Communicating Storm Risk: Insights on Human Behavior in the Wake of Superstorm Sandy and the 2017 Hurricanes.

Findings from The Coastal Storm Awareness Program, a collaboration of the Connecticut, New York and New Jersey Sea Grant programs, with NOAA National Sea Grant.

$1.8M in Sandy Supplemental funds enabled Sea Grant to support ten social science research projects at institutions from Yale to Mississippi State. The researchers looked at how coastal storm risks are communicated, and how people process and respond to those risks, based on their experience with Sandy in 2012.

Photo credit: https://upload.wikimedia.org/wikipedia/commons/8/8e/Hurricane_Harvey_%282017%29_170828-Z-FG822-026_%2836127995543%29.jpg

*We were not expecting the worst... Hurricane Irene didn't really do much damage at all...**we were told to evacuate at our door and we chose to stay**...*

From interviews conducted by S. Moran et al., 2015, SUNY-CESF

The need for social science research and outreach continues

Despite storm surge warnings and evacuation orders that were issued days before Sandy's landfall, 40 deaths were by drowning; nearly half of which occurred in flooded homes (based on American Red Cross and CDC data). The black dots on the figure indicate the location of drowning deaths that occurred in lower NYC with respect to the FEMA storm surge area in blue and Evacuation Zone A outlined with the hash marks.

Previous experience with Tropical Storm Irene influenced the reaction of some people to warnings about Sandy. (Quote

- How do coastal residents obtain storm warning information and which sources do they trust?
- What primary factors influence coastal residents in deciding whether to heed storm warnings?
- How can coastal storm warnings be made more informative or impactful?

CSAP framing questions

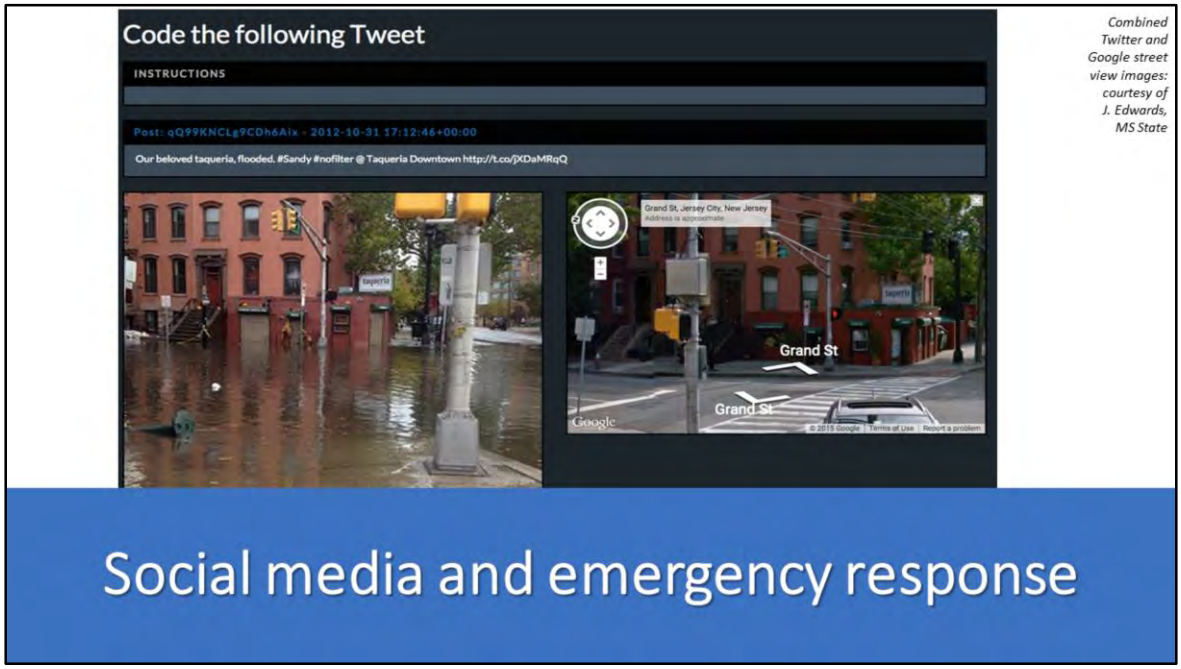
The Coastal Storm Awareness Program was based on three framing questions:

1 – What sources do people look to for storm warning information?

2) What primary factors influence the decisions people make with respect to storm warnings?

3) How can storm warnings be made more effective, to increase understanding and compliance?

Coastal residents obtain storm warning info from…



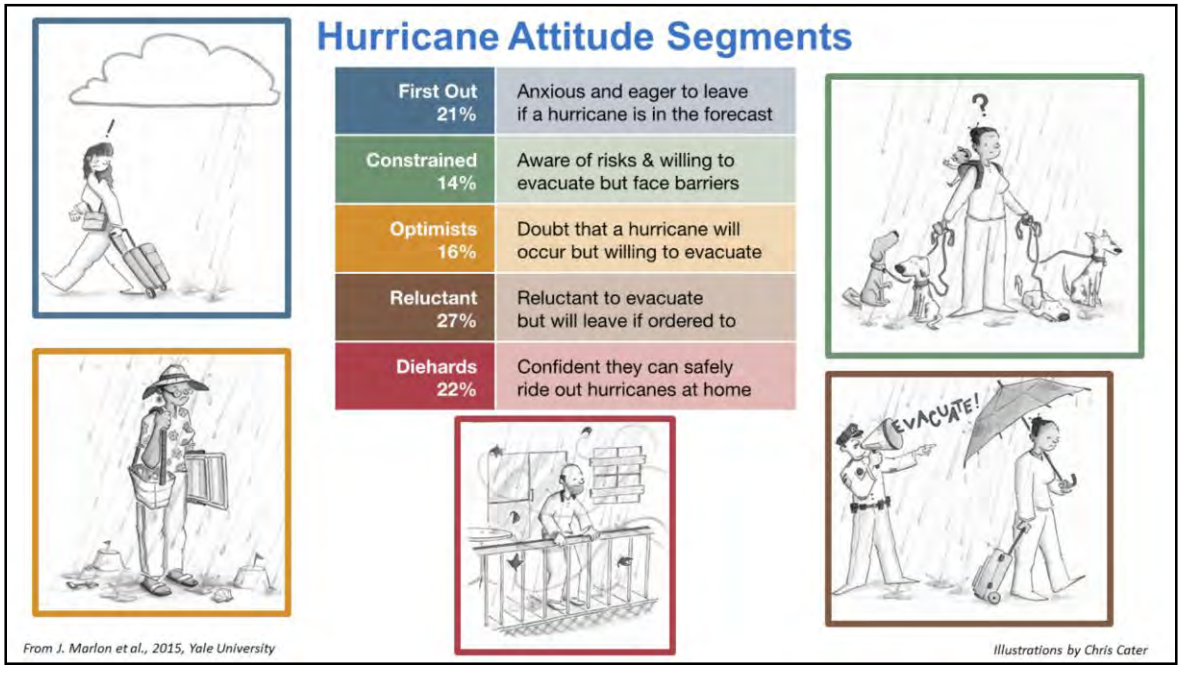
Combined Twitter and Google street view images: courtesy of J. Edwards, MS State

Twitter image: courtesy of J. Edwards and Twitter

Among the new tools and websites generated by the research effort is bi-directional communication software. Mississippi State researchers filtered and geocoded images shared by Twitter users during Hurricane Sandy (such as the one on the left), and verified their locations with Google street-view (on the right). They developed a software application that facilitates bi-directional communication between emergency managers and the public, and envision its usefulness in helping identify priority response areas in near real-time.

Crowd sourcing.

“Know your audience” is important to successful messaging, yet this can be complicated when the same message (like a storm warning) is perceived differently by groups of individuals within the same community.



Researchers at Yale conducted a human segmentation analysis of Connecticut coastal residents living in ACOE Evac Zone A or B that grouped people into five categories based on their perception of risk among other factors.

First Out

- Perceive greatest risk from hurricanes, including wind, flooding, surge
- Do not perceive barriers to evacuation
- Less prepared on average
- More likely to know live in evacuation zone

From J. Marlon et al., 2015, Yale University

Illustration by Chris Cater

Constrained

- Understand risks of staying
- Cite barriers - trouble evacuating
- Will evacuate if warranted/needed
- Less likely to be prepared

From J. Marlon et al., 2015, Yale University

Illustration by Chris Cater

Optimists

- Substantially underestimate risk from any hurricane
- Least prepared
- Perceive significant barriers to evacuation
- Will evacuate but "won't be necessary"

From J. Marlon et al., 2015, Yale University

Illustration by Chris Cater

Reluctant

- Less afraid on average
- Tend to live farther from coast
- Would evacuate if told to do so by official (@levels of First Out)
- Do not perceive barriers to evacuation

From J. Marlon et al., 2015, Yale University

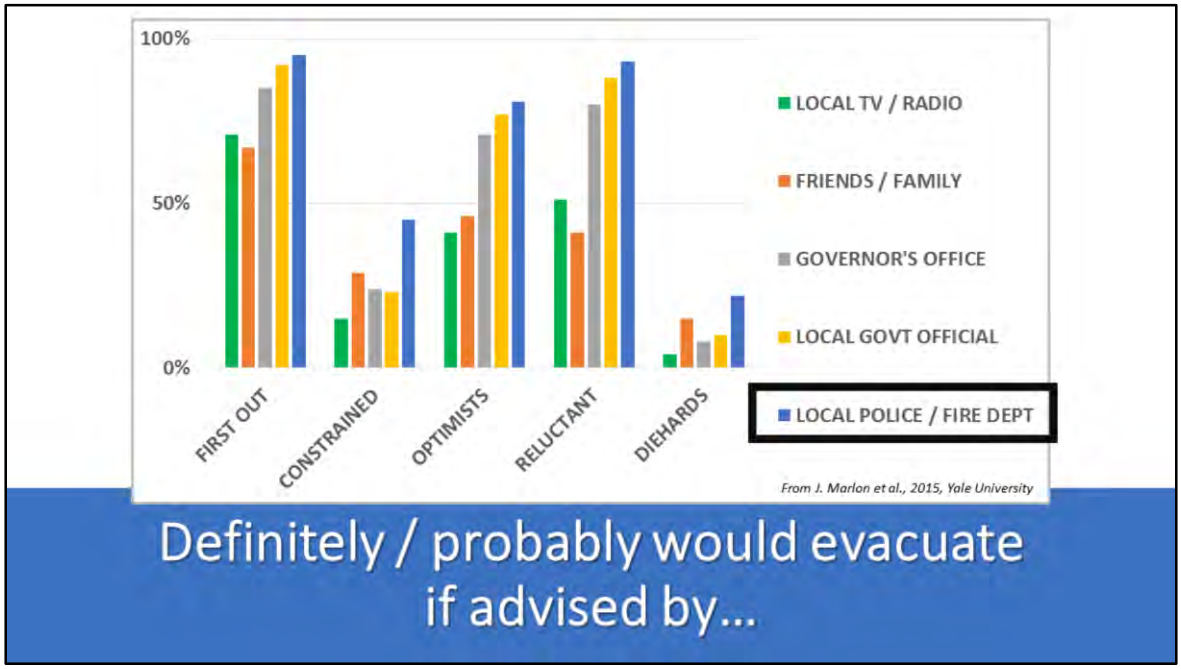
Illustration by Chris Cater

Diehards

- Lowest hurricane risk perception
- Least likely to evacuate for any category hurricane, with or without official order
- Self-reliant, prepared
- Protect property, watch storm
- Pets important barrier for 25%

From J. Marlon et al., 2015, Yale University

Illustration by Chris Cater



Going back to the categories of people based on risk perception, the Yale study indicates that if you want people to pay attention to evacuation orders, have local fire or police (blue bars) issue them as they have the greatest likelihood of being listened to by all five groups of people. Note that after local fire and police, the Optimists and Reluctants will listen to local or state officials (yellow and gray bars); while the Constrained and Diehards rely more on the opinions of their friends and family (orange bars).

*We had **4 dogs and 4 cats… frantically calling shelters** to see if they would take us, none would… **forced to ride out the storm with our children and pets…***

From interviews conducted by S. Moran et al., 2015, SUNY-CESF

- Medical or health constraints
- Financial constraints
- Transportation constraints

Personal constraints / barriers

Photo: courtesy of N. Balcom

*Went to back of school to try to get in using the ramp [for my **motorized wheelchair**] … **locked gate prevent[ed] anyone from using the ramp to the accessible entrance.** There were no shelter volunteers at the locked accessible entrance…**decided it would be safest for us to return home**…*

From interviews conducted by S. Moran et al., 2015, SUNY-CESF

"Ride it out" vs accessibility concerns

Researchers from SUNY documented experiences of disabled residents from Sandy-affected areas. Key factors in their decisions to shelter in place and "ride it out" were concerns about accessibility to a new location, transportation, lack of confidence that wherever they went would be able to accommodate their needs, and a lack of real-time updates on the status of various shelters.

Americans with Disabilities Act addresses a civil rights issue and communities need to reach out to the disabled to include them into conversations on local storm preparation. Privacy issues must also be considered.

((Note - In NYC, a federal class action lawsuit brought in 2011 resulted in a deal that calls for disaster centers to be upgraded to accommodate 120,000 disabled people by September 2017.
(http://www.huffingtonpost.com/2014/10/02/nyc-disabilities-disasters-_n_5921714.html))

Photo: courtesy of Sharon Moran and William Peace

The needs of the disabled must be considered, with their participation – "nothing about us without us"

*There were **similar warnings about a previous storm** and it turned out to be **very mild and no reason to leave.** I thought about these warnings and **felt we were in no harm**. I was **in total shock at the devastation** that this storm did to my house and the neighborhood that I live in.*

*When they said it was going to be a really bad storm, **I envisioned the worst I had experienced**. I didn't have a vision for worse than what I experienced...**I don't know what kind of information they could have shared that would have said 'beyond your imagination level'.***

From interviews conducted by S. Moran et al., 2015, SUNY-CESF; G. Wang-Parodi, Carnegie Mellon University

Previous experience with coastal storms

Previous experience with coastal storms is another factor that had a strong influence on how people reacted to storm warnings for Sandy. Columbia researchers found that while the most important factor in a decision TO evacuate during Sandy was the family's personal safety, the most important factor in a decision NOT to evacuate was previous experience.

As shown by the top quote, SUNY researchers found that previous experience with Irene resulted in decisions to ignore the evacuation orders during Sandy.

Carnegie Mellon researcher found that previous experience hinders or colors a person's ability to conceptualize just how bad a storm can be. People can only imagine the worst storm <u>they</u> have ever experienced.

- Didn't know about hurricane or storm surge potential
- Believed house high enough
- Previous bad experience with traffic
- Waited too long
- Wanted to deal with damage right away

NCAR/UGA Marine Extension/GA Sea Grant; August 2017

More reasons for not evacuating

NCAR / UGA / GA Sea Grant

Photo: https://cdn.vox-cdn.com/thumbor/dsVpbmJOiMw5gb8sC7R3qs3DfEU=/0x0:3000x2000/1310x873/cdn.vox-cdn.com/uploads/chorus_image/image/56393525/839979032.0.jpg

- Concern about post-storm isolation
- No water or power
- Concern for family safety
- Evacuation mandatory and required by law

NCAR/UGA Marine Extension/GA Sea Grant; August 2017

More reasons for evacuating

NCAR / UGA / GA Sea Grant

Photo: https://c1.staticflickr.com/5/4429/36015108554_09463ccee8_b.jpg

Will "property safe" homes result in fewer evacuations?

From C. Scherer et al., Cornell University

Preparedness vs willingness to evacuate conundrum

An interesting question that arose from studies conducted by Cornell, Yale and Hofstra is – whether or not state and federal requirements for flood-compliant homes in vulnerable coastal areas will have an affect on future evacuation behavior.

Cornell researchers found through their surveys that some people felt that if their financial risk was minimized by having safer flood compliant homes, they would be **MORE likely** to leave. However, people participating in focus group discussions indicated that if their homes were safer, they would be **less likely** to evacuate during future storms. In other words, My home is safe now, why should I leave it?

Photo credit: Nancy Balcom, CT Sea Grant
FEMA, states and communities are working to require homes in vulnerable coastal areas be flood compliant. Ready.gov

As far as you know, do you live in an officially designated flood* zone?	
Yes	29.7%
No	47.4%
I am not sure	22.5%

From C. Cuite et al., 2015, Rutgers University

*Similar results for question about evacuation zone

Knew Live in Evac Zone:

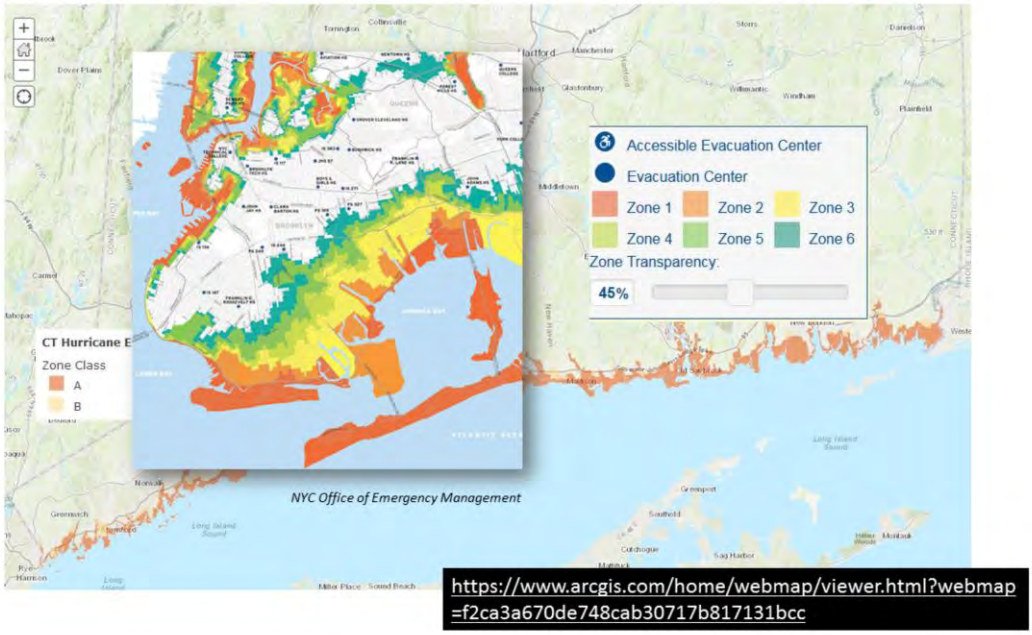
From J. Marlon et al., 2015, Yale University

- First Out – 58%
- Constrained – 34%
- Diehards – 30%
- Optimists – 20%
- Reluctant – 14%

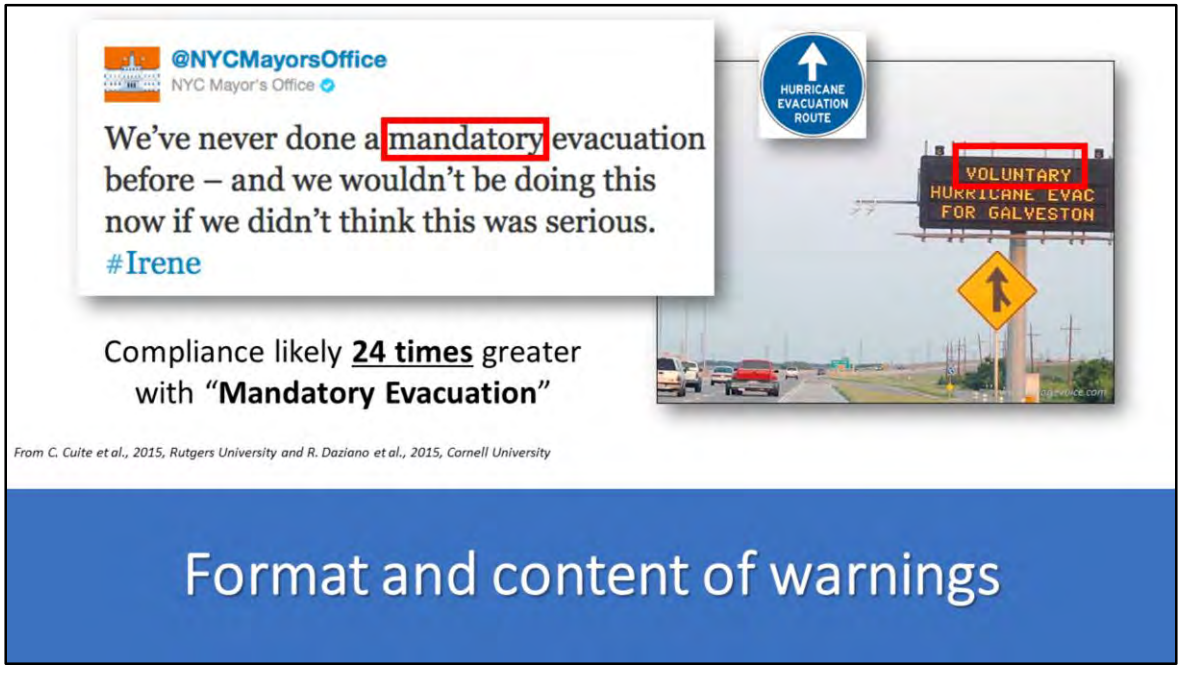
70% of coastal Connecticut residents surveyed don't know or are unsure whether they are living in an evacuation zone

From J. Marlon et al., 2015, Yale University

Evacuations orders or flood warnings are meaningless if people don't know where they live, relative to the scope of those orders or warnings.



In 2013, NYC revised its hurricane evacuation zones and initiated a “Know Your Zone” campaign to help familiarize residents with these changes, with maps like the one shown.



Format and content of warnings

The format of warnings also influenced the decisions people made. Researchers at both Rutgers and Cornell confirmed the ineffectiveness of the word voluntary, which seems to have a reverse effect on people's decisions and actions related to evacuation. Very few people seriously consider evacuating if it is promoted as a voluntary measure. In contrast, the use of the word "mandatory" with evacuation orders gets people's attention - even if the orders are considered unenforceable. At Cornell, researchers found that compliance was likely to be 24X greater when the words "Mandatory Evacuation" were used.

Credits: screenshot of NYC Mayor's Office Tweet www.villagevoice.com
Galveston Evac sign: AP Photo boston.com

Effect of mandatory evacuation orders = shadow evacs

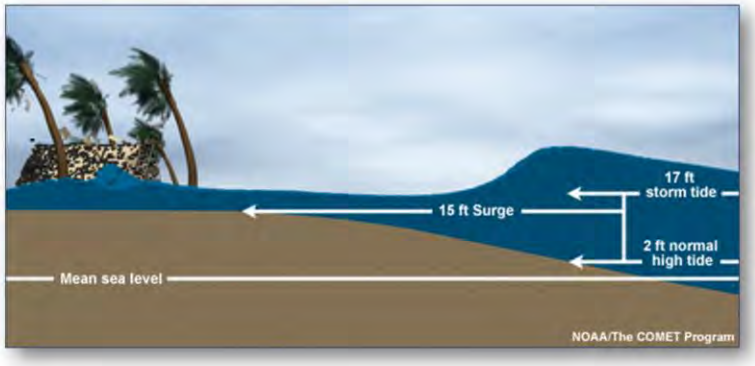
Photos: traffic: http://media-cdn.timesfreepress.com/img/photos/2016/10/06/1475812543_76967915-46d678b33fb7484d93f968e61342ee4a_t1070_h1c4238b76f82939773c92b5a23e8eede147007e2.jpg

Katrina housing pic: Houston,TX.,9/1/2005--Thousands of hurricane Katrina survivors from New Orleans are bussed to refuge at a Red Cross shelter in the Houston Astrodome. FEMA photo/Andrea Booher

General confusion about exactly what "**storm surge**" means

Predictions were for an 11 foot surge; did that mean…

- 11 feet > low tide?
- 11 feet > high tide?
- If high tide is 7 ft, is it 4 ft above high tide?



From C. Scherer et al., 2015, Cornell University

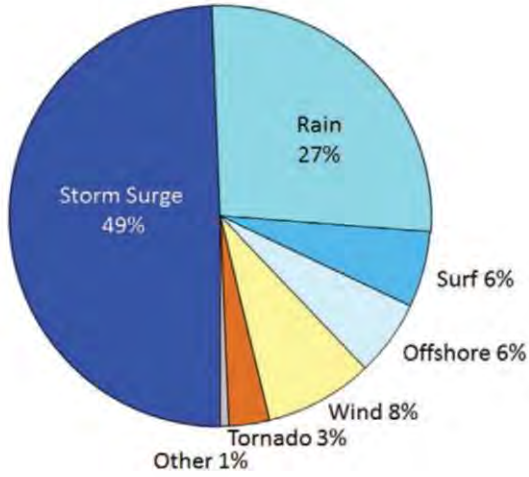
Terminology / Jargon

The terminology used in storm warnings can play an important role in whether or not the risk conveyed is understood by the general population. Columbia researchers found that few people had any concept of what the term "storm surge" meant; some envisioned a tsunami. The new effort by the NOAA NWS to characterize storm surge as "height of the water above ground level" will hopefully help reduce this confusion by helping people people visualize better what is being conveyed in future storm surge warnings.

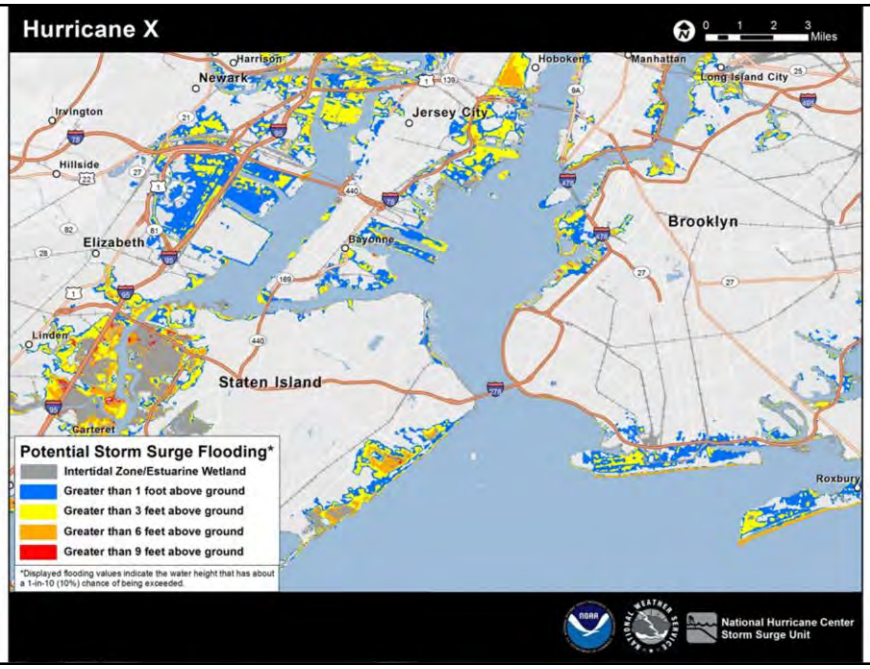
Cause of death in the US directly attributable to Atlantic tropical cyclones, 1963–2012

<u>66% - 75% of each category said high winds</u> greatest threat of injury/death

Marlon et al, 2015



Fatalities in the United States from Atlantic Tropical Cyclones: New Data and Interpretation
Edward N. Rappaport, National Weather Service, National Centers for Environmental Prediction, National Hurricane Center, Miami, Florida https://doi.org/10.1175/BAMS-D-12-00074.1



From 1990-2008, population density increased by 17% in Atlantic coastal counties (US Census Bureau 2010)
http://www.nhc.noaa.gov/surge/

- Maps with recognizable landmarks/titles
- Show storm surge at multiple scales
  - regional scale = spatial extent of potential flooding
  - local scale = how specific places may be affected

NCAR/UGA Marine Extension/GA Sea Grant; August 2017

Visualizing storm surge

Statistics
Progress in Puerto Rico
Hurricane Maria Update

Signs of recovery	1 DAY	30 DAYS	45 DAYS
Cell service	5%	61%	92%
Potable water	44%	69%	83%
Patients cared for	--	6,100	33,165
Open ATMs	114	1,047	1,160
Generators	10	148	423
Gas Stations	40%	78%	84%
Power	0%	21%	41%
Installation of Blue Roof	0	439	5,975

# of days after Maria made landfall

FEMA

Long-term recovery

500 more people died in PR in September 2017 than in Sept 2016. However, official death toll for Maria still remains at 55 (government officials).

Photo:
https://www.dhs.gov/sites/default/files/styles/large/public/images/3848320.jpg?itok=ZVMDBmmt

- Access to storm information is maximized through the use of many media platforms
- Evacuation decisions are influenced by many factors
- Safer, flood compliant homes may affect future evacuation decisions
- Coastal residents need to be familiar with local evacuation / flood zones and evacuation routes
- More people pay attention to mandatory evacuation orders; can lead to shadow evacuation
- Familiar landmarks / scales can help explain potential extent of storm surge

Wrapping Up

QUESTIONS?

Photo credit: Members of the South Carolina's Helicopter Aquatic Rescue Team (SC-HART) perform rescue operations in Port Arthur, Texas, August 31, 2017. The SC-HART team consists of a UH-60 Black Hawk helicopter from the South Carolina Army National Guard with four Soldiers who are partnered with three rescue swimmers from the State Task Force and provide hoist rescue capabilities. Multiple states and agencies nationwide were called to assist citizens impacted by the epic amount of rainfall in Texas and Louisiana from Hurricane Harvey. (U.S. Air National Guard photo by Staff Sgt. Daniel J. Martinez)

CSAP documentary: www.nyseagrant.org/csap

CSAP summary: CT Sea Grant *Wrack Lines* article (here)

NCAR / UGA Marine Extension / GA Sea Grant:

www.mmm.ucar.edu/chime

Links

Sea Grant

Management:

- Joshua Brown, National Sea Grant
- Sylvain De Guise, CT Sea Grant / University of Connecticut
- Peter Rowe, NJ Sea Grant Consortium
- William Wise, NY Sea Grant / Stony Brook University

Research Coordination, Extension and Communications:

- CTSG – Juliana Barrett, Syma Ebbin, Bruce Hyde, Peg Van Patten, Nancy Balcom,
- NYSG – Jay Tanski, Lane Smith, Barbara Branca, Paul Focazio, Kathy Bunting-Howarth, James Pearce
- NJSGC – Jon Miller, Amy Williams, Michael Schwebel, Matthew McGrath
- National Sea Grant – Elizabeth Rohring

Researchers

- Cara Cuite et al., Rutgers University (NJ)
- Rachel Hogan Carr et al., Nurture Nature Center (PA)
- Christina Hoven et al., Columbia University (NY)
- Clifford Scherer et al., Cornell University (NY)
- Ricardo Daziano et al., Cornell University (NY)
- Sharon Moran et al., SUNY CESF (NY)
- Jennifer Marlon et al., Yale University (CT)
- John Edwards et al., Mississippi State University (MS)
- Gabrielle Wong-Parodi et al., Carnegie-Mellon University (PA)
- E. Christa Farmer et al., Hofstra University (NY)

CSAP Collaborators

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Program Steering Committee Members

Connecticut

- Brian Thompson, CT Dept. Energy and Environmental Protection, Coastal Zone Management
- Denise Savageau, Conservation Commission, Town of Greenwich
- Robert Thompson, NOAA NWS, Taunton MA

New York

- John Baroni, Nassau County Fire Commission
- Jeffrey Tongue / Nelson Vaz, NOAA NWS, Upton NY

New Jersey

- Michael Oppegaard, Monmouth County Sheriff's Office
- Joseph Miketta, NOAA NWS, Mount Holly NJ
- Buzz Baldanza, Office of Emergency Management, Borough of Oceanport
- Dorina Frizzera, NJ Dept. Environmental Protection, Office of Science

CSAP Collaborators

nancy.balcom@uconn.edu

CSAP website: www.nyseagrant.org/csap