 15.6%
   - Any other social media — 15.1%
   - Other — 9.4%

How reliable were each of these methods of receiving weather-related information?

- Face-to-face
  - Very Reliable   50.0%
  - Somewhat Reliable   41.7%
  - Neither Reliable nor Unreliable   1.7%
  - Somewhat Unreliable   4.6%
  - Very Unreliable   0.8%

- Television
  - Very Reliable   65.6%
  - Somewhat Reliable   30.3%
  - Neither Reliable nor Unreliable   0.8%
  - Somewhat Unreliable   1.6%
  - Very Unreliable   0.8%

- Telephone
  - Very Reliable   58.0%
  - Somewhat Reliable   34.5%
  - Neither Reliable nor Unreliable   2.0%
  - Somewhat Unreliable   4.0%
  - Very Unreliable   0.5%

- Radio
  - Very Reliable   58.4%
  - Somewhat Reliable   34.5%
  - Neither Reliable nor Unreliable   1.6%
  - Somewhat Unreliable   2.7%
  - Very Unreliable   2.0%

- Newspaper
  - Very Reliable   52.0%
  - Somewhat Reliable   34.3%
  - Neither Reliable nor Unreliable   2.9%
  - Somewhat Unreliable   2.0%
  - Very Unreliable   2.0%

- Text message
  - Very Reliable   57.0%
  - Somewhat Reliable   36.6%
  - Neither Reliable nor Unreliable   2.3%
  - Somewhat Unreliable   2.3%
  - Very Unreliable   0.6%

- Internet (non-social media specific)
  - Very Reliable   53.8%
  - Somewhat Reliable   39.2%
  - Neither Reliable nor Unreliable   0.4%
  - Somewhat Unreliable   4.4%
  - Very Unreliable   0.0%

- Cellphone weather apps
  - Very Reliable   61.4%
  - Somewhat Reliable   33.0%
  - Neither Reliable nor Unreliable   0.9%
  - Somewhat Unreliable   2.6%
  - Very Unreliable   1.7%

- Twitter
  - Very Reliable   40.2%
  - Somewhat Reliable   46.7%
  - Neither Reliable nor Unreliable   1.9%
  - Somewhat Unreliable   6.5%
  - Very Unreliable   0.9%

- Any other social media
  - Very Reliable   37.9%
  - Somewhat Reliable   46.6%
  - Neither Reliable nor Unreliable   8.7%
  - Somewhat Unreliable   2.9%
  - Very Unreliable   0.0%

- Other
  - Very Reliable   70.3%
  - Somewhat Reliable   20.3%
  - Neither Reliable nor Unreliable   4.7%
  - Somewhat Unreliable   1.6%
  - Very Unreliable   1.6%

9. Of the ways you received weather-related information, from which did you get *most* of your information?

- Face-to-face   5.3%
- Television   16.1%
- Telephone   10.8%
- Radio   11.0%
- Newspaper   4.0%
- Text message   4.2%
- Internet (non-social media specific)   11.9%
- Cellphone weather apps   9.5%
- Twitter   3.4%
- Any other social media   0.8%
- Other   0.0%

10. During the storm, did the way that you received most of your information change?

Yes   35.4%

If yes …

a) After it changed, how did you get most of your information?

- Face-to-face   19.2%
- Television   10.0%
- Telephone   8.3%
- Radio   20.4%
- Newspaper   1.3%
- Text message alert   5.8%
- Internet (non-social media specific)   11.7%
- Cellphone weather apps   7.5%
- Twitter   2.9%
- Any other social media   1.3%
- Other   9.2%

b) Why did the way you received most of your information change during the storm?

- Power went out   70.8%
- Internet connection went out   7.1%
- Cell phone battery died   2.5%
- Lost cell service   1.3%
- Radio batteries died   0.4%
- Landline telephone line went out   0.8%
- News agency stopped broadcasting   0.4%
- Lost trust in original information source   2.1%
- Someone recommended new primary source   1.3%
- Other   8.8%

11. Upon receiving information about Hurricane Sandy, did you do any of the following?
   - Evacuate   6.1%
   - Prepare in place   69.4%
   - Did something else   5.1%

12. If you evacuated, where did you go first?
   - Hotel/motel   9.5%
   - Friend's home   28.6%
   - Family member's home   42.9%
   - Public shelter   2.4%
   - Other   16.7%

13. What sources of information most influenced you in your choice to [evacuate/prepare/take other action]?
   - Friends   9.8%
   - Family   18.3%
   - Household Member   5.4%
   - Local news networks   44.3%
   - National news networks   12.2%
   - Federal agencies   5.9%
   - State agencies   7.6%
   - Other   17.0%

14. How did those who influenced you to [evacuate/prepare/take some other action] share important information with you?
   - Face-to-face   20.5%
   - Television   42.9%
   - Telephone   14.9%
   - Radio   9.6%
   - Newspaper   1.5%
   - Text message   8.2%
   - Internet (non-social media specific)   4.2%
   - Cellphone weather apps   5.2%
   - Twitter   4.2%
   - Any other social media   1.8%
   - Other   4.8%

15. At any time during Hurricane Sandy, did your household lose access to:
    - Electrical power   61.8%
    - Television signal   58.0%
    - Non-cellular Internet connection?   53.2%
    - Landline telephone service?   45.0%
    - Cellphone service?   26.5%

16. Did you get any information from Twitter that you considered untrustworthy?
    Yes   20.2%
    If yes, who sent the untrustworthy tweet?
    - Friends   25.0%
    - Family   0.0%
    - Household member   1.9%
    - Local news networks   9.6%
    - National news networks   1.9%
    - Federal agencies   1.9%
    - State agencies   0.0%
    - Other   21.2%

17. During Hurricane Sandy, did you tweet or retweet storm-related information?
    - Tweet   40.9%
    - Retweet   35.8%

    a) What was the nature of the information that you tweeted or retweeted?
    - Storm or weather-related warnings   28.4%
    - Storm damage   31.9%
    - Personal experiences with the storm   33.9%
    - Your own evacuation details   5.4%
    - Evacuation information in general   7.8%
    - Other   3.5%

b) What was the source of the information that you tweeted or retweeted?
- Your own eyewitness experience   34.6%
- Friends   15.6%
- Family   7.8%
- Household members   2.7%
- Local news networks   20.2%
- National news networks   16.3%
- Federal agencies   10.1%
- State agencies   10.9%
- Other   1.2%

c) What form of information did you tweet or retweet?
- Photograph   37.4%
- Weather map image   16.0%
- Other image   10.1%
- Text   28.8%
- Internet link (hyperlink, URL)   16.7%
- Other   1.2%

18. Do you follow any of these sources of information on Twitter?
- FEMA   14.4%
- NOAA   13.6%
- National Weather Service   25.7%
- Red Cross   8.9%
- Local TV News   29.2%
- Local Radio Station   14.0%
- Local meteorologist   14.4%
- Weather Channel   22.6%
- Other   14.0%

19. Of the ones you follow, which would you trust most during a weather-related emergency?
- FEMA   9.5%
- NOAA   13.3%
- National Weather Service   22.9%
- Red Cross   2.9%
- Local TV News   15.2%
- Local Radio Station   5.7%
- Local meteorologist   7.6%
- Weather Channel   5.7%
- Other   5.7%

20. Of the ones you follow, which would prompt you to take action in a weather-related emergency?
    - FEMA   9.5%
    - NOAA   9.5%
    - National Weather Service   23.8%
    - Red Cross   1.9%
    - Local TV News   21.9%
    - Local Radio Station   4.8%
    - Local meteorologist   7.6%
    - Weather Channel   2.9%
    - Other   2.9%

21. At present, what do you consider your most important source of weather-related emergency information?
    - Face-to-face   2.2%
    - Television   44.0%
    - Radio   8.6%
    - Friends/family   2.5%
    - Newspaper   0.7%
    - Text message alert   2.8%
    - Internet (non-social media specific)   16.5%
    - Cellphone weather apps   16.4%
    - Twitter   2.2%
    - Any other social media   0.6%
    - Other   2.8%

22. At the time of Hurricane Sandy, did you rent your home, own your home, or did you have some other living arrangement?
    - Rent   38.7%
    - Own   53.2%
    - Some other living arrangement   5.3%

23. At the time of Hurricane Sandy, which best describes your place of residence?
    - Single-family home   55.3%
    - Duplex   6.9%
    - Multi-unit apartment or condominium   33.6%
    - Other   3.1%

24. At the time of Hurricane Sandy, approximately how far was your place of residence from an open body of water such as a river, inlet, bay, or ocean? Do not include closed bodies of water such as swimming pools, lakes, ponds, or reservoirs.

- Less than 1 mile   31.1%
- Between 1 and 5 miles   27.0%
- Between 5 and 10 miles   15.5%
- More than 10 miles   21.9%

25. During Hurricane Sandy, how many adults 18 years of age or older were living in your household?

- 0   1.6%
- 1   18.2%
- 2   41.1%
- 3   19.9%
- 4   10.3%
- 5   4.5%
- 6   1.3%
- 7   0.4%
- 8   0.4%
- 10   0.1%
- 15   0.1%
- More than 20   0.1%

26. During Hurricane Sandy, did you have any children under the age of 18 living in your household?
    Yes   37.7%

    If yes, how many children under 18 were living in your household during the storm?

- 0   0.4%
- 1   39.3%
- 2   42.0%
- 3   11.3%
- 4   3.5%
- 5   1.9%
- 6   0.8%
- 7   0.4%

27. As of Hurricane Sandy, what was the highest level of education you have completed?
- Less than high school   5.1%
- High school or equivalent   18.4%
- Vocational education   0.3%
- Some college   19.4%
- Associate's degree   5.4%
- Bachelor's degree   26.0%
- Master's degree or higher   21.2%
- Some graduate studies   1.9%

    27a. Has your education level changed since then?
      Yes   16.1%
        If yes, what is your education level now?
- Less than high school   0.9%
- High school or equivalent   3.6%
- Vocational education   11.8%
- Some college   36.4%
- Associate's degree   10.0%
- Bachelor's degree   13.6%
- Master's degree or higher   19.1%
- Some graduate studies   2.7%

28. Do you consider yourself Hispanic (or Latino/a)?
- Yes   14.2%

29. What is your race? Would you say:
- White   56.0%
- Black or African American   15.4%
- Asian   5.4%
- Native Hawaiian or other Pacific Islander   0.4%
- Respondent indicated multi-racial   4.4%
- Respondent indicated some other race   10.5%

30. In what year were you born? 19____?

31. What best describes your 2013 household income from all sources BEFORE taxes?
- Less than $10,000   4.2%
- $10,000 to $25,000   6.7%
- Over $25,000 but less than $50,000   11.3%
- Over $50,000 but less than $75,000   12.7%
- Over $75,000 but less than $100,000   8.2%
- Over $100,000 but less than $150,000   11.3%
- Over $150,000 but less than $250,000   8.9%
- More than $250,000   3.1%

32. What is the respondent's gender?
- Man   50.9%
- Woman   47.8%

Note: The percentages of some sets of response options for a given survey item may be less than 100 since each set of response options included the choices of "Not Sure" and "No Comment" which were both excluded for purposes of this data summary. Additionally, the percentages of some sets of response options may be greater than 100 since some survey items allowed the respondents to select multiple responses.

Appendix B

Hurricane Sandy Keywords, Hashtags, and Top Users

Keywords & Hashtags	Top Users		
sandy	ConEdison	NotifyNYC	redcrossny
frankenstorm	camdencountynj	PepcoConnect	readydotgov
superstorm	CMCGovernment	Amtrak	femaregion2
hurricane	CityofNewarkNJ	NJ_TRANSIT	jcp_1
#sandy	NJOEM2010	nycoem	NHC_Atlantic
#superstorm	ACElecConnect	govchristie	usNWSgov
#hurricanesandy	CityofHoboken	311NYC	sbagov
#superstormsandy	CTRedCross	corybooker	femaregion1
#fucksandy	UnitedIllum	dawnzimmernj	CTNationalGuard
#CTSandy	RedCrossNorthNJ	FEMA	nycgov
#SandyNYC	CTLightandPower	GovMalloyOffice	njbeachreport
#sandyhelp	ctdemhs	MikeBloomberg	JimmyVanBramer
#frankenstorm	PSEGNews	NewYorkCares	NationalGuardNY
#frankenstormlive	NYGovCuomo	NJNationalGuard	hudnews
#tropicalstorm	craigatfema	NOAA	
#tropicalstormsandy	nycmajorsoffice	NWS	
#hurricane	fdny	NWSNewYorkNY	
#sandyrelief	PANYNJ	RedCross	
#frankenstormsandy	FDNY	RedcrossmetroN	

Note. Words in chart represent the most frequent search terms, hashtags, and top users.

Appendix C

Images of Damage and Flooding Captured in a Simulated Real-time Software Test
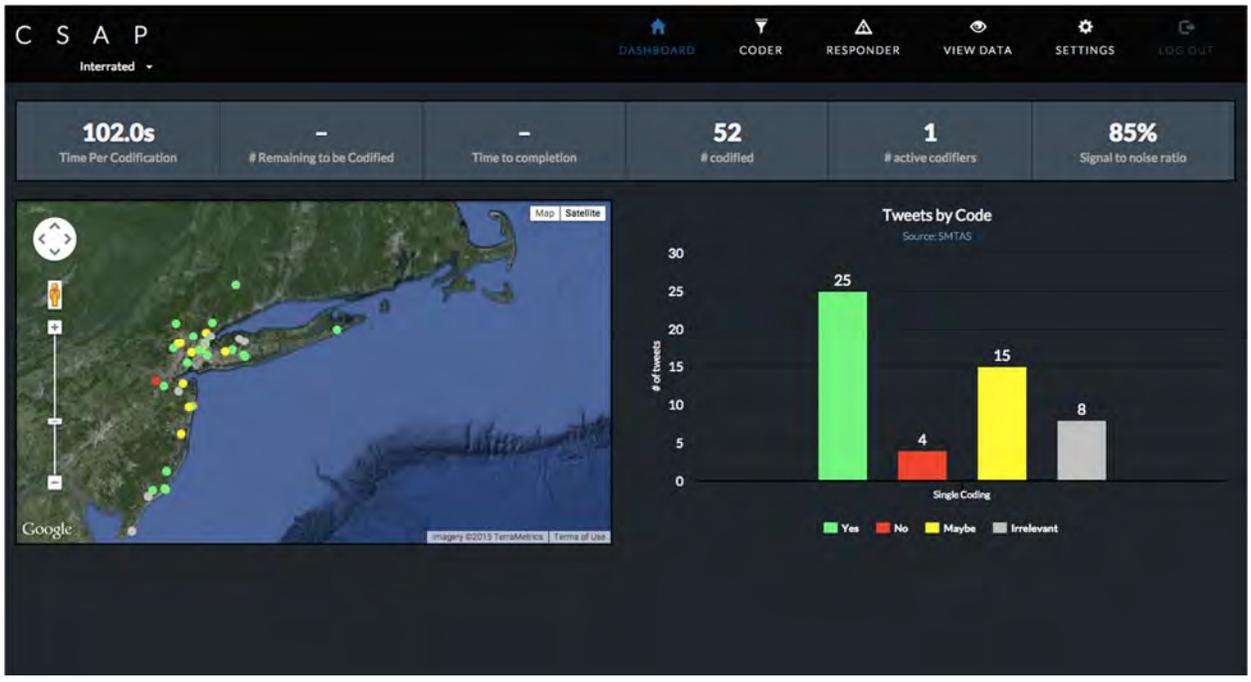
Code the following Tweet

INSTRUCTIONS

Post: pFj667ZzsL5GwMw9s - 2012-10-30 20:55:13+00:00

Haven't seen much damage in Astoria, but saw this down the street #sandy @ I.S. 126 http://t.co/NYPzJKXf

Code the following Tweet

INSTRUCTIONS

Post: FpNFTiBuqxiG5pbP4 - 2012-10-30 21:16:04+00:00

Bill Gleeson's house in Loch Arbour suffered severe damage. 3ft of sand left inside. #sandy cc @matthewwells http://t.co/4nJdinLt

Code the following Tweet

INSTRUCTIONS

Post: 4Bkdry9fTspKJ652m - 2012-10-30 21:17:54+00:00

More damage in Loch Arbour #sandy http://t.co/2JAd5ow2

102 Edgemont Ave, Loch Arbour, New Jersey
Address is approximate

Edgemont Ave

Edgemont Ave

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Code the following Tweet

INSTRUCTIONS

Post: B7e2FXKCjpnTsaxSx - 2012-10-31 17:58:25+00:00

Damage and debris by the marina in Brigantine #sandynj http://t.co/PR5K4tCs

904 Fownes Ave, Brigantine, New Jersey
Address is approximate

Fownes Ave

Fownes Ave

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Code the following Tweet

Post: W6LaQPBqaiCetvYYM - 2012-10-31 03:32:22+00:00

#erock #eryc #flooded #hurricanesandy #ny @ East Rockaway Yacht Club http://t.co/UhCnCoPA

Code the following Tweet

Post: TtB3fuajRjs5377B9 - 2012-10-31 16:58:35+00:00

Hoboken Medical Center Day 2 — still flooded. #hoboken #sandy @ Hoboken University Medical Center http://t.co/H4FeEGQq
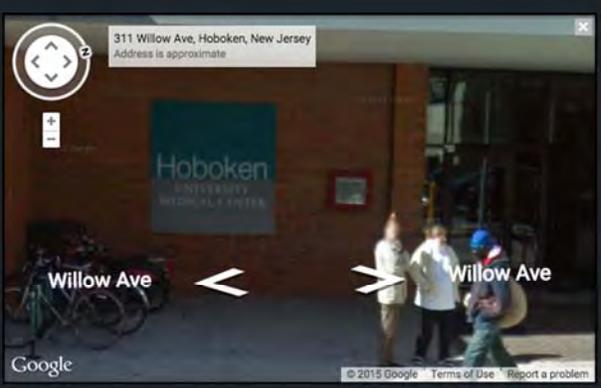
Code the following Tweet

INSTRUCTIONS

Post: jvbw23ZG9viLAE8WC - 2012-10-31 04:09:53+00:00

Hess gasstation underwater last night #hess #hurricanesandy #flooded @ Hess Express http://t.co/2fqgNv8B

Code the following Tweet

INSTRUCTIONS

Post: qQ99KNCLg9CDh6Aix - 2012-10-31 17:12:46+00:00

Our beloved taqueria, flooded. #Sandy #nofilter @ Taqueria Downtown http://t.co/jXDaMRqQ

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Syma Ebbin syma.ebbin@uconn.edu, Research Coordinator, Connecticut Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Syma Ebbin at (860) 405-9278. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: Gabrielle Wong-Parodi

Date of Report submission: June 1, 2015

Project #: R/CSAP-9-CT

Dates of the project: From April 1, 2014 to May 1, 2015.

Project Title: Behaviorally realistic communications to improve the public's response to and preparedness for high impact storm events

Principal Investigator(s) and Affiliation(s):

1. Gabrielle Wong-Parodi, Carnegie Mellon University

2. Baruch Fischhoff, Carnegie Mellon University

3. Ben Strauss, Climate Central

A. PROJECT GOALS AND OBJECTIVES:

Project Goal 1 - To identify decision-relevant information for designing personalized flooding risk and preparation strategies for communications for residents of New Jersey and New York
- Obtained IRB approval (February 14, 2014)
- Developed and pilot-tested exert interview protocol (February 2014). About 1-month delay in start because of delays with IRB approval and funds transfer.
- Conducted 11 expert interviews in NJ and NY (March-April 2014), including emergency managers, community leaders, city and regional planners, and environmental justice representatives. These interviews characterized expert views on the risks of high impact storm events, as well as preparedness strategies the public can adopt to combat near-term and long-term risks.

- Interviews transcribed and used to develop public interview protocol (April 2014), as well as to inform the first draft of the communication materials.

Project Goal 2 - Descriptive research – developing behaviorally realistic communication content
- Conducted 14 interviews with long-time residents of NJ (May 2014).
- Transcribed and analyzed qualitative interviews and revised communication in light of findings (June 2014).
- Developed structured survey for estimating prevalence of key beliefs revealed in interviews (June 2014).
- Distributed surveys to 225 coastal NJ residents of Highlands, Sea Bright, Tuckerton and Little Egg Harbor (August-September 2014). We debated whether or not we should send out a mail survey, and ultimately decided not to based on the input from key public officials in local communities. Apparently many residents either don't live in their homes anymore and therefore would not be available to take the survey or they are feeling fatigued from being "over-studied." Therefore we decided to leverage our contacts in local communities who distributed the surveys for us.
- The survey results have been analyzed and have been used to inform the deployment of a larger survey/experiment being sent out to a representative sample of coastal residents in CT, NY and NJ (February 2015).
- Two manuscripts have been produced based on this research. One has already been submitted to Weather, Climate and Society (April 2015) and the other is still being completed and will likely be submitted to Risk Analysis (Present).

Project Goal 3 – Prescriptive Research: Building the coastal flooding communication intervention
- A website has been developed that provides tailored information to coastal residents. Below are some sample screen shots (October-December 2014).
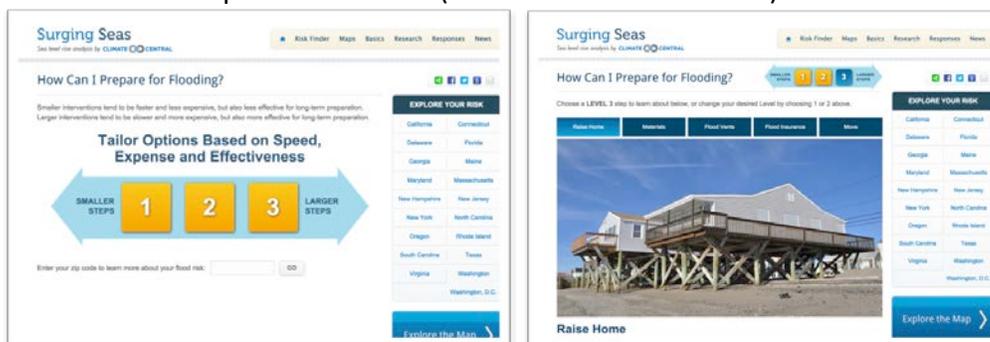
- User testing and website evolution has been conducted (December 2014-January 2015).

Project Goal 4 – Evaluation research: Evidence based approach
- We conducted an experiment with a representative sample of 1,150 coastal residents at risk for coastal residents at risk for high impact storm events in CT, NY and NJ (May-June 2015). Here, our working hypothesis was that exposure to both risk information and the preparation website will enhance motivation to prepare for high impact storm events; exposure to just the risk information will decrease motivation to prepare. Below is a flowchart of our study design.
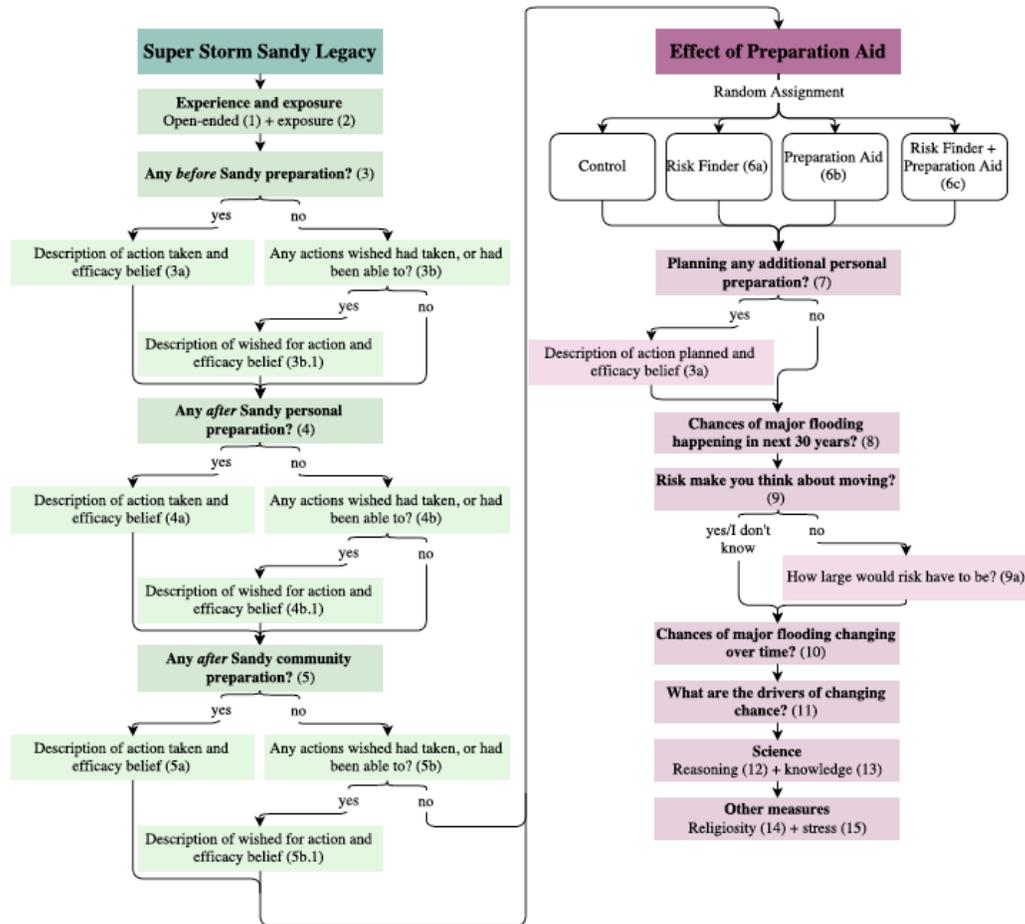
- The experimental results have been analyzed as of June 2015; we plan on preparing the results for publication in a peer-reviewed journal.

B. **RESULTS: (***Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*

Project Goal 1 - To identify decision-relevant information for designing personalized flooding risk and preparation strategies for communications for residents of New Jersey and New York
- We identified a list of short-term and long-term measures that individuals could take to protect themselves and their property against damages that might occur due to high impact storm events.
- Experts think that the public do not see themselves as responsible for preparing themselves for the increasing risk of high impact storm events.
- We experienced a one-month delay due to funds not being transferred.
- We were able to develop and maintain relationships with a number of organizations that helped in our research efforts including NJ Future and the Jacques Cousteau National Estuarine Research Reserve.
- These results helped to inform the content of our communication materials.

Project Goal 2 - Descriptive research – developing behaviorally realistic communication content
- Main results of the interviews and surveys:
  o People recognize that the chances of high impact storm events are increasing and that the consequences are dire (e.g., impacts to local economy, way of life, social fabric of community), yet still express a strong commitment to staying in their communities. Indeed, if forced to leave their communities (e.g., permanently inundated by water), many would move to a similar beach community.
  o People by and large see themselves as primarily responsible for preparing for the impacts (e.g., flooding, etc.) of high impact storm events. The reason being is that they've chosen to live in a vulnerable location, and therefore should shoulder the responsibility for preparing for threats. [However, we had a fairly affluent crowd do the interviews and the follow-up survey so this may not reflect the views of everyone]
  o People need help visualizing the risks that they face (what at the impacts) and help understanding the options available (and appropriate) to them to mitigate those risks.
  o The most trusted source of information on preparing for high impact storm events are local and state officials (e.g., they know and understand the unique circumstances of each community); however, the most trusted informal source of information are still friends and family.
  o Before Sandy, people took a lot of short-term (immediate) measures such as procuring nonperishable goods, water, moving vehicles to higher ground. After Sandy, people reported taking (or intending to take) more long-term measures

such as installing flood vents, raising their home on pilings, etc. Therefore, these types of high impact events represent a "window of opportunity" to provide prepare for future events.

- The results of the interviews and surveys helped to identify how to present the information that people need in the "preparation website."
- Here we were able to develop and maintain relationships with community members in NJ.
- We experienced no delays in achieving goal 2.

Project Goal 3 – Prescriptive Research: Building the coastal flooding communication intervention

- Here we successfully developed and tested our "preparation website" that offers coastal residents information tailored to meet their needs to help them identify ways that they can prepare for high impact storm events.
- This website will be used for the next phase of the project, where it will be evaluated for its influence on motivating people to prepare for high impact storm events.
- We experienced no delays in achieving goal 3.

Project Goal 4 – Evaluation research: Evidence based approach

- Here we successfully conducted an experiment to evaluate the effectiveness of providing tailored information about preparing for high impact events on people's motivation to prepare, as well as on their risk perceptions.
- We experienced an extensive delay due to Carnegie Mellon University and GfK expressing disagreements over a contractual agreement of about 3 months. Data collection was completed by the middle of June 2015.
- Data analysis was completed by the end of June 2015.
- On balance, our findings are suggestive that exposure to tailored information about preparing for high impact flood events increased people's intention to prepare for those events but decreased their risk perceptions.

C. COLLABORATORS, PARTNERS, and INTERACTIONS: *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

- NJ Future
- Gfk
- Monmouth University (advice on recruitment)
- Public officials in Tuckerton/LEH/Sea Bright/Highlands
- Jacques Cousteau National Estuarine Research Reserve.

D. <u>PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS</u>: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers:

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.:

Technical Reports / Other Publications:

Other Products (including popular articles):

Planned Publications:

- **Views on preparing for coastal flooding risk among vulnerable communities in New Jersey** (Wong-Parodi and Strauss); submitted April 2015 to Weather, Climate and Society

- **What predicts mitigating flood risk behavior and how does preparation influence risk perceptions in communities impacted by Super Storm Sandy?** (Wong-Parodi, Fischhoff, and Strauss); will be submitted summer 2015 to Risk Analysis

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

- Wong-Parodi, **Preparing for coastal flooding risk in vulnerable communities**. Center for Climate and Energy Decision Making, Carnegie Mellon University, May 21, 2015. [Oral presentation; invited]

E. <u>FUNDS LEVERAGED:</u> *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

N/A

F. <u>STUDENTS:</u> (*Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "<u>New</u>" students are those who **have <u>not</u>** worked on this project previously. "<u>**Continuing**</u>" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

Total number of **<u>new</u>** K-12 students:
Total number of **<u>new</u>** undergraduates:
Total number of **<u>new</u>** Masters degree candidates:
Total number of **<u>new</u>** Ph.D. candidates:

Total number of **continuing** K-12 students:
Total number of **continuing** undergraduates:
Total number of **continuing** Masters degree candidates:
Total number of **continuing** Ph.D. candidates:

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name:
Degree Sought:
Thesis or Dissertation Title:
Date of thesis completion:
Expected date of graduation:

G. VOLUNTEER HOURS:
(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

NJ Future and Jacques Cousteau National Estuarine Research Reserve reviewed the survey materials and did pretesting. The 26 interview and 225 survey participants were not compensated for their time as suggested by my partners. Rather, I gave presentations at meetings of the results of the interviews and surveys.

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.*)

Here is a link to the preparation website. We would appreciate if the link is not shared until after completion of the experiment (http://sealevel.climatecentral.org/flood-preparation).

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.)*
Specify:
  a) Name of person or group receiving recognition:
  b) Name of award or honor:
  c) Group or individual bestowing the award or honor:
  d) What it was for:
  e) Date:

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

Climate forecasts indicate that high-impact coastal storm events will become more frequent and intense in the coming years. As a result, residents will be forced to respond to forecasts regarding events whose frequency fall outside their past experience, meaning that their intuitions will no longer provide a trustworthy guide for their decision making. It is thus imperative that communications provided in advance of storm events by emergency managers and insurance companies help people make well informed, sound decisions. It is important that these decisions are not subject to people's natural inclination to rely on social cues (My neighbor isn't putting out sandbags, so maybe the storm isn't so bad) and past experience (The last storm caused minimal damage, so I will stay home). Therefore, local emergency manages and insurance companies need better ways of communicating accurate and behaviorally realistic information about high-impact storm events. Thus, the purpose of this study is to adapt Climate Central's Surging Seas Risk Finder (www.climatecentral.surgingseas.org) to include behaviorally and locally appropriate preparation strategies and then evaluate its effect on people's reported motivation to prepare for future high-impact coastal storm events, their actual preparedness behavior, and their expressed support for public and private sector preparedness measures. This research proposal will foster applications that include (a) developing a framework for communicators to use in communicating the public, (b) integrating psychological methodologies of discovery learning, perceptions, and risk communication with the goals of the NWS and NOAA to build theories for communication, and (c) provide a foundation for improving preparedness that can easily be adapted for a wide-variety of high-impact storm-related events that may become more frequent in coastal areas due to the impacts of climate change. In sum, our personalized online communication can help emergency managers and insurance companies provide the public with improved information to help them better prepare for and respond to high-impact coastal storm events that are likely to become more frequent due to climate change.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

1. We conducted conduct interviews with local stakeholders, including members of the general public, community leaders, emergency managers, media, insurance representatives to discuss the risks of high-impact storm events with a focus on coastal flooding.
2. We worked with experts to identify behaviorally realistic and practical high-impact coastal storm (emphasis on coastal flooding) preparation strategies.
3. We developed and conducted a survey on a sample of New Jersey residents for estimating prevalence of key beliefs revealed in the interviews.
4. Informed by steps 1-3, we developed and tested a "preparation website" – an extension of Climate Central's Surging Seas Risk Finder that includes tailored preparation strategies.

5. We experimentally evaluated the effect of tailored preparation information on a representative sample of NJ, NY and CT residents' motivation to prepare for high impact storm events.
6. The preparation website will be officially rolled-out as part of an update to Surging Seas web-based platform in the near future.

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

Consider the following as they apply to your research and any related outreach/education.

- What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?
    o We have developed an extension of Climate Central's Surging Seas Risk Finder now called "preparation website."
    o The intended audience is the general public who live in areas at-risk of high impact storm events.
    o The channels of communication should be trusted sources of information such as local officials.

- What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?
    o N/A

- What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?
    o The expected social payoff is that more people who are at-risk will at the very least be more aware of the preparation strategies and resources available to them that meet their needs.
    o We found that those exposed to the preparation website and risk/impact visualization information are more motivated to take action to prepare than those who see simply the risk information or nothing at all.
    o The website will be made live after the experiment, so that users of Climate Central will have access to it.
    o We will also make public announcements through our Climate Central contacts to make sure that as many people who live in affected areas are aware of this new product.

What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?
    o N/A

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

The risk of coastal flooding is increasing due to more frequent and intense high-impact storm events, rising sea levels, and more people living in flood-prone areas. Although taking private mitigation measures can reduce damage and risk, people who live in risk-prone areas rarely taken mitigation measures voluntarily. Most research has focused on factors that motivate people to take private mitigation measures, however little has been done to investigate how people views on preparation and information needs. Here we investigate the views of New Jersey coastal residents impacted by Superstorm Sandy. Residents expressed deep attachment to their community and although they see increasing flooding risk due to natural and/or human causes, they expressed reluctance to consider moving even if they were to experience another event like Sandy. Indeed, they see themselves as responsible for their choice to live in a vulnerable community and described private mitigation measures they deemed appropriate for meeting immediate and long-term risks. While these measures may be appropriate, they recognized that they may not be feasible for all due to heterogeneous social and economic circumstances. Therefore, residents expressed the need for tailored information about appropriate and effective mitigation measures as well as improved visualizations to better understand the impact of the risk, which should be provided by trusted sources such as local officials. An experiment assessing the affect of tailored information on motivation to prepare found that providing such information did indeed enhance intentions to prepare, but at the same time was associated with lower perceived chances of there being a Sandy-like event in the future. Thus, it seems that preparing for high impact events may lead people to feel like their overall risk is reduced. These results suggest tailored information provided by trusted sources may provide useful guidance for the development of behaviorally realistic risk communications.

CSAP Final Progress Report Form

Please complete this final report form and return by the date indicated in the emailed final report request from the Connecticut, New York and New Jersey Sea Grant College Programs. Fill in the requested information using your word processor (i.e., Microsoft Word), and e-mail the completed form to Dr. Syma Ebbin syma.ebbin@uconn.edu, Research Coordinator, Connecticut Sea Grant College Program. Do NOT mail or fax hard copies. Please try to address the specific sections below. If applicable, you can attach files of electronic publications when you return the form. If you have questions, please call Syma Ebbin at (860) 405-9278. Please note that this report will be shared with the other CSAP PIs and the Program Steering Committee.

Please fill out all of the following that apply to your specific research project. Pay particular attention to goals, accomplishments, benefits, impacts and publications, where applicable.

Name of Submitter: E. Christa Farmer

Date of Report submission: 1 June 2015

Project #: ___R/CSAP-10-CT_____

Dates of the project: From [1 Jan 2014]   to   [1 June 2015].

Project Title: "Evaluating evacuation decision-making processes among residents of Long Beach, NY before Superstorm Sandy: Lessons for the role of authority and language in storm warnings"

Principal Investigator(s) and Affiliation(s):

1. E. Christa Farmer, Associate Professor, Geology, Environment, and Sustainability, Hofstra University

2. Mary Anne Trasciatti, Associate Professor, Rhetoric and Communication, Hofstra University

3. Elisabeth Ploran, Assistant Professor, Psychology, Hofstra University

A.   PROJECT GOALS AND OBJECTIVES:

1. To identify the particular information residents used to make evacuation decisions prior to Hurricane Sandy

2. To identify mismatches between resident understanding of risk posed by Hurricane Sandy and the scientific information relayed by media reports and official advisories

3. To test specific changes to advisory wording and selection of spokespeople to create positive changes in understanding and retention of risk information

B. RESULTS: (*Summarize the results/findings relative to each of the project goals and objectives. Highlight outstanding accomplishments, outreach and education efforts; describe problems encountered and explain any delays.)*

We have just finished the data collection and are still in the process of fine-tuning and finalizing our analyses, so this summary is very preliminary.

With regards to **Goal #1**, we have completed 52 interviews with residents of Long Beach, NY about their experiences during Sandy, including 8 Spanish-language interviews performed with an interpreter. All of these interviews have been transcribed from the audio files of the interview session, and all of those transcriptions have been hand-coded for analysis using the Linguistic Inquiry and Word Count (LIWC) software under **Goal #2**. The findings of that analysis of language use indicate that residents talk much more about family and friends when describing their decision to evacuate than they talk about traditional authority figures. Additional analysis of the context of that language is necessary. A manuscript will be prepared over Summer 2015.

With regards to **Goal #3**, we wrote a survey and administered it to 291 adult participants at various locations in Long Beach, Island Park, Oceanside, and Baldwin, NY such as coffee shops, public libraries, fitness centers, restaurants, ice cream shops, garden centers, dance centers, bagel shops, and grocery stores. We found that the most successful locations for soliciting participants were public locations like libraries and recreation centers, and independently owned establishments like coffee shops, bagel shops, diners, and gyms, where the patrons were not in a big hurry. We did eventually secure permission from the Long Island Railroad to administer the survey at the Long Beach station, but that turned out not to be very successful because most passers-by there were in a rush. A team of 12 Hofstra University undergraduate research assistants worked a total of 919 hours over 7 weeks using an iPad acquired through this project (in addition to another iPad acquired with Elisabeth Ploran's Hofstra research funds) to collect the survey data.

34 survey questions each posed a different coastal storm warning message and asked the participant whether they would evacuate, consider leaving, or stay put. On average, participants completed the survey within 10-12 minutes. Message posed in the survey ranged from exact transcriptions of "robo-calls" issued to residents of Long Beach, NY in the days prior to Sandy's landfall by City of Long Beach government officials, to specific statements made by major news outlets, to specific statements about storm magnitude in terms of storm surge and wind speed, to more general statements by fictional figures who are not traditional authority

figures in this type of situation. These fictional characters included local store owners, long-time coastal residents, an "avid local fisherman," a professor of atmospheric sciences at Stony Brook University, and superintendents of local school districts.

A ranking of all responses from survey participants who indicated that they lived on Long Island during Sandy reveals some very interesting results. Weighting responses with "stay" as 1, "consider leaving" as 2, and "evacuate" as 3, allows the scenarios to be sorted by whether they persuade the participants to say they will evacuate or at least consider evacuating. Based on the language analysis of our interviews, we expected the non-traditional authority figures to be more persuasive. In fact, the top ten scenarios included the Governor, members of the local fire department, and the county executive. Notably, none of the non-traditional authority figures made this list. The rest of the top ten scenarios contained only storm magnitude information, or used the words "mandatory evacuation." Also notable is the apparent importance of face-to-face interaction, as the scenario including the fire fighters specified that they were going door-to-door. The scenario mentioning sewer outages was particularly effective, as well. A paper written about these data will be submitted for publication to a peer-reviewed journal sometime in 2015-2016.

C. **COLLABORATORS, PARTNERS, and INTERACTIONS:** *(List and describe any additional organizations or partners involved in the project, including participation or interactions with CT, NY or NJ Sea Grant extension staff, and industry, agency, or other stakeholder representatives.)*

We have worked extensively with the Long Beach Latino Civic Association in order to interview Spanish-speaking residents of Long Beach, NY, to accomplish our research under Goal #1.

We have established a collaboration with Larry Levy, National Center for Suburban Studies at Hofstra University, to set up a website in order to archive the interview data and other project artifacts.

With support from the Hofstra University Cultural Center, we held a panel event on the Hofstra campus on April 30, 2015, for which panelists included:
- Adam Sobel, Professor, Columbia University, and author of *Storm Surge: Hurricane Sandy, Our Changing Climate, and Extreme Weather of the Past and Future*;
- Amy Simonson, Hydrologic Technician, United States Geological Survey, Coram, NY, and contributing author of *Learning from the Impacts of Superstorm Sandy*, J Bret Bennington and E. Christa Farmer, Editors;
- Nelly A. Romero, Program Director, Long Beach Latino Civic Association;
- Anthony Eramo, Member, Long Beach City Council;
- John McNally, Co-chair, Long Beach Community Reconstruction Program, and Associate Director, Suffolk County Industrial Development Agency;

- Paul Wilders, Director of Emergency Planning, Nassau County Office of Emergency Management; and
- Erika Schaub, assistant director of public safety and emergency management officer, Hofstra University.

Elisabeth Ploran, Principal Investigators on this project, also participated as a panelist to disseminate the results of the research we have done with this grant; the other two Principal Investigators served as moderators of the two panels. We worked with Barbara Branca, New York Sea Grant Communications Manager, and Karla Schuster, Hofstra University Relations, to publicize this event. In addition, we disseminated fliers announcing the event to the participants we meet through our community-based data collection. There were approximately 50-60 people in attendance, from students and faculty at Hofstra to concerned community members.

D. **PROJECT PUBLICATIONS, PRODUCTS, PRESENTATIONS, AND PATENTS**: *(Include published materials with complete references, as well as those in press. Please attach electronic versions of any journal articles, reports, and abstracts not previously provided.)*

Journal Articles: *(List URLs)*

Conference Papers:

E.J. Ploran, M.A. Trasciatti, E.C. Farmer. The use of personal interviews to design and test new pre-storm evacuation messages. Submitted to The Psychonomic Society, 2015 Annual Meeting.

Other articles, such as proceedings or book chapters:

Web sites, Software, etc.:

Technical Reports / Other Publications:

Other Products (including popular articles):

Planned Publications:

The use of personal narratives to identify decision-making processes prior to a major weather event - to be submitted by approximately December 2015 to *Journal of Behavioral Decision Making* or something similar.

Patents: *(List those awarded or pending as a result of this project.)*

Presentations and Posters: *(Include name and date of the conference or meeting, whether it was a talk or poster, if it was invited, and who the presenter was.)*

E. **FUNDS LEVERAGED:** *(If this Sea Grant funding facilitated the leveraging of additional funding for this or a related project, note the amount and source below.)*

$1,500 from the Hofstra University Cultural Center, to produce the 30 April 2015 panel event on Superstorm Sandy and future hurricane preparedness (see section C for more information).

F. **STUDENTS:** *(Document the number, type, and name of students involved with this project, during this reporting period. Indicate those that received Sea Grant (CSAP) funding. Note: "**New**" students are those who **have not** worked on this project previously. "**Continuing**" students are those who **have** worked on this project previously. If a student volunteered time on this project, please use section G, below.)*

*Note: these are totals for the entire life of the project.

Total number of **new** K-12 students: 0
Total number of **new** undergraduates: 2+4+10+1 = 17
Total number of **new** Masters degree candidates: 1
Total number of **new** Ph.D. candidates: 3

Total number of **continuing** K-12 students:
Total number of **continuing** undergraduates:
Total number of **continuing** Masters degree candidates:
Total number of **continuing** Ph.D. candidates:

In the case of graduate students, please list student names, degree pursued, and thesis or dissertation titles related to this project.

Student Name: Joe McCabe
Degree Sought: Ph.D., Clinical Psychology
Thesis or Dissertation Title: (not related to this project)
Date of thesis completion: TBD
Expected date of graduation: TBD

Student Name: Tiffany Bruder
Degree Sought: Ph.D., Clinical Psychology
Thesis or Dissertation Title: (not related to this project)
Date of thesis completion: TBD
Expected date of graduation: TBD

Student Name: Kyle Haney
Degree Sought: Ph.D., Clinical Psychology

Thesis or Dissertation Title: (not related to this project)
Date of thesis completion: TBD
Expected date of graduation: TBD

Student Name: Kurt Sensenbrenner
Degree Sought: MFA, Documentary Studies and Production
Thesis or Dissertation Title: (not related to this project)
Date of thesis completion: 2014
Expected date of graduation: 2014

G. VOLUNTEER HOURS:

(List the number of hours provided to the project by volunteers, i.e., individuals who were not compensated in any way or for whom involvement is not part of their paid occupation. This could be students or citizens. What was their contribution?)

Three undergraduate research assistants in Psychology contributed approximately 10 hours each as of this report, towards data collection and analysis.

H. PICTORIAL: (*Provide high resolution images/photos of personnel at work, in the field or laboratory, equipment being used, field sites, organism(s) of study. Attach images as separate files (do not embed). Include links to websites associated with the research project. Please include proper photo credits and a caption with date, location, names of people, and activity. These images are useful to document your project in future CSAP publications, websites and presentations.)*

Attached separately are several files:
"Polar Bear Research Team.jpg": a photograph of PIs Mary Anne Trasciatti and Elisabeth Ploran, with undergraduate research assistant Douglas Fabian, collecting survey participant data on the Long Beach boardwalk, at the Polar Bear Swim on 1 February 2015.

The files 2015_04_29_Contino1crop.jpg, 2015_04_29_Contino2.jpg, and 2015_04_29_Contino4.jpg are photos taken at the Cross Fit King of Island Park on 29 April, 2015, of study participant Vincent Contino taking our survey on an iPad. The files 2015_04_29_Pearsall_IMG_4181.jpg, 2015_04_29_Pearsall_IMG_4182.jpg, 2015_04_29_Pearsall_IMG_4183.jpg, 2015_04_29_Pearsall_IMG_4184.jpg, and 2015_04_29_Pearsall_IMG_4185.jpg are photos taken at the Cross Fit King of Island Park on 29

April, 2015, of study participant Sean Pearsall taking our survey on an iPad. The files SeanPearsall.pdf and VincentContino.pdf are NY Sea Grant photo releases signed by those participants.

The file 2015_05_08_DSC01329.jpg is a photo taken 8 May 2015 at the GES Department end-of-year picnic, of some of the student research assistants who helped with the project. From left to right, they are: Douglas Ferraiolo, Anthony Armao, Janel Mayo, Ivan Bermejo, Vanessa Fernandes, Emily Dorward. All of them signed NY Sea Grant photo release forms, which are in file 2015_05_08_releases.pdf

Other files contain images taken at the 30 April 2015 event:
GROUPPHOTOHURRICANEPANEL.jpg
From left to right:
John McNally, Paul Wilders (subsituting for Craig Craft), Anthony Eramo, Nelly Romero, Amy Simonson, Mary Anne Trasciatti, E. Christa Farmer, Erika Schaub, Adam Sobel, Elisabeth Ploran

DBW_4889.jpg:
Nelly Romero and Anthony Eramo discussing their experiences with Superstorm Sandy at the 30 April 2015 panel event at Hofstra.

DBW_4899.jpg:
E. Christa Farmer introducing Adam Sobel and other panelists at the Hofstra University panel event.

DBW_4910.jpg:
Amy Simonson and Adam Sobel discussing their research on Superstorm Sandy at the 30 April 2015 panel event at Hofstra.

DBW_4920.jpg:
Anthony Eramo makes a point at the 30 April 2015 panel event at Hofstra.

DBW_4925.jpg:
Adam Sobel's book for sale at the 30 April 2015 panel event at Hofstra.

DBW_4928.jpg:
Adam Sobel makes a point at the 30 April 2015 panel event at Hofstra.

DBW_4959.jpg:

Erika Schaub makes a point at the 30 April 2015 panel event at Hofstra, while Mary Anne Trasciatti moderates and Paul Wilders listens.

DBW_4961.jpg:

Erika Schaub makes a point at the 30 April 2015 panel event at Hofstra, while Mary Anne Trasciatti moderates and Paul Wilders listens.

DBW_4969.jpg:

Paul Wilders makes a point at the 30 April 2015 panel event at Hofstra.

DBW_4974.jpg:

Paul Wilders makes a point at the 30 April 2015 panel event at Hofstra while Erika Schaub and the audience listen.

DBW_4989.jpg:

John McNally speaks at the 30 April 2015 panel event at Hofstra.

I. HONORS AND AWARDS: *(List any honors or awards received during the reporting period, for anyone working on the project. This can be for best paper or poster, university awards, etc.)*
Specify:
   a) Name of person or group receiving recognition: Mary Anne Trasciatti
   b) Name of award or honor: Champion of the Arts and Humanity in Action Award
   c) Group or individual bestowing the award or honor: Long Beach Christmas Angel, Inc.
   d) What it was for: Recording Long Beach residents' narratives of their Superstorm Sandy experiences and creating a public memory archive for long-term preservation.
   e) Date: December 6, 2014

J. PROJECT OUTCOMES AND IMPACTS

RELEVANCE OF PROJECT: *(Describe briefly the issue/problem / identified need(s) that led to this work.)*

Low levels of pre-storm evacuation before Superstorm (hurricane turned post-tropical cyclone) Sandy in October 2012 led to concern about the adequacy of pre-storm messaging.

RESPONSE: *(Describe briefly what key elements were undertaken to address the issue, problem or need, and who is/are the target audience(s) for the work.)*

Our project analyzed transcriptions of personal interviews with Long Beach, NY residents about their experiences with Superstorm Sandy. The results from language analysis of these interviews informed the development of new messaging that was tested among residents of the evacuation zone to measure impact on evacuation intention. The information about the most impactful messages should be useful to emergency managers and news outlets in the event of future coastal storm events.

RESULTS: *(Summarize findings and significant achievements in terms of the research and any related education or outreach component; cite benefits, applications, and uses stemming from this project, including those expected in the future. Include qualitative and quantitative results.)*

Consider the following as they apply to your research and any related outreach/education.
·   What new tools, technologies, methods or information services were developed from this work? Have any been adopted / implemented for use and by whom?

Our principal preliminary findings include:
1) Of the 152 respondents to our survey living on the barrier island containing Long Beach, NY, 31 (20.4%) said either they would never leave or are unlikely to leave in the event of an evacuation.
2) Based on our initial analysis of the interviews, people mention family, friends, and neighbors more than specific authority figures and news sources. However, further analysis of the context is necessary to determine the degree of influence of these sources on the ultimate evacuation decision.
3) People in our survey say they are more likely to evacuate when the storm information comes from traditional authority figures like the state governor, county executive, fire department, and police, than from local nontraditional folks like neighbors, a "long-time coastal resident," an "avid fisherman," state park officials, Long Island Railroad officials, and superintendents of the school system.
4) Quantitative information about the intensity of the storm and its effects apparently also makes a difference, because people were more likely to say they would evacuate when the predictions of storm surge and wind speed were stated to be higher in our survey.
5) Face-to-face interactions with sources of information seem to be effective because of the very high score of the door-to-door scenarios in our survey. Messages from our survey that indicate limited or no water and sewer service during and after a storm also influenced decision-making.

·   What are the environmental benefits of this work? Have policies been changed? How has conservation (of ecosystems, habitats or species) been improved?

· What are the social payoffs of this work? Who has benefited from this work? Have attitudes / behaviors of target audience changed? Elaborate. Have policies been changed?

This work has the potential to reshape pre-storm messaging to more closely match the factors that are most important to residents of coastal zones, which in turn will more effectively influence evacuation behavior.

· What are the economic implications / impacts of this work? (Where possible, please quantify.) Have new businesses been created /or existing businesses retained as a result of this research? Have new jobs been created or retained? Are new businesses or jobs anticipated?

Higher compliance with evacuation orders prior to landfall of coastal storms will reduce fatalities and injuries. In addition, resources that would have been spent on search and rescue can be shifted to other needs like storm recovery and rebuilding infrastructure.

K. Stakeholder Summary (This is an abstract of your research and findings written for a lay audience)

Despite coastal storm surge warnings and evacuation orders starting several days before landfall, only 33% of coastal residents in Long Beach, NY left their homes prior to Superstorm Sandy. The resulting damage from the storm caused 90% of residents to evacuate due to damage to their homes, surrounding infrastructure, and threats to personal safety from the aftermath. The current project used personal interviews with residents, both those who did and did not evacuate, to determine the sources of information and influence most critical to personal evacuation decisions. Preliminary analysis of the interviews indicates that very few people (fewer than 10%) talk about specific authority figures (e.g., the governor, local emergency management officials). Instead, most people describe the role of television media and friends, family, and neighbors in their decision to stay or to evacuate. In addition, many of our interviewees (~45%) describe a comparison to the impact of Hurricane Irene that often negatively impacted their decision to leave, even if that comparison was made using second-hand information from family and neighbors.

Using the themes identified from the interviews as described above, new potential pre-storm messages were developed and tested for effectiveness in persuading residents to heed evacuation orders in a hypothetical major coastal storm scenario similar to Superstorm Sandy. These messages included commentary from local non-traditional authorities (e.g., a local business owner), standard descriptions of impending storm surge and wind speeds, descriptions of actions taken by police and fire departments, and more traditional messages about mandatory evacuation orders set by the governor and county executive. Several actual

messages from local emergency management and media outlets prior to Superstorm Sandy were also included for comparison.

The results suggest that despite the descriptions from the interviews of reliance on media and personal connections, residents do heed some messages coming from traditional authorities (e.g., the governor or county executive), particularly if those messages describe a mandatory evacuation. Residents also understand magnitude differences in technical weather information and will evacuate if the predictions are sufficiently dire (e.g., 6-12 feet of storm surge, 90-100 mph winds). Importantly, however, messages noting actions taken by authorities (e.g., evacuating their own families or going door-to-door) and the potential loss of water/sewer service (as opposed to electrical outages) may have a high level of influence not previously identified. This last result may indicate an area for potential growth and development in pre-storm messaging. Interjecting messages about specific evacuation activities and potential post-storm damage may persuade more residents of coastal storm areas to evacuate prior to storm landfall, allowing for more post-storm resources to be diverted to rebuilding infrastructure instead of rescue operations.

Appendix VI:

Press release

NOAA and Sea Grant Announce Projects for $1.4M Coastal Storm Awareness Program
Ten Projects to Improve Hazard Warnings for New Jersey, New York and Connecticut Residents

Contacts:

Margaret (Peg) Van Patten, Communications Director, Connecticut Sea Grant,
E: peg.vanpatten@uconn.edu, P: 860-405-9141

Kim Kosko, Director of Communications, New Jersey Sea Grant Consortium, E: kkosko@njseagrant.org, P: 732.872.1300 ext 18

Barbara A. Branca, New York Sea Grant, Communications Manager, E: barbara.branca@stonybrook.edu, P: 631-632-6956

SILVER SPRING, MD, JANUARY 16, 2014 – Connecticut Sea Grant, New Jersey Sea Grant, and New York Sea Grant have awarded funds totaling $1.4 million to support ten social science research projects to improve community understanding and response to coastal storm hazard information as part of NOAA Sea Grant's Coastal Storm Awareness Program.

Despite the unparalleled accuracy of the forecast for Post Tropical Cyclone Sandy, too many coastal residents either failed to fully understand the severity of the storm and the dangerous conditions it would produce, or chose not to evacuate in spite of the serious risks of staying in their homes. The awarded projects will study community response to disasters by closely examining the coastal storm warning systems, the information conveyed (what to expect, when to expect it, and what do) and the factors that affect whether recipients of this information decide to act on it. The results of this research will improve the communication of coastal hazards to both the general community and to community leaders.

This national competition drew on the decades of experience within NOAA and Sea Grant as well as the well-earned reputation for credibility and trust of the Sea Grant outreach communities in New York, New Jersey and Connecticut. By combining Sea Grant's established relationship within local communities with current social science research, this effort will be able to maximize awareness and understanding of the true severity of coastal hazards - even amongst hard to reach, isolated groups within communities.

Sea Grant's CSAP is a part of the Disaster Relief Appropriations of 2013 (DRA), commonly referred to as the Sandy Supplemental. DRA provided supplemental appropriations to the NOAA to improve and streamline disaster assistance associated with Post-Tropical Cyclone Sandy, and for other purposes. In addition to recovering and rebuilding infrastructure from the devastation of Sandy, NOAA will conduct a coordinated program of activities to improve NOAA information and services for decision makers, communities, and the public in preparation for, response to, and recovery from other high-impact events. The results of these efforts will contribute to NOAA's vision of resilient ecosystems, communities, and economies.

To see the list of ten projects, go to: http://web2.uconn.edu/seagrant/publications/CSAP/csap-projects.pdf

This web site describes the program in detail:http://www.nyseagrant.org/csap

Margaret (Peg) Van Patten
Communications Director, Connecticut Sea Grant
University of Connecticut
1080 Shennecossett Road
Groton, CT 06340-6048
860-405-9141
http://www.seagrant.uconn.edu

Appendix VII:

Three-page fact sheet

Coastal Storm Awareness Program

Connecticut
New York
New Jersey

Behaviorally Realistic Communications to Improve the Public's Response to and Preparedness for High Impact Storm Events

Principal Investigators: Dr. Gabrielle Wong-Parodi / Dr. Baruch Fischhoff / Dr. Ben Strauss
Lead University: Carnegie Mellon University

This study will use a mix of surveys and interviews with coastal residents in New Jersey and New York about their beliefs and behavior regarding storm events to develop a personalized online decision-making tool for emergency managers, flood insurance companies, and meteorologists. The tool will help them develop strategies to better communicate to the public about high-impact storm events. Climate Central's Surging Seas model will be adapted to include the strategies identified in the initial stages, to improve citizen understanding, preparedness and response to extreme weather.

Project Contact: Dr. Gabrielle Wong-Parodi • Department of Engineering and Public Policy • 129 Baker Hall • Carnegie Mellon University • Pittsburgh, PA 15213 • Phone: 510-316-1631 • Email: gwongpar@cmu.edu

Assessment of Social Media Usage During Severe Weather Events and the Development of a Twitter-based Model for Improved Communication of Storm-related Information

Principal Investigators: Dr. John F. Edwards / Dr. Somya D. Mohanty / Dr. Patrick Fitzpatrick
Lead University: Mississippi State University

This project will build on social media techniques developed in Mississippi to establish better storm event communication between agencies such as the National Weather Service and emergency managers with residents and coastal communities. The model to be developed will primarily focus on leveraging use of the social media platform Twitter, using information from surveys and analysis of geo-referenced messages sent in the tri-state region before, during and after Sandy and other extreme weather events. The effect on human perceptions and behavior resulting from specific types of messages will be evaluated.

Project Contact: Dr. John F. Edwards • Social Science Research Center • One Research Boulevard • Suite 103 • Mississippi State University • Starkville, MS 39759 • Phone: 662-325-9726 • Email: je@ssre.msstate.edu

An Audience Segmentation Analysis of Connecticut Coastal Residents to Support Storm Preparedness

Principal Investigators: Dr. Jennifer R. Marlon / Dr. Anthony Leiserowitz
Lead University: Yale University

This project will survey at least 1,000 Connecticut coastal residents to assess their coastal storm risk perceptions, experiences, and behaviors. A better understanding of how much residents understand, information sources, and why they behave as they do will give emergency planners and responders a better understanding of the audiences they serve. Analysis of the survey results will take into account various demographic and social-cultural characteristics to support the design and development of storm-related information tailored to specific subgroups within the public. Results will be provided to Connecticut's emergency managers and responders.

Project Contact: Dr. Jennifer R. Marlon • School of Forestry and Environmental Studies • 195 Prospect Street • Yale University • New Haven, CT 06511 • Phone: 203-436-2598 • Email: Jennifer.marlon@yale.edu

Evaluating evacuation decision-making processes among residents of Long Beach, NY before Superstorm Sandy: Lessons for the role of authority and language in storm Warnings

Principal Investigators: Dr. Christa E. Farmer / Dr. Mary Anne Trasciatti / Dr. Elisabeth J. Ploran
Lead University: Hofstra University

This research team will analyze qualitative interviews with residents of ethnically diverse Long Beach, NY, many of whom ignored evacuation warnings before Hurricane Sandy, regardless of the remarkably successful forecasts of the storm track. Researchers will look at both language barriers and cultural attitudes in affecting understanding and acceptance of risk information and use interpreters for extended interviews of ethnic minorities when needed. The goal is to create improved guidelines for the specific language used by government officials and weather authorities to relay coastal storm information, risk assessment, and evacuation recommendations
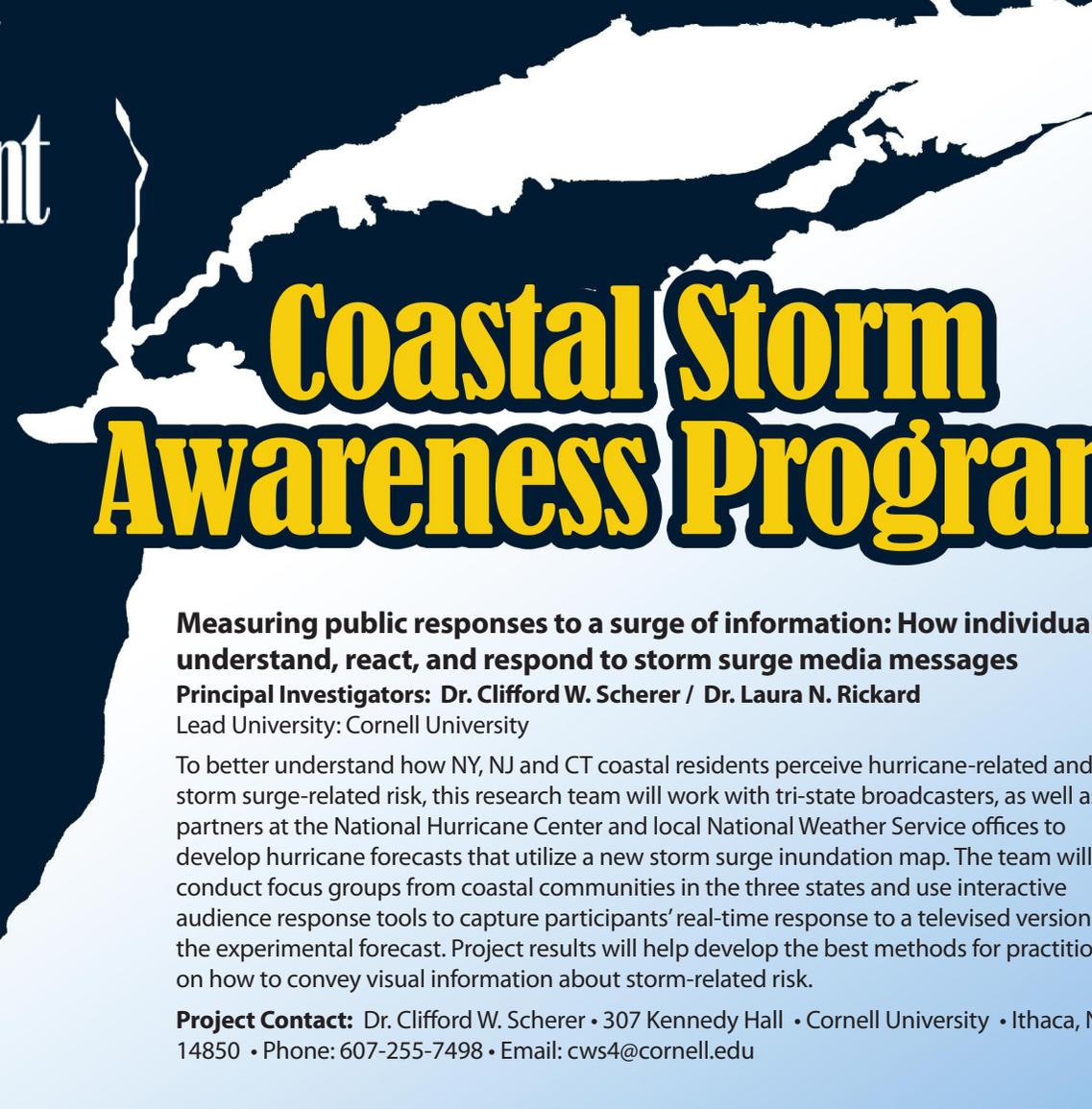
Project Contact: Dr. Christa E. Farmer • 145 Gittleson Hall • Hofstra University • Hempstead, NY 11549-1140 • Phone: 516-463-5566 • geoecf@hofstra.edu

Coastal Storm Awareness Program

Connecticut
New York
New Jersey

Measuring public responses to a surge of information: How individuals understand, react, and respond to storm surge media messages

Principal Investigators: Dr. Clifford W. Scherer / Dr. Laura N. Rickard

Lead University: Cornell University

To better understand how NY, NJ and CT coastal residents perceive hurricane-related and storm surge-related risk, this research team will work with tri-state broadcasters, as well as partners at the National Hurricane Center and local National Weather Service offices to develop hurricane forecasts that utilize a new storm surge inundation map. The team will conduct focus groups from coastal communities in the three states and use interactive audience response tools to capture participants' real-time response to a televised version of the experimental forecast. Project results will help develop the best methods for practitioners on how to convey visual information about storm-related risk.

Project Contact: Dr. Clifford W. Scherer • 307 Kennedy Hall • Cornell University • Ithaca, NY 14850 • Phone: 607-255-7498 • Email: cws4@cornell.edu

Forecasting evacuation behaviors of coastal communities in response to storm hazard Information

Principal Investigators: Dr. Ricardo A. Daziano / Dr. Linda K. Nozick / Dr. Philip L. Liu / Dr. Jonathon P. Schuldt

Lead University: Cornell University

In this Cornell project, focus groups and in-depth interviews will be used to assess attitudes, knowledge, and behaviors related to both coastal hazards and the products and tools used to both communicate and visualize risks and emergency actions. The experimental design will be a time-dependent discrete choice experiment, where subjects will self report the likelihood of evacuation for each discrete time and hypothetical storm. The researchers will design effective evacuation communication tools and explore the use of smartphone apps to collect data about stated evacuation preferences. Attitudes and response to new sources of information (Twitter and other social media), will be evaluated using sociological theories that integrate concepts such as subjective norms and behavioral control into discrete choice models.

Project Contact: Dr. Ricardo A. Daziano • 305 Hollister Hall • Cornell University • Ithaca, NY 14850 • Phone: 607-255-2018 • Email: ra477@cornell.edu

Understanding Responses to Storm Warnings: Learning from Those Who "Rode Out" Hurricane Sandy

Principal Investigators: Dr. Sharon D. Moran / Dr. William Peace

Lead University: Syracuse University • Sponsoring Sea Grant Program: New York Sea Grant

This research team will identify the gaps in understanding between coastal managers and the people who could not or would not evacuate during storms, document the perceptions and 'lived experience' of those who remained behind and elaborate on the differential vulnerabilities of the nonevacuators, from their own viewpoint, especially as they concern people with disabilities. By working with key stakeholders, the team will conduct focus groups, run surveys and analyze data that will help build training modules. Multiple versions of the modules, tailored for CT, NY and NJ residents, will be in the form of both online tutorials and for classroom use and will be pilot tested with managers.
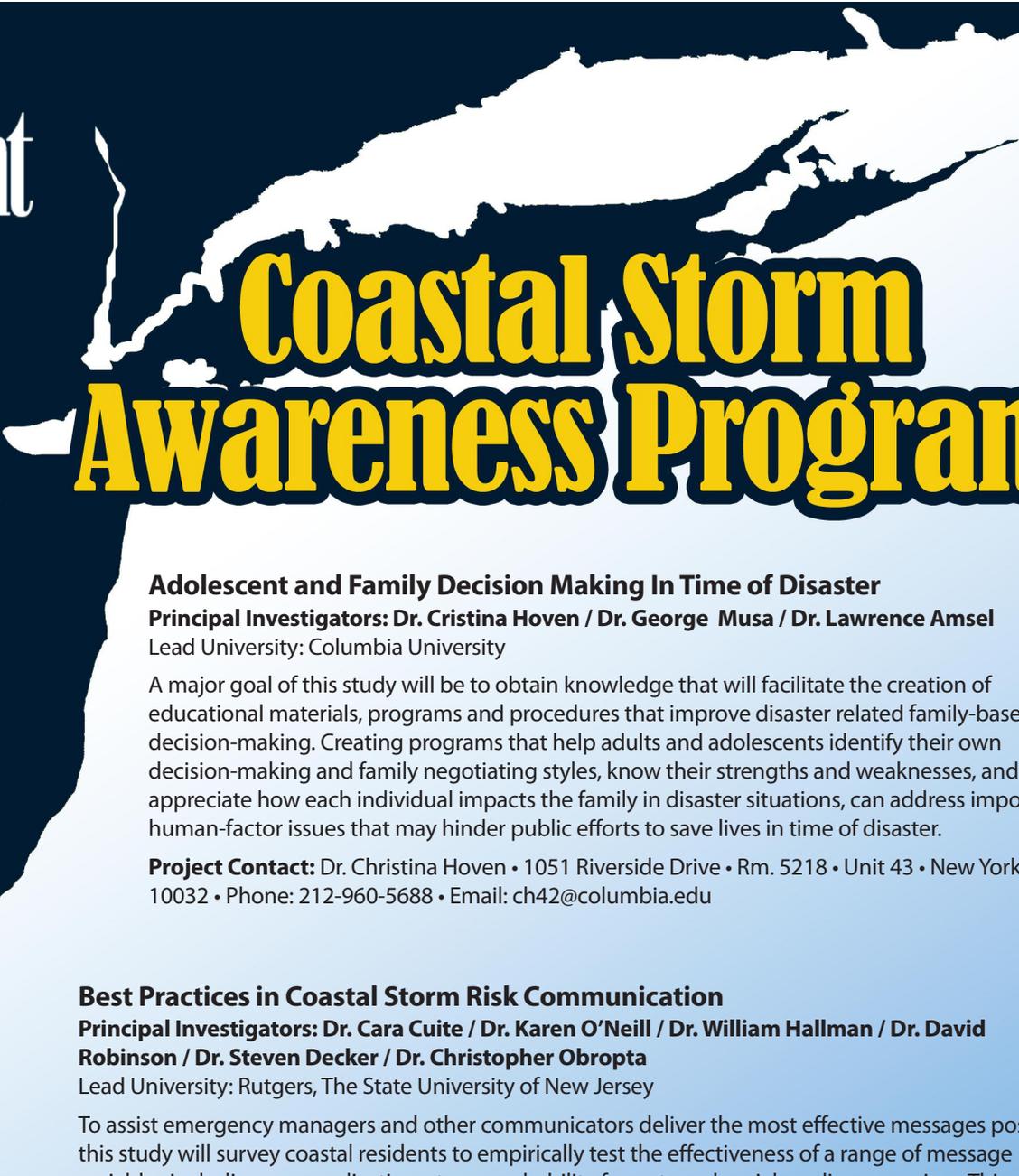
Project Contact: Dr. Sharon D. Moran • 113 Marshall Hall • 1 Forestry Drive • Syracuse, NY 13210 • Phone: 315-470-6690 • Email: smoran@esf.edu

Coastal Storm Awareness Program

Sea Grant

**Connecticut
New York
New Jersey**

Adolescent and Family Decision Making In Time of Disaster
Principal Investigators: Dr. Cristina Hoven / Dr. George Musa / Dr. Lawrence Amsel
Lead University: Columbia University

A major goal of this study will be to obtain knowledge that will facilitate the creation of educational materials, programs and procedures that improve disaster related family-based decision-making. Creating programs that help adults and adolescents identify their own decision-making and family negotiating styles, know their strengths and weaknesses, and appreciate how each individual impacts the family in disaster situations, can address important human-factor issues that may hinder public efforts to save lives in time of disaster.

Project Contact: Dr. Christina Hoven • 1051 Riverside Drive • Rm. 5218 • Unit 43 • New York, NY 10032 • Phone: 212-960-5688 • Email: ch42@columbia.edu

Best Practices in Coastal Storm Risk Communication
Principal Investigators: Dr. Cara Cuite / Dr. Karen O'Neill / Dr. William Hallman / Dr. David Robinson / Dr. Steven Decker / Dr. Christopher Obropta
Lead University: Rutgers, The State University of New Jersey

To assist emergency managers and other communicators deliver the most effective messages possible, this study will survey coastal residents to empirically test the effectiveness of a range of message variables including personalization, storm probability formats and social media messaging. This information will be the basis for developing a validated and tested best practices guide that will serve as an important tool for emergency managers to keep residents of their municipalities safe.

Project Contact: Dr. Cara Cuite • Department of Human Ecology • School of Environmental and Biological Sciences • Rutgers University • 55 Dudley Rd • New Brunswick, NJ 08901
Phone: 848-932-4544 • Email: cuite@aesop.rutgers.edu

They Had the Facts, Why Didn't They Act?: Understanding and Improving Public Response to NWS Coastal Flooding Forecasts
Principal Investigators: Rachel Hogan Carr / Dr. Burrell Montz / Gary Szatkowski / Lisa Auermuller / Dr. Susan Frankel / Elizabeth Goldman
Lead University/Institution: Nurture/Nature Center

New Jersey coastal community residents currently receive information about storm risk from a variety of products and sources in different formats at different times prior to a storm event. The complexity and variety of information leads to confusion and could decrease people's understanding of the full spectrum of risks that they face. Exposure to a briefing document, which combines various pieces of information and provides both graphical information and narrative explanations will improve understanding by the public and emergency management officials of the intensity and range of possible outcomes from an impending coastal storm, and improve the likelihood of people taking evacuation or other proper warning response actions.

Project Contact: Rachel Hogan Carr • Nurture/Nature Center • 518 Northhampton Street • Easton, PA 18042
Phone: 610-253-4432 • Email: rhogan@nurturenature.org

Appendix VIII:

Tri-fold brochure

Measuring public responses to a surge of information: How individuals understand, react, and respond to storm surge media messages

Lead University: Cornell University

To better understand how coastal residents perceive hurricane and storm surge-related risk, researchers will work with tri-state broadcasters, the National Hurricane Center and local weather service offices to develop hurricane forecasts that use a new storm surge inundation map. A televised version of the experimental forecast will be tested in focus groups from tri-state coastal communities to help practitioners design the best methods for conveying storm-related risk visually.

They Had the Facts, Why Didn't They Act?: Understanding and Improving Public Response to National Weather Service Coastal Flooding Forecasts

Lead University/Institution: Nurture/Nature Center

This research team will create briefing documents which combine both graphical information and narrative explanations about storm risk that will improve understanding by coastal residents and emergency management officials of the intensity and possible outcomes of an impending coastal storm, increasing the likelihood of people evacuating or taking other appropriate warning response actions.

Understanding Responses to Storm Warnings: Learning from Those Who "Rode Out" Hurricane Sandy

Lead University: SUNY College of Environmental Science and Forestry

By working with key stakeholders including those with disabilities, this research team will conduct focus groups and surveys to document the perceptions of those who could not or would not evacuate during Hurricane Sandy. The resultant data will help build several training modules tailored for CT, NY and NJ residents to be pilot tested by coastal managers.

For more info contact:

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Feb. 2014

COASTAL STORM AWARENESS PROGRAM

A Joint Program of

New York, New Jersey and

Connecticut Sea Grant

Programs funded by NOAA

Sea Grant

NOAA

www.nyseagrant.org/CSAP

The Coastal Storm Awareness Program

The Sea Grant programs of New York, New Jersey and Connecticut have awarded funds totaling $1.4 million to support ten social science research projects to improve community understanding and response to coastal storm hazard information as part of the National Oceanic and Atmospheric Administration (NOAA) Sea Grant "Coastal Storm Awareness Program" (CSAP).

Despite the accuracy of the forecast for Sandy, too many coastal residents either failed to fully understand the severity of the storm and the dangerous conditions it would produce, or chose not to evacuate in spite of the serious risks of staying in their homes.

These ten projects will study community response to disasters by closely examining the coastal storm warning systems, the information conveyed (what to expect, when to expect it, and what to do) and the factors that affect whether recipients of this information decide to act on it.

Research funded through CSAP will be guided by a Program Steering Committee drawn from the ranks of the coastal emergency management response and communication communities. Their involvement will help ensure that the prgoram produces results of direct use in preparing for future hazardous coastal storms.

NOAA image of Hurricane Sandy

Projects Funded by the NOAA/ Sea Grant Coastal Storm Awareness Program:

Adolescent and Family Decision Making In Time of Disaster

Lead University: Columbia University

The major goal of this study is to create educational programs that help adults and adolescents understand the importance of family dynamics in decision making and use it to address factors that may hinder efforts to save lives in time of disaster.

An Audience Segmentation Analysis of Connecticut Coastal Residents to Support Storm Preparedness

Lead University: Yale University

Responses to a survey of over 1,000 Connecticut coastal residents assessing their coastal storm risk perception, experience, understanding and behavior will be correlated to population demographics to support the development of targeted storm-related messages and shared with local emergency managers and responders.

Assessment of Social Media Usage During Severe Weather Events and the Development of a Twitter-based Model for Improved Communication of Storm-related Information

Lead University: Mississippi State University

Building on techniques developed in Mississippi to establish better storm event communication between the National Weather Service and emergency managers with coastal residents, researchers will develop a model based on Twitter, using analysis of geo-referenced messages sent in the tri-state region before, during and after Hurricane Sandy and other extreme weather events. Researchers will evaluate the effects of specific types of messages on human perceptions and behavior.

Behaviorally Realistic Communications to Improve the Public's Response to and Preparedness for High Impact Storm Events

Lead University: Carnegie Mellon University

This study will use surveys and interviews with New York- New Jersey coastal residents about their beliefs and behavior regarding high-impact storm events to develop a personalized online decision-making tool. Climate Central's Surging Seas model will be adapted to include strategies that can be used to improve citizen understanding, preparedness and response to extreme weather.

Best Practices in Coastal Storm Risk Communication

Lead University: Rutgers, The State University of New Jersey

To assist emergency managers and other communicators deliver the most effective messages possible, this study will survey coastal residents to empirically test the effectiveness of a range of message variables including personalization, storm probability formats and social media messaging. This information will be the basis for a best practices guide that will serve as an important tool for emergency managers.

Evaluating evacuation decision-making processes among residents of Long Beach, NY before Superstorm Sandy: Lessons for the role of authority and language in storm Warnings

Lead University: Hofstra University

This research team will analyze interviews with residents of ethnically diverse Long Beach, NY, many of whom ignored evacuation warnings about Hurricane Sandy, looking at both language barriers and cultural attitudes in affecting understanding and acceptance of risk information. The goal is to create improved guidelines for the specific language used by government officials and weather authorities to relay coastal storm information, risk assessment, and evacuation recommendations.

Forecasting evacuation behaviors of coastal communities in response to storm hazard Information

Lead University: Cornell University

Researchers will use focus groups and interviews to conduct time-dependent discrete choice experiments, where subjects will self-report the likelihood of evacuation for each of a series of hypothetical storms. The team will explore the use of smartphone apps to collect data about stated evacuation preferences and evaluate the attitudes and response to new sources of information (Twitter and other social media) using integrated sociological theories.

Appendix IX:

Agendas for NOAA Science Days, Hill Briefings, NOAA Leadership Briefing

Silver Spring Seminar
SSMC II Rm 2358

October 27, 1:00 - 4:35pm EDT

AGENDA

1:00 – 1:05 **Opening Remarks**
Dr. Rick Spinrad, NOAA Chief Science Advisor

1:05 – 1:15 **Introductory Remarks**
Alexander "Sandy" MacDonald, Ph.D., OAR Chief Science Advisor

1:15 – 1:40 **Improving operational numerical hurricane forecast system to reduce errors in tropical cyclone track, intensity and structure forecasts**
Vijay Tallapragada, Ph.D., Chief of Global Climate and Weather Modeling Branch, Environmental Modeling Center, National Centers for Environmental Information

1:40 – 2:05 **Accelerating U.S. global weather prediction**
Tim Schneider, Physical Scientist, OAR Earth System Research Laboratory Global Systems Division

2:05 – 2:30 **CINAR TEMPEST: A rapid response storm study for the Northeast**
Glen Gawarkiewicz Ph.D., Physical Oceanographer, Woods Hole Oceanographic Institute, NOAA Cooperative Institute for the North Atlantic Region

2:30 – 2:55 **Communicating risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy?**
Nancy Balcom, Associate Director and Senior Extension Educator, Connecticut Sea Grant College

2:55 – 3:10 BREAK

3:10 – 3:35 **Science and coastal resilience: Building partnerships and leveraging resources for maximum results**
 Jeanne Herb, Associate Director, Environmental Analysis and Communications Group, Edward J. Bloustein School of Planning and Public Policy, Rutgers

3:35– 4:00 **High-resolution digital elevation models to support refined coastal inundation forecasts**
Barry Eakins, Ph.D., Marine Geophysicist, Geophysical Sciences Division, NOAA National Centers for Environmental Information

4:00 – 4:25 **Social impacts and lessons learned from Hurricane Sandy on the commercial recreational fishing industries in New York and New Jersey**
Lisa Colburn, Ph.D., Social Scientist/Anthropologist, NMFS Northeast Fisheries Science Center

4:25 – 4:35 **Closing Remarks**
Alexander "Sandy" MacDonald, Ph.D., OAR Chief Science Advisor

Briefing for NOAA Leadership

NOAA Science Days: Sandy Supplemental
Research & Results to Improve Disaster Prediction, Assistance & Response
Wednesday October 28, 2015
1:00 - 2:00 pm EDT
Herbert C. Hoover Building (HCHB) Rm. 1410

1:00 – 1:10   **Opening and Introductory Remarks**
                Alexander "Sandy" MacDonald, Ph.D., OAR Chief Science Advisor

1:10 – 1:25   **Accelerating U.S. global weather prediction**
                Tim Schneider, Physical Scientist, OAR Earth System Research Laboratory
                Global Systems Division
                Recent high-impact storms, such as Superstorm Sandy, show how adequate preparation is dependent on accurate forecasts with sufficient lead-time. The High Impact Weather Prediction Project (HIWPP) is a three-year Sandy Supplemental project spread across eleven organizations that is accelerating the development of the next generation operational modeling system. To achieve these lofty goals, the project will focus research and development on several areas to include hydrostatic and non-hydrostatic global models, data assimilation, improvements to parameterizations of key physical processes, ensembles and statistical post-processing, moving hurricane nested models, expansion of the National Multi-Model Ensemble (NMME) and development of a program to test and evaluate the accuracy of global numerical weather prediction systems and making the data available to NOAA's partners. HIWPP is using existing high-performance computing (HPC) systems more effectively and exploring new HPC technologies for numerical weather prediction. This presentation will provide an overview of HIWPP, the progress so far and how these models are being transitioned to the National Weather Service Next Generation Global Prediction System (NGGPS).

1:25 – 1:40   **CINAR TEMPEST: A rapid response storm study for the Northeast**
                Glen Gawarkiewicz Ph.D., Physical Oceanographer, Woods Hole Oceanographic Institution, NOAA Cooperative Institute for the North Atlantic Region
                Forecasting storm intensity is a difficult problem, particularly as hurricanes cross the continental shelf. Cooling of the ocean surface during storm passage affects storm intensity. With funding from the Sandy Supplemental appropriation, our regional team has developed an integrated system for measuring ocean temperature and salinity structure from the deep ocean to shallow water. The system includes low cost Storm Buoys that also measure sea level, wind and waves. Results from recent deployments during Hurricane Arthur and other recent storms will be described as well as implications for ocean feedbacks to storm intensity and coastal flooding.

1:40 – 1:55 **Communicating risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy?**
Nancy Balcom, Associate Director and Senior Extension Educator, Connecticut Sea Grant College
The Coastal Storm Awareness Program, managed by the Connecticut, New York, and New Jersey Sea Grant programs, is a social science research and outreach initiative to improve understanding of how coastal residents respond to storm hazard information and to recommend best practices for communicating risk. What factors influence a person's decision to evacuate or "ride out" a coastal storm? Can the risk associated with coastal storms be communicated more effectively, increasing the likelihood that residents take appropriate action to avoid becoming casualties? This presentation evaluates risk communication during Hurricane Sandy, examining how coastal residents obtain storm warnings, what factors influence residents heeding warnings and how warnings can be more impactful.

1:55 – 2:00 **Closing Remarks**
Alexander "Sandy" MacDonald, Ph.D., OAR Chief Science Advisor

Briefings to House and Senate
October 29, 2015

10:00 am - 11:00 am
House Briefing
Rayburn House Office Building: Committee Room TBA

11:30 am – 12:30 pm
Senate Briefing
Senate Dirksen Room G11

AGENDA

3 minutes   **Opening Remarks and Introduction: Dr. Steve Fine**

12 minutes   **Accelerating U.S. global weather prediction**
Tim Schneider, Physical Scientist, OAR Earth System Research Laboratory Global Systems Division

12 minutes   **CINAR TEMPEST: A rapid response storm study for the Northeast**
Glen Gawarkiewicz Ph.D., Physical Oceanographer, Woods Hole Oceanographic Institute, NOAA Cooperative Institute for the North Atlantic Region

12 minutes   **Communicating risk: What have we learned about people and coastal storm warnings in the aftermath of Sandy?**
Nancy Balcom, Associate Director and Senior Extension Educator, Connecticut Sea Grant College

~20 minutes   **Questions**

1 minute   **Closing Remarks: Dr. Steve Fine**

Three years after Sandy

Hear how NOAA is improving hurricane forecasts and communicating risk

NOAA and American Meteorological Society co-host roundtable in Washington, D.C.

Contact
Monica Allen, monica.allen@noaa.gov, 301-734-1123

October 21, 2015

Next week, to mark the third anniversary of Hurricane Sandy, NOAA and partner scientists will brief media on the research milestones that have been made in severe storm prediction, assistance, and response. The media roundtable will be co-hosted by NOAA and the American Meteorological Society and held Wednesday, October 28, from 10 to 11 a.m. ET at AMS at 1200 New York Avenue NW, Suite 450, Washington, D.C.

NOAA received $309 million in Congressional funding as part of the Disaster Relief Appropriations Act of 2013 to accelerate research that helps communities and businesses prepare for the next big storm. The briefing will highlight projects to improve global weather prediction, develop a new ocean observation system to predict storm strength and social science research to improve storm warnings for the public designed to save lives and property.

WHAT:
NOAA science briefing, co-hosted by NOAA and the American Meteorological Society

TOPIC:
Research to improve severe weather prediction, response and recovery

WHEN:
Wednesday, October 28, 2015, from 10:00 to 11:00 a.m. ET

WHERE:

American Meteorological Society, 1200 New York Avenue NW, Suite 450, Washington, D.C.

CALL-IN:
Media unable to come in person may call in. Please email monica.allen@noaa.gov

WHO:

- Alexander MacDonald, chief scientist, NOAA Office of Oceanic and Atmospheric Research, overview and introductions
- Tim Schneider, physical scientist, NOAA's Earth System Research Laboratory, Boulder, Colorado: Advances in global weather prediction
- Glen Gawarkiewicz, coastal oceanographer, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts: New ocean observing system to predict northeast storm strength
- Nancy Balcom, associate director and extension program leader, Connecticut Sea Grant, Groton, Connecticut: What Hurricane Sandy taught us that can improve storm warnings for the public

RSVP:
Media must RSVP to Monica Allen, director of public affairs for NOAA Research, by Tuesday, Oct. 27, at 5 p.m. Please RSVP by email to monica.allen@noaa.gov

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NOAA's mission is to understand and predict changes in the Earth's environment, from the depths of the ocean to the surface of the sun, and to conserve and manage our coastal and marine resources. Join us on **Twitter**, **Facebook** and our other **social media channels**. Visit our **news release archive.**

Founded in 1919, the **American Meteorological Society (AMS)** is the nation's premier scientific and professional organization promoting and disseminating information about the atmospheric, oceanic, hydrologic sciences. Our more than 13,000 members include scientists, researchers, educators, broadcast meteorologists, students, weather enthusiasts, and other professionals in the fields of weather, water, and climate.

Appendix X:

Media Hits from NOAA Science Day presentations that included CSAP information

Capital News Service: NOAA Discusses new disaster relief techniques
https://www.youtube.com/watch?v=FWK9MLtX3Ow&feature=youtu.be

The Record: Disaster aid used to improve ability to predict storm intensity

Asbury Park Press: Sandy anniversary lesson: Don't ignore evacuation orders

Palm Beach Post: Study reveals who people trust most during a storm, not who you think

Appendix XI:

Flyers from New Jersey Sea Grant Extension workshops

Making Sense Of Surge

New Jersey Sea Grant Consortium and its partners invite New Jersey's coastal mayors, town planners, public works departments, OEM managers, environmental commissions, residents and community members to attend a program on storm surge awareness and its impact to communities during hurricanes and other coastal storms. Attendees will obtain information that will enable them to make informed decisions when faced with potential surge events, such as how to prepare and when to evacuate. Invited panelists include Dr. Jon Miller and Dr. Amy Williams of Stevens Institute of Technology with an introduction by Dr. Peter Rowe of NJSGC.

For more information on NJSGC programs, visit the website at
http://njseagrant.org/ and https://www.facebook.com/njseagrant

August 17 • 7:00 PM

City Hall Council Chambers, 2nd Floor
344 Broadway, Long Branch NJ 07740

Please register at awillia5@stevens.edu
Co-hosted by Long Branch and Oceanport Emergency Management

Dune It Right!

Monday, August 24 • 10:00am - 11:30am

Cape May Convention Hall
714 Beach Avenue, Cape May NJ 08204
Please register by Friday, August 21
at awillia5@stevens.edu

Light refreshments will be served. Free parking available upon request.
Co-hosted by the City of Cape May

New Jersey Sea Grant Consortium and its partners invite New Jersey's coastal mayors, town planners, public works departments, OEM managers, environmental commissions, residents and community members to attend a work shop on the importance of dunes and beaches to mitigate the impact of coastal storms.

Attendees will obtain information that will enable them to make informed decisions on coastal resilience and will be able to comment on a dune manual that will incorporate beach and dune dynamics with suitable plantings. Invited panelists include Dr. Peter Rowe of NJSGC, Dr. Amy Williams of Stevens Institute of Technology and Mr. Chris Miller of Cape May Plant Material Center/USDA-NRCS.

(For more information on NJSGC programs, visit the website at http://njseagrant.org/
and the electronic version of the Dune Manual at http://njseagrant.org/extension/coastal-concerns/dune-it-right/)