

Societal Response to Hurricanes:

Risk Perception and Forecast Messaging

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TOPICS

- *Why is the final step in forecasting so difficult?*
- *What are the elements of effective warning messages?*
- *What factors influence risk perception?*
- *How can social science improve forecast communication?*

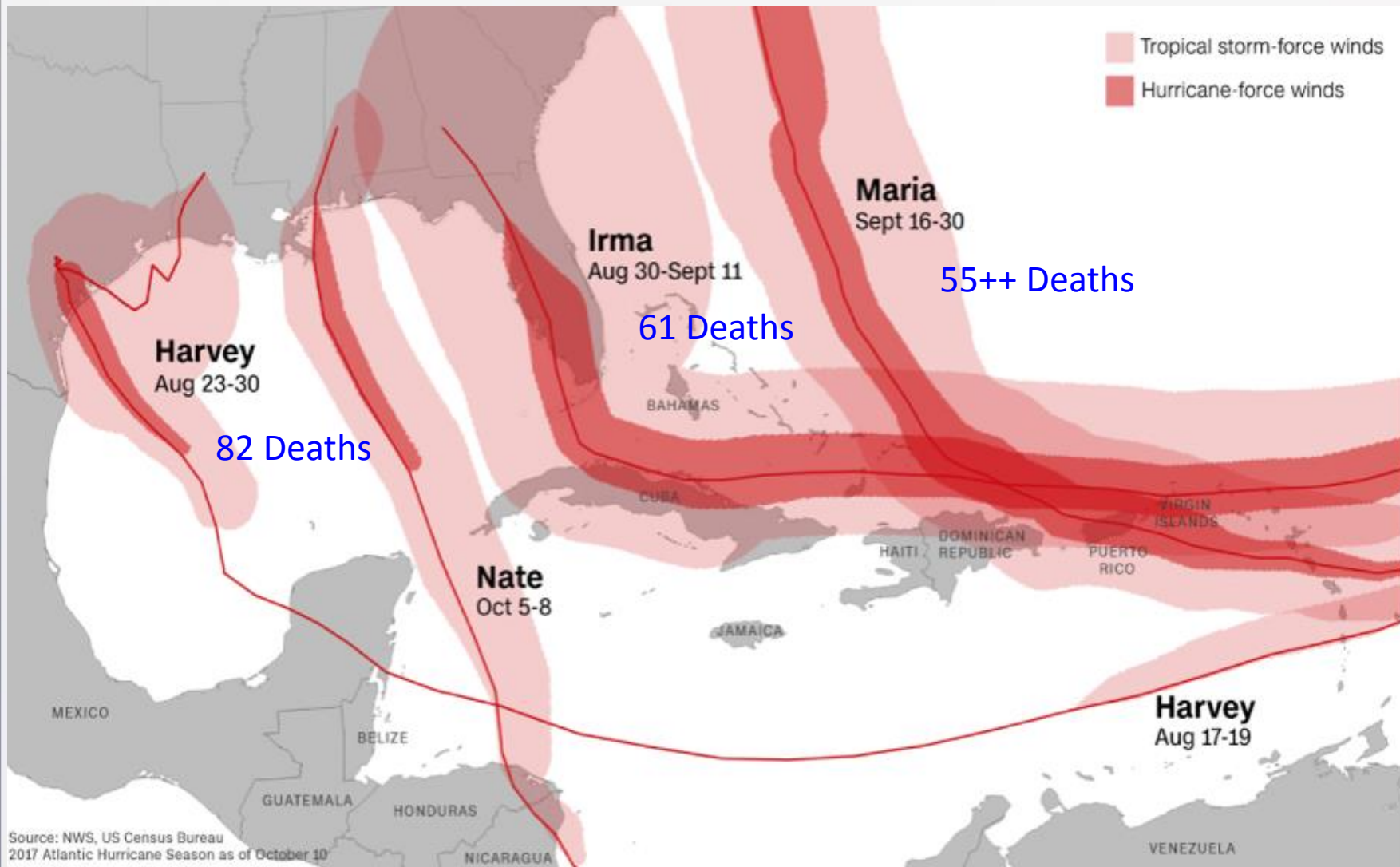


Forecast Accuracy

Earlier,
more accurate
warnings

Better protective actions
available

Yet, people still die



Did these people receive the forecasts?

Did they understand the messages?

Did they know they applied to them?

Did they understand their risk?

“Do people get the message and understand what it means to them? That’s the only question that matters.”

Bryan Norcross Official Blog
04 September 2012

Steps To Effective Warning Response

1

**Understand
Hazard**

2

**Receive and
Understand
Message**

3

**Perceive
Risk**

4

**Believe It
Applies**

5

**Know What
To Do**

RESOURCES?

Appropriate Protective Action

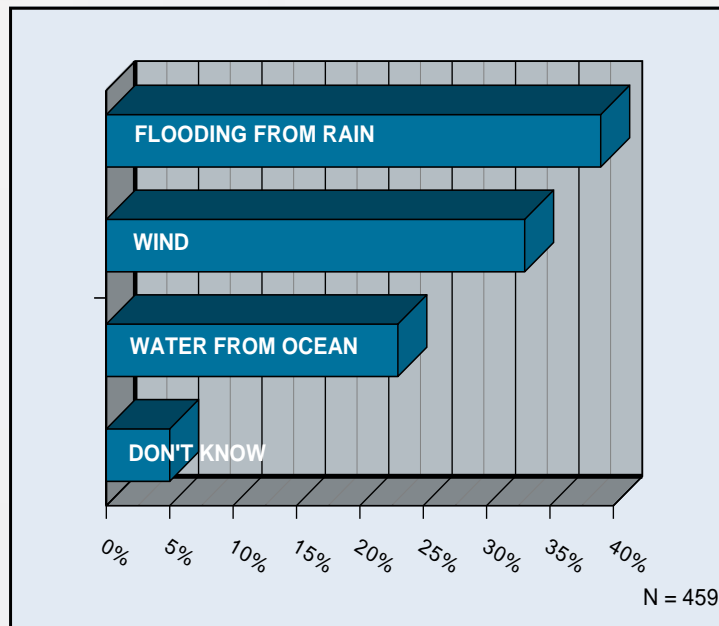
Understand
Hazard

People in your region are most likely to underestimate the potential impacts of which TC hazard?

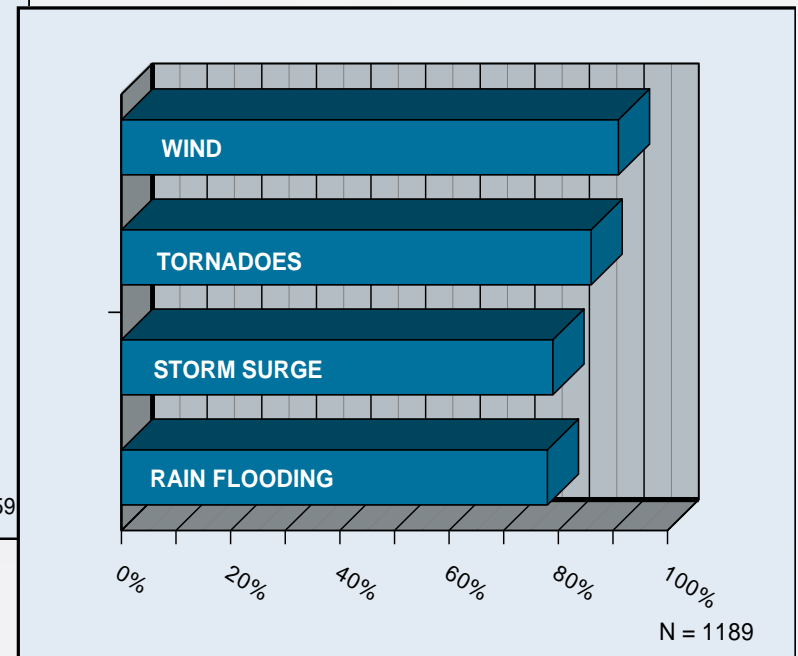
- A. Rain
- B. Wind
- C. Surge
- D. Tornadoes

Understand Hazard

Public Opinion on What Hazard Causes the Most Deaths



Coastal Public On-Line Survey on Tropical and Extratropical Cyclone Forecast Communication Products – Report to NOAA. 2012. Eastern Research Group, Inc.



HFIP-SEIA Storm Surge Panel Survey. "Likelihood of Deaths from Major Hurricane" NCAR 2010. Lazo, Jeffrey.

1

Understand Hazard

“Slow Rising Water”?

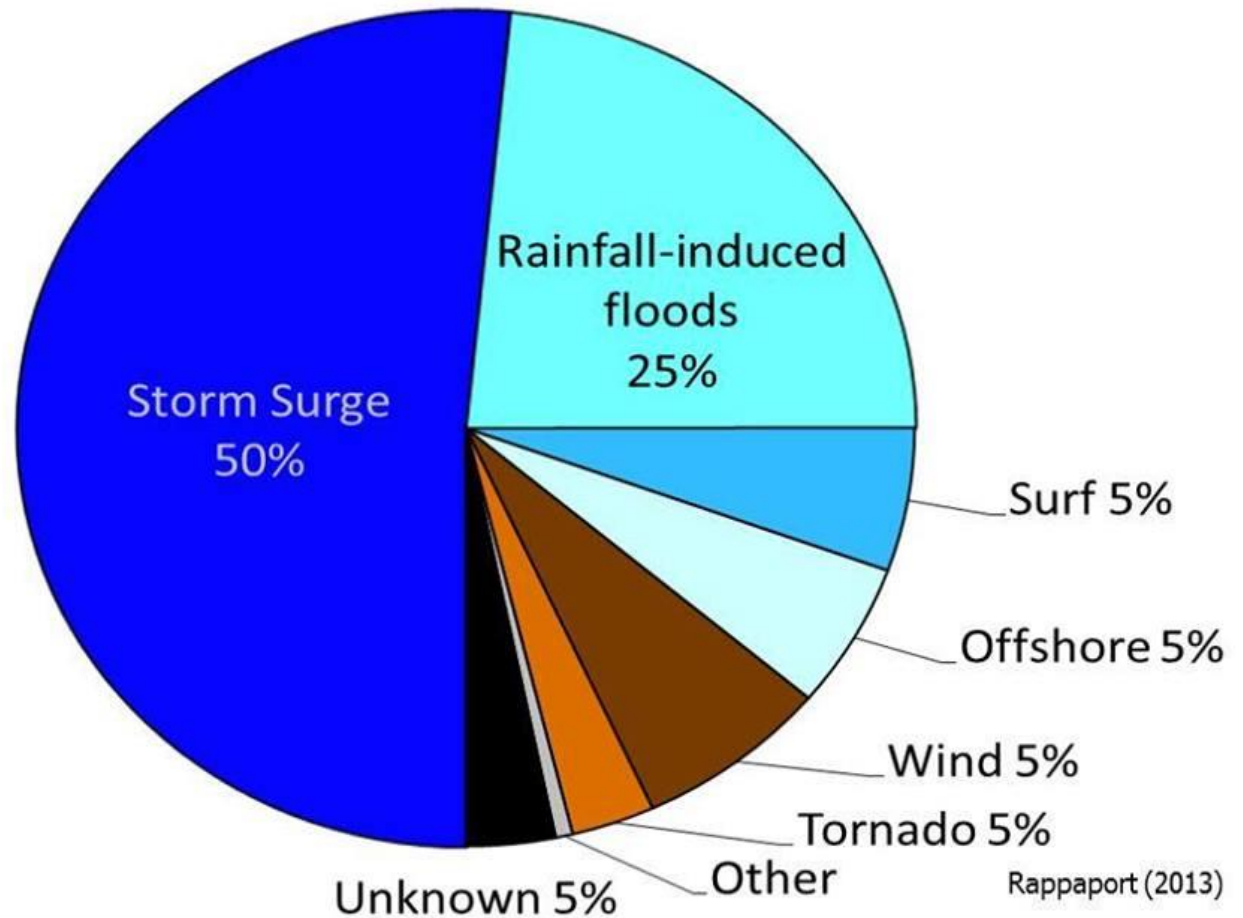


UltimateChase.com

“I’ll leave if it starts to get bad.”

Understand Hazard

U.S. Tropical Cyclone Deaths, 1962-2011



Rappaport, Edward N. 2014. Fatalities in the United States From Atlantic Tropical Cyclones. *Bulletin of the American Meteorological Society*, March.

Understand Hazard

Misunderstanding of Storm Surge by Coastal Residents

Incorrect Statement	Somewhat or Completely Agree
Surge only affects within one mile of coast	25%
Storm category refers to wind and surge	41%
Surge caused by rain	20%
Surge and tsunamis are same	17%

Lazo, Jeffrey. 2010. *HFIP-SEIA Storm Surge Panel Survey*. NCAR. N = 1121-1168

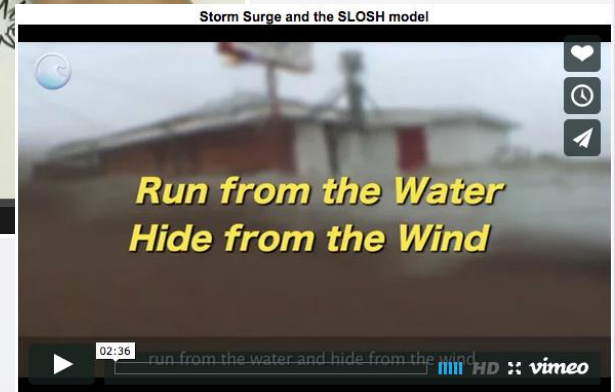
SURGE EDUCATIONAL RESOURCES

<https://www.nhc.noaa.gov/surge>

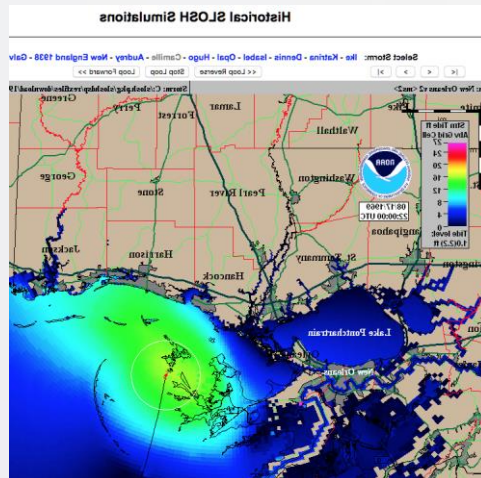
ANIMATIONS



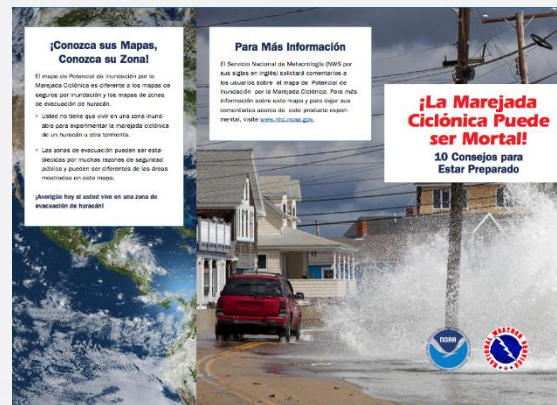
VIDEOS



HISTORICAL SLOSH RUNS



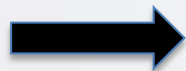
TIP SHEETS



1

Understand Hazard

POTENTIAL
IMPACTS
FROM EACH
HAZARD
WILL BE PART
OF PLANNED
INTERACTIVE
WEBSITE



NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

[HOME](#)
[FORECAST](#)
[PAST WEATHER](#)
[WEATHER SAFETY](#)
[INFORMATION CENTER](#)
[NEWS](#)
[SEARCH](#)
[ABOUT](#)

Hurricane Threats and Impacts

The Hurricane Threats and Impacts web site is an internet-based decision-support service consisting of at least four informational elements: high wind impacts, storm surge impacts, inland flooding impacts, and tornado impacts. During the Atlantic & Caribbean Hurricane Season, the information will be generated and posted by 23 coastal WFOs whenever tropical cyclone watches and/or warnings are in effect for their area.

For more information, visit the [National Hurricane Center](#) website.

[Local Forecast](#)
[Local Statements](#)
[Local Threats/Potential Impacts](#)
[Local Threat Meter](#)

THREAT LEVEL
NONE
ELEVATED
MODERATE
HIGH
EXTREME

Wind

Point Forecast: Miami - South Florida (25 Miles W Florida City FL) Lat: 25.5 Lon: -80.88 Elevation: 3 ft.

Local Threat Meter - Wind (Neighborhood)

Storm Local Threat Assessment

Wind

Storm Surge

Flooding Rain

Tornadoes

US Dept of Commerce
National Oceanic and Atmospheric Administration
National Weather Service

Disclaimer
Information Quality
Help
Glossary

Privacy Policy
Freedom of Information Act (FOIA)
About Us
Career Opportunities

Receive and
Understand
Message

Receiving was more of a problem in the past

Galveston Hurricane - 1900



8000 Deaths

Receive and
Understand
Message

*Where do you think most
people in your region FIRST
hear about a TC threat?*

- A. TV
- B. Radio
- C. Cable or national TV
- D. Smart phones
- E. Social contacts
- F. Other

Receive and
Understand
Message

*Where do you think most people in your region get **MOST** of their TC forecast information?*

- A. TV
- B. Radio
- C. Cable or national TV
- D. Smart phones
- E. Social contacts
- F. Other

Receive and Understand Message

SOURCE	PERCENT
Local Radio	41
Cable or Satellite TV	24
Local TV	20
Internet	6
The Weather Channel	1
NOAA Weather Radio	1
Friends or Family	1
Other	5

Morrow and Gladwin. 2014. *Puerto Rico Hurricane Evacuation Study Behavioral Analysis*. Through Dewberry for FEMA and USACE.

Information Sources Used Great Deal During Sandy:

- 62% local TV
- 53% national TV
- 48% The Weather Channel
- 29% local radio
- 21% Internet
- 8% social media
- 8% NOAA radio

Gladwin and Morrow . 2013. Communication and Understanding of Hurricane Sandy Forecast and Warning Information. National Science Foundation #1322088.



Receive and
Understand
Message

Understand?

- Tropical cyclone
- Tropical vs. Extratropical
- Convective structure
- Wind radii
- Global models, model consensus
- Barometric pressure

Interpreted by broadcast mets, local WFOs, officials

What about those received by internet or social media?

Understand?

**Table 14. Respondents Correctly Defining Watches and Warnings
(Percent)**

	Louisiana	Alabama	Mississippi	Florida Panhandle	Florida Keys	Total
Hurricane Watch	63	63	64	60	70	62
Hurricane Warning	40	35	43	40	41	40

Gladwin, H. and B. H. Morrow 2005. *Hurricane Ivan Behavioral Study*. Submitted through Dewberry & Davis to FEMA and USACE.

Receive and
Understand
Message

Some Implications:

- Multiple channels of communication, including radio
- Simple language and messages with suggestions/links to more in-depth information
- Self-explanatory graphics and maps

Some Research Findings on Risk Perception :

- Socially constructed out of past experiences (mental models)
- Strong social component
- Affected by cultural differences in attitudes toward risk
- Affected by experience, but with diminishing effects
- Lots of “false” experience

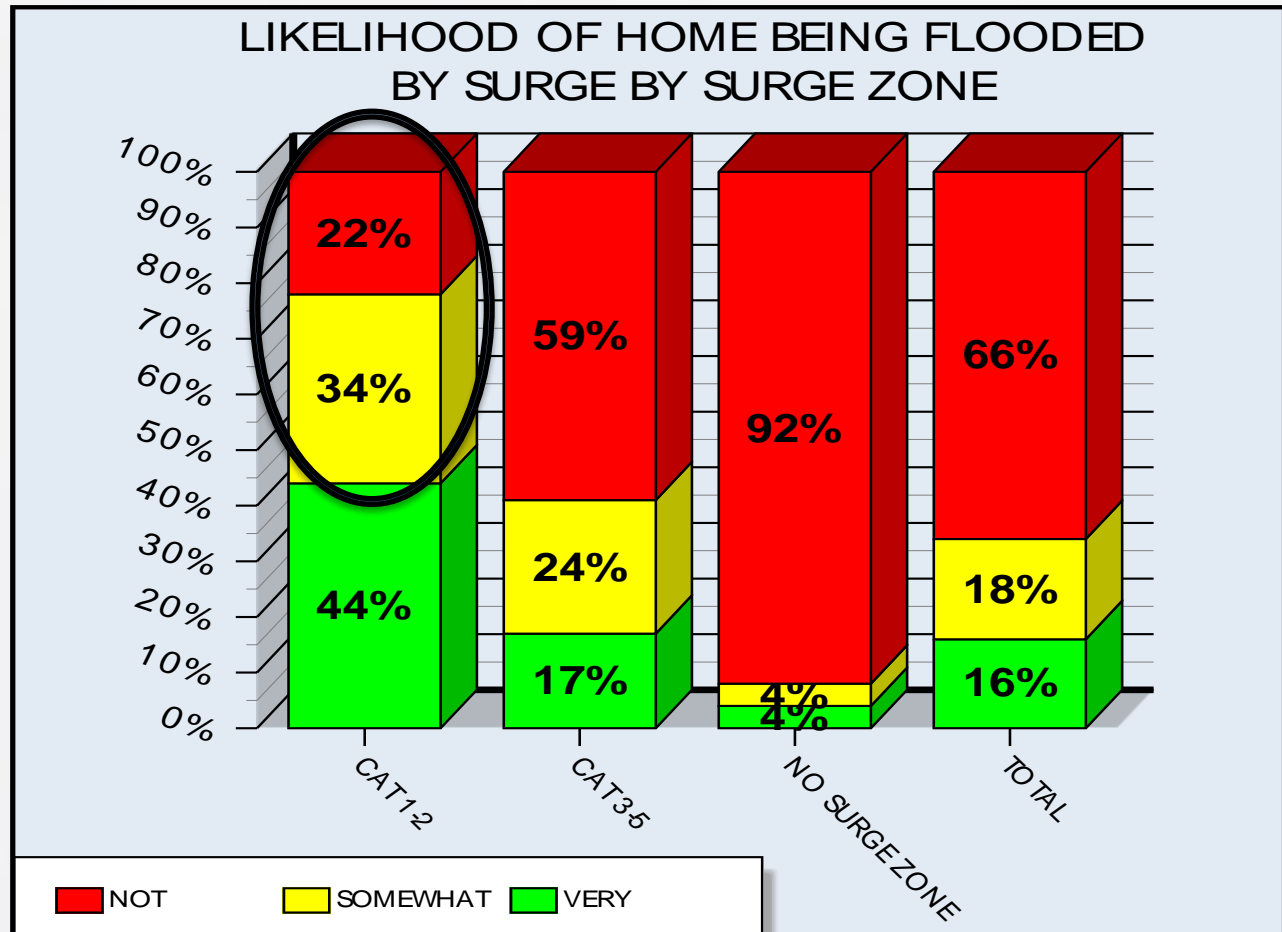
Perceive
Risk

Which factor do you think MOST influences whether people think they need to take protective action?

- A. Strength of the wind (Category)
- B. Size of the storm
- C. Potential storm surge
- D. Location of their home in relation to track
- E. Characteristics of their home (shutters, etc.)
- F. Their estimate of the probability it will happen
- G. How much of a chance they're willing to take

Perceive Risk

Do people understand their exposure?

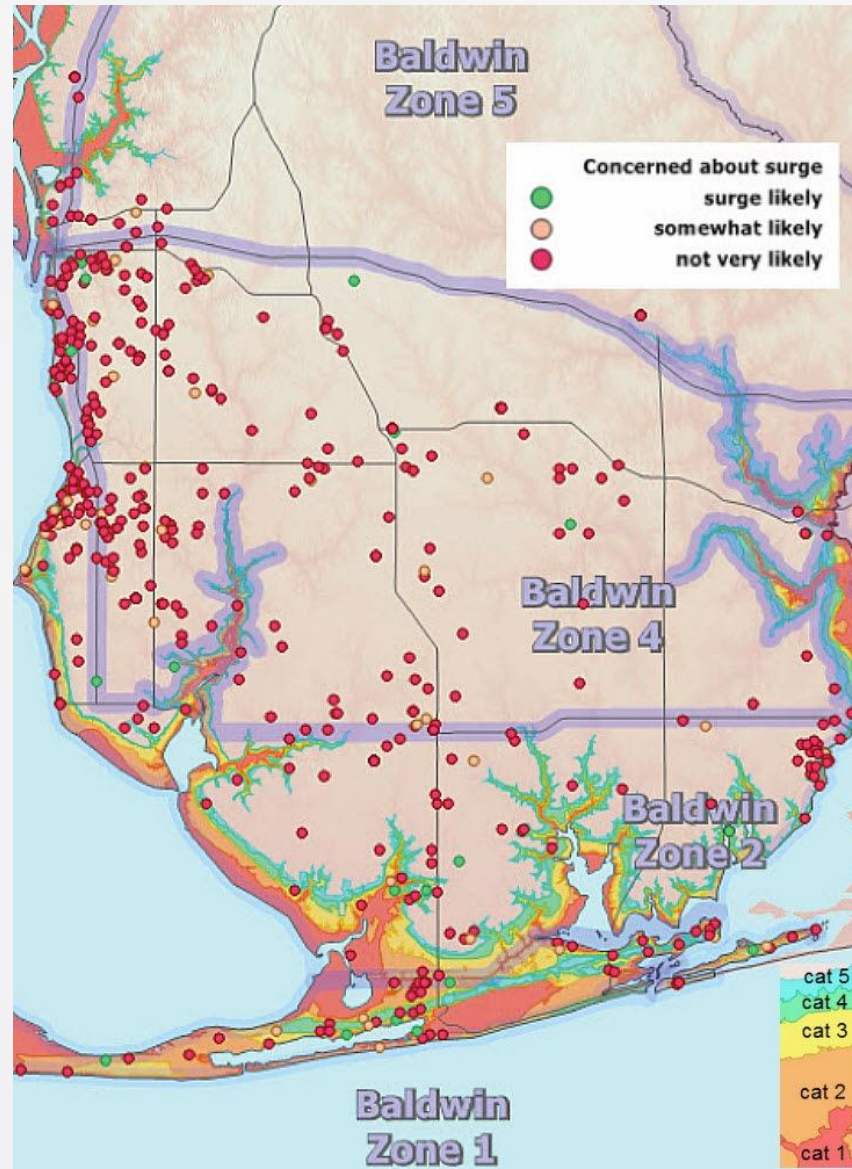


Mississippi Behavioral Analysis. 2011. Morrow & Gladwin through Dewberry for FEMA and USACE

3

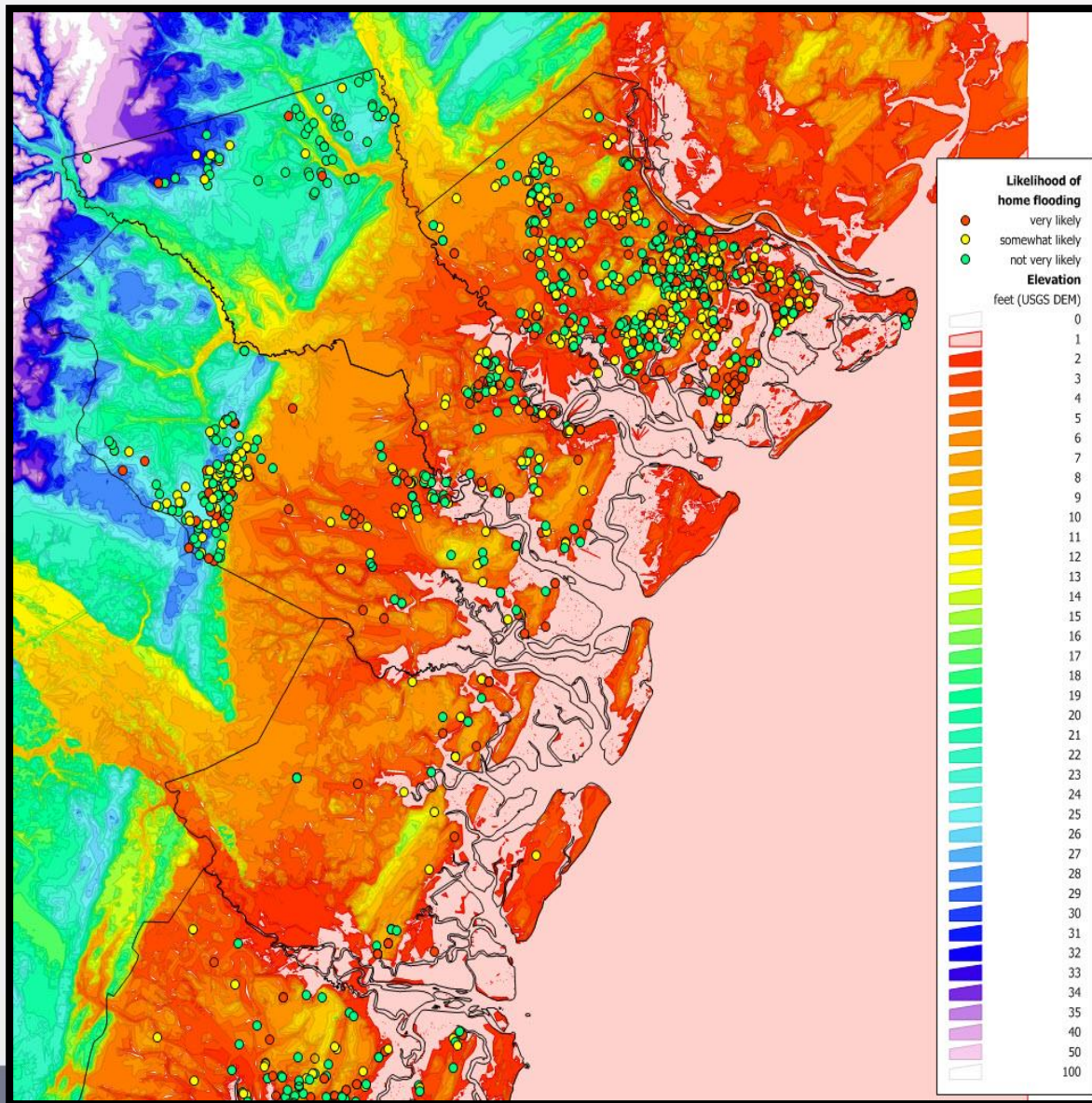
Do people understand their exposure?

Perceive
Risk






Alabama Behavioral
Analysis for
*Hurricane
Evacuation Study.*
2011. Morrow &
Gladwin through
Dewberry for FEMA
and USACE.

Do people understand their exposure?

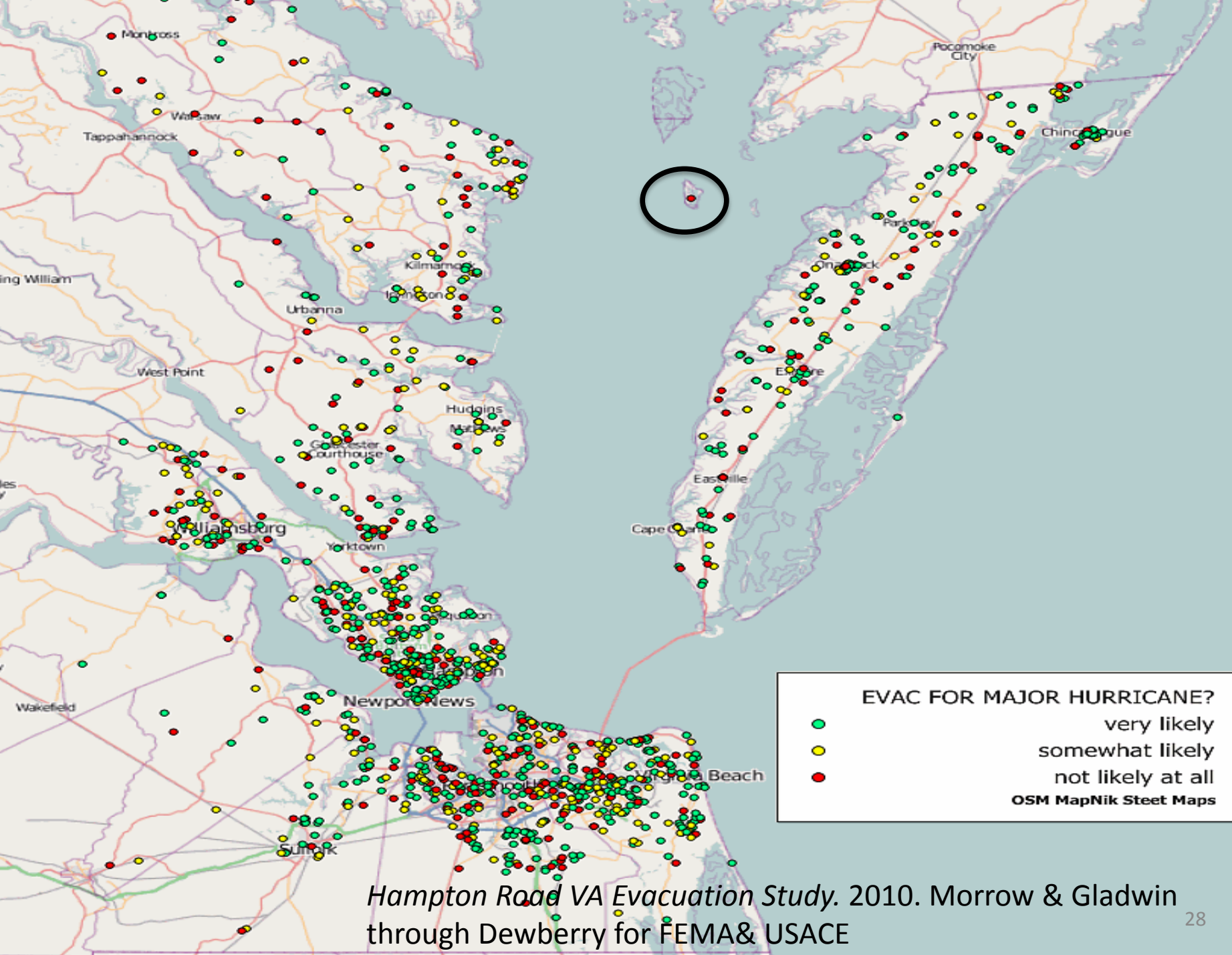


Likelihood Would Be Flooded in Major Hurricane:

-  Not Very Likely
-  Somewhat Likely
-  Very Likely

Each dot = one interview

Coastal Georgia Evacuation Study. 2010. Morrow & Gladwin through Dewberry. 2009 for FEMA and USACE.



Perceive
Risk

Vulnerability can be increased by:

- Rapid population growth
- Poverty
- Lack of access to adequate land
- Lack of access to safe housing
- Deforestation
- Urbanization
- Tourism
- Cultural beliefs

Perceive
Risk

*Do you think the public
understands forecast
probability?*

- A. Not at all
- B. Sometimes
- C. Usually
- D. Most of the time

**Perceive
Risk**

Some findings related to communicating forecast uncertainty

- Public is used to uncertainty in rainfall forecasts
- People infer uncertainty from deterministic forecasts
- More likely to reduce exposure when uncertainty information provided
- Broadcast mets are in unique position to explain level of uncertainty
- More research needed on the best ways to express TC forecast uncertainty especially in web and social media

Perceive
Risk

Low Probability, High Impact Events Are Challenging

Compare:

- A. 10% chance of precipitation
- B. 10% chance of TC winds
- C. 10% of life-threatening surge

What are some examples of people taking protective actions against low probability events?

Perceive
Risk

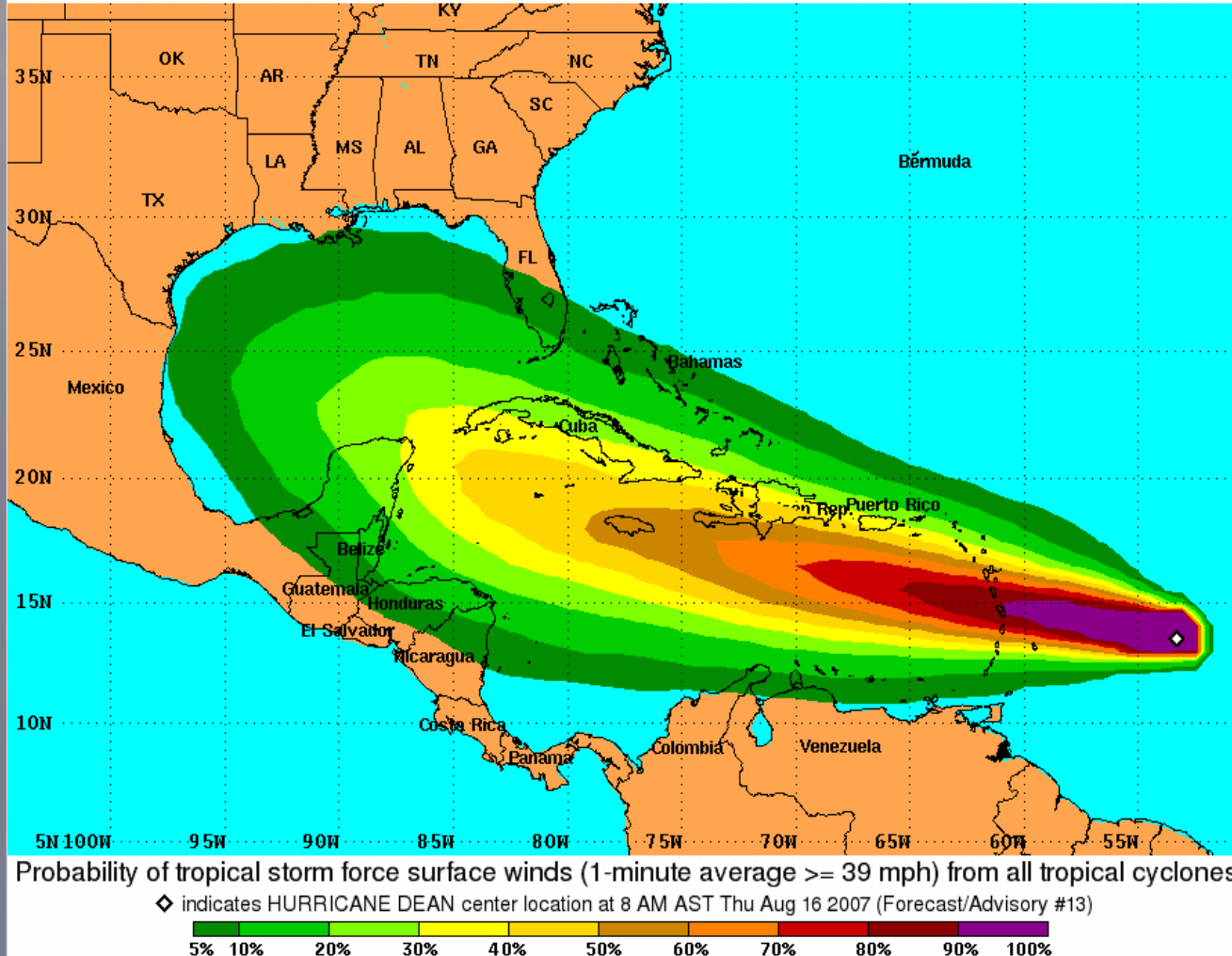
What is the best way to distinguish between a POSSIBLE vs. EXPECTED event?

- A. Warning, Urgent Warning
- B. Watch, Warning
- C. Alert, Warning
- D. Other



Tropical Storm Force Wind Speed Probabilities

For the 120 hours (5 days) from 8 AM AST Thu Aug 16 to 8 AM AST Tue Aug 21



73% EMs said they Always or Frequently use this map

Eastern Research Group for NOAA. 2016. Survey of Coastal Emergency Managers and Media.

Perceive
Risk

PERSONAL FACTORS

Individual Differences in Risk Taking

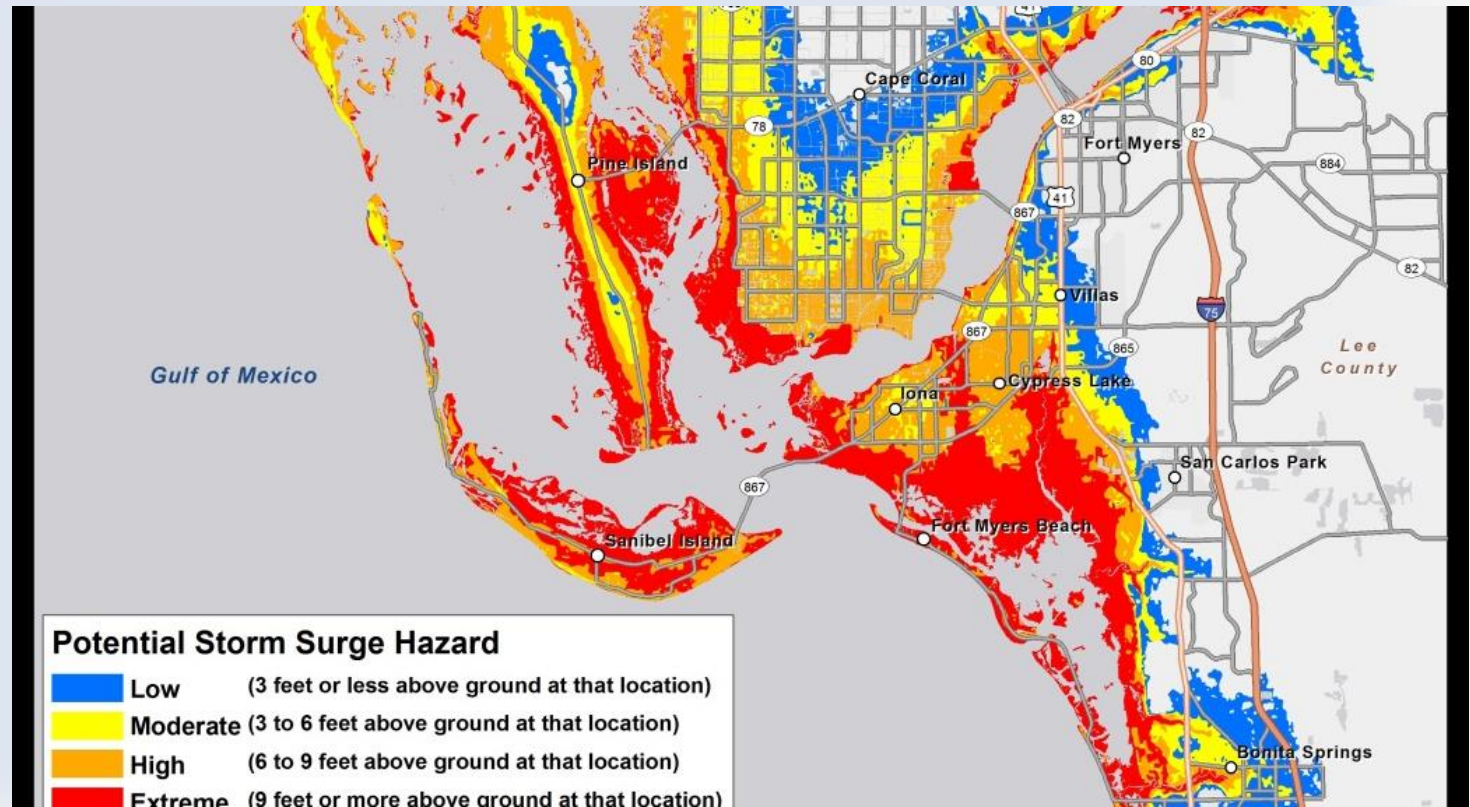
- Personality?
 - Impulsive sensation seeking
 - Aggression
- Biological traits?
 - Sensation seeking
 - (dopamine receptor gene)
- Age Differences
- Gender Differences



Believe It
Applies to
Them

Personalizing the Hazard

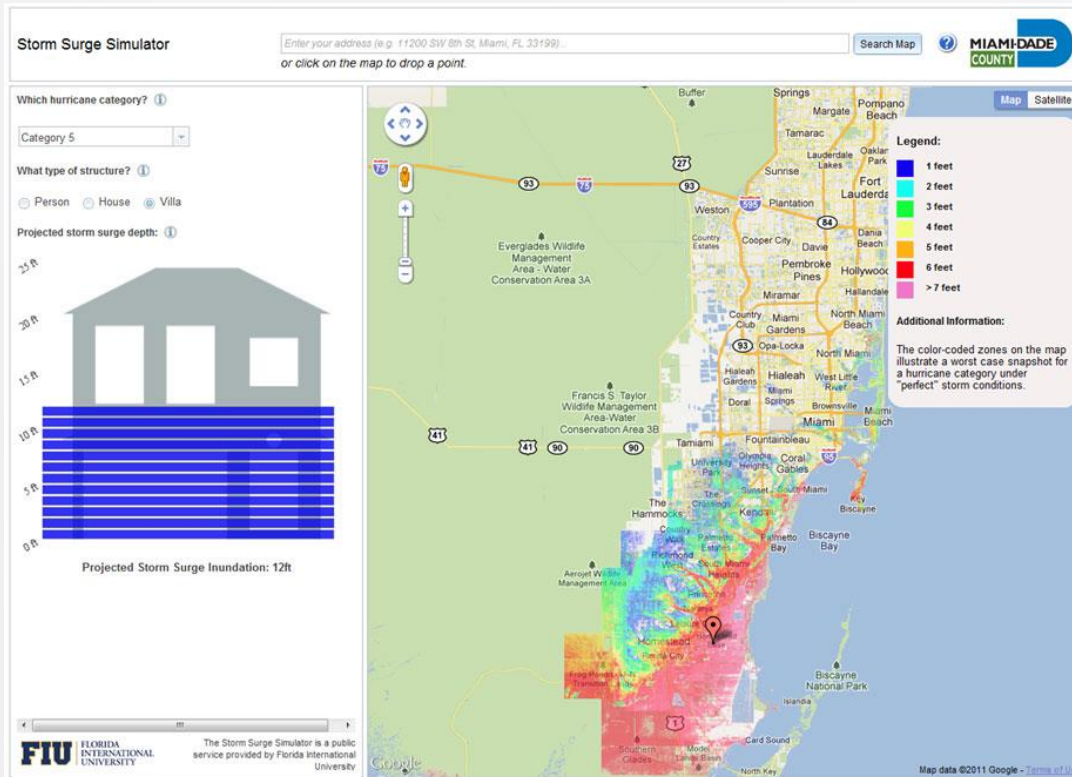
Relationship between forecast and their location needs to be clear



Personalizing the Hazard



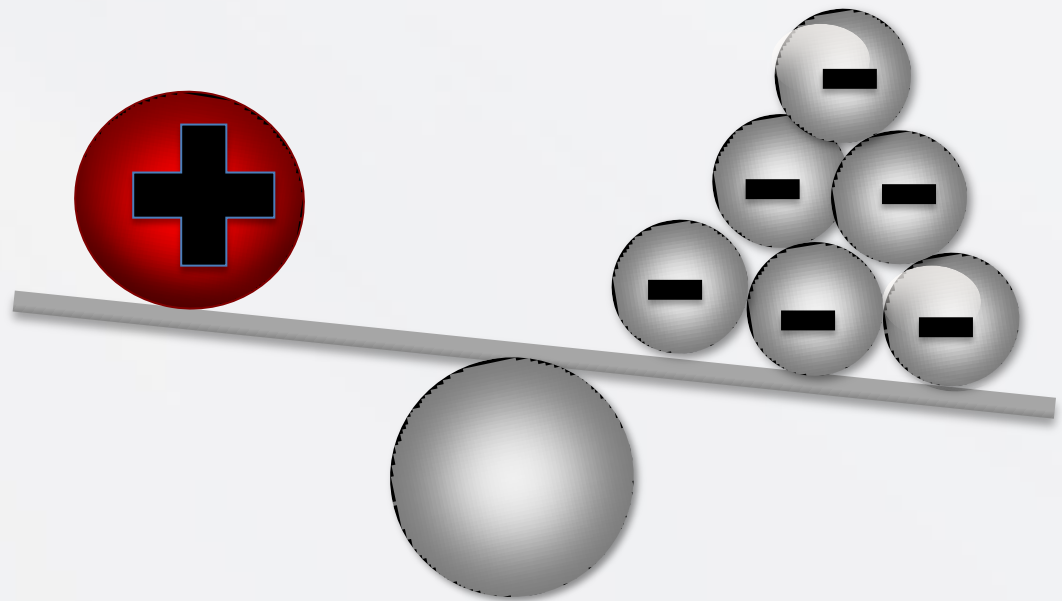
Personalizing the Hazard



A Little Bit of Psychology

DO I REALLY NEED TO LEAVE?

Must evoke strong FEELINGS
to overcome the reasons NOT
to leave



Complexities of Personal Safety Decisionmaking

MIND MAP OF A SURGE ZONE RESIDENT

COGNITIVE

KNOWLEDGE
EXPERIENCE

World View
Personality Traits
Mental Models

Sees world as safe or scary
Self efficacy
"Surge is like a flood."

SOCIAL

Relationships
Interactions
Networks
*"What are they
going to do?"*

Evacuate?

AFFECTIVE

FEELINGS ABOUT:

Hurricanes
Forecasts
Home safety
Travel, Etc.
RISK

5

Know What
To Do



Policy Question:

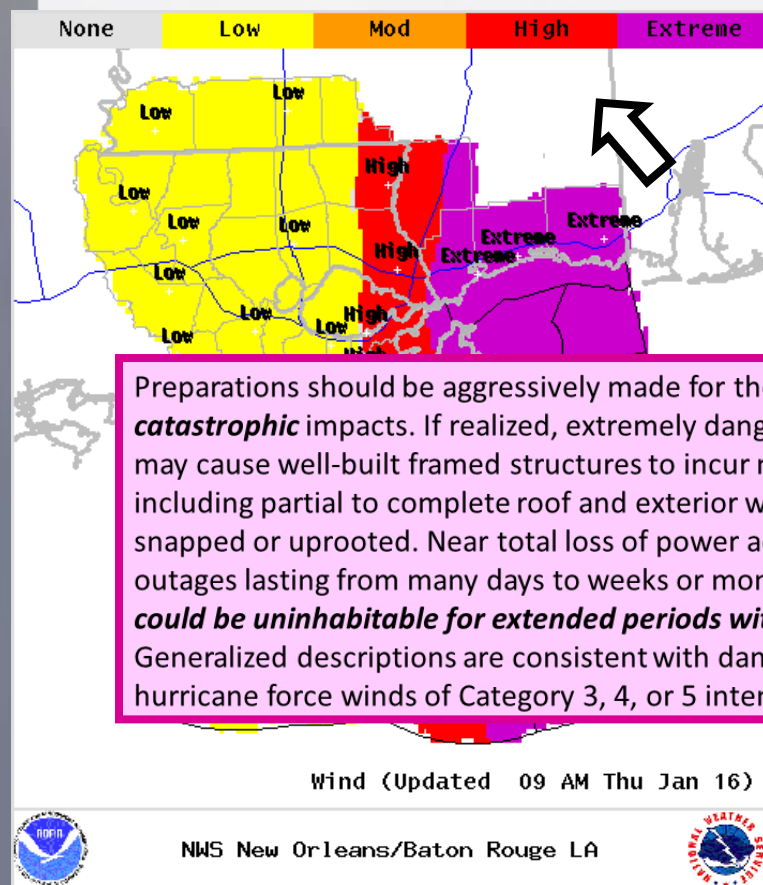
Who should be responsible for advising the public about protective actions?

**Know What
To Do**

Do you agree that weather service forecasters should include Protective Action recommendations to citizens as part of their TC forecasts?

- A.Strongly agree
- B.Somewhat agree
- C.Somewhat disagree
- D.Not sure

Example of Proposed NWS Local Impacts and Actions Product



Threat	Potential Impacts to Communities
Extreme	Prepare for the potential of devastating to catastrophic impacts from major hurricane force wind.
High	Prepare for the potential of extensive impacts from hurricane force wind.
Mod	Prepare for the potential of significant impacts from strong tropical storm force wind.
Low	Prepare for the potential of limited impacts from tropical storm force wind.
None	No preparations needed at this time; little to no impacts as wind should remain below tropical storm force.

RESOURCES?

Hurricane Katrina - 2005



Good Forecast
56 hours before landfall

Some Wanted To Leave But Couldn't

- Insufficient resources
 - Transportation
 - Cash for gas
 - No place to go

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Applies**

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**Know What
To Do**

RESOURCES?

Appropriate Protective Action

Social scientists are your friends!

Do people understand TC hazards, such as surge?

Do they understand forecast messages?

Do they understand uncertainty and probabilities?

How do they react to various text and colors?

What factors are associated with risk perception?

Do they recognize their vulnerability?

How much confidence do they have in forecast?

Do they know what the potential impacts and what protective actions to take?

One Social Science Research Model



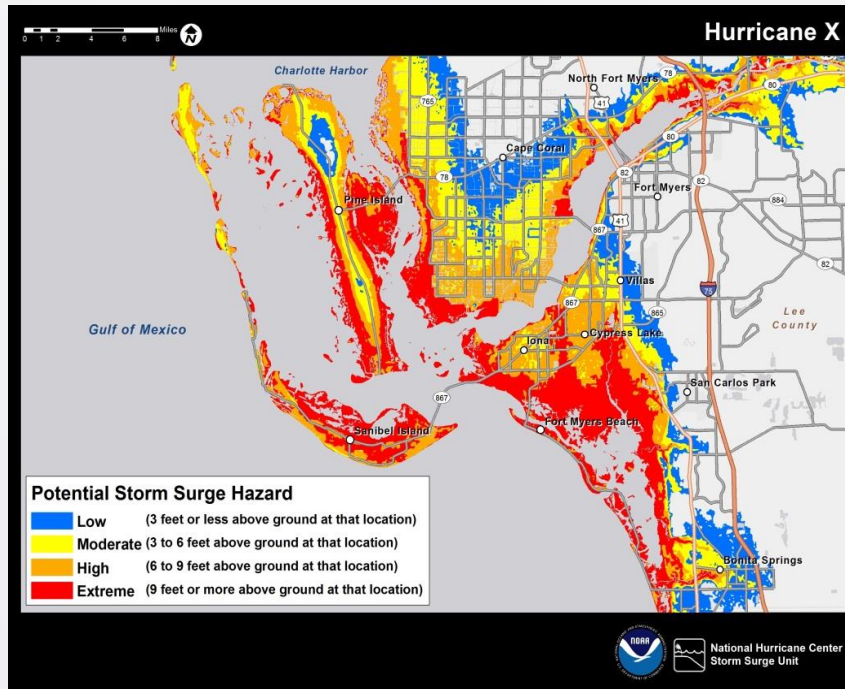
PRODUCTS:

**STORM SURGE
FLOODING MAP**

**STORM SURGE
WARNING**

Work completed through
Eastern Research Group
& National Center for
Atmospheric Research
and funded by HFIP and
NOS Surge Roadmap.

Storm Surge Map Survey Results



- Preference for this map over solid blue one or graduated blue one
- Problems with using “low” to describe storm surge hazard

Positive Ratings*

- Ease of understanding

- 96% by Media
- 86% by EMs
- 77% by Public
- 90% by WCMs

- Usefulness

- 94% by Media
- 84% by EMs
- 98% by Public
- 83% by WCMs

* Excellent, Very Good or Good

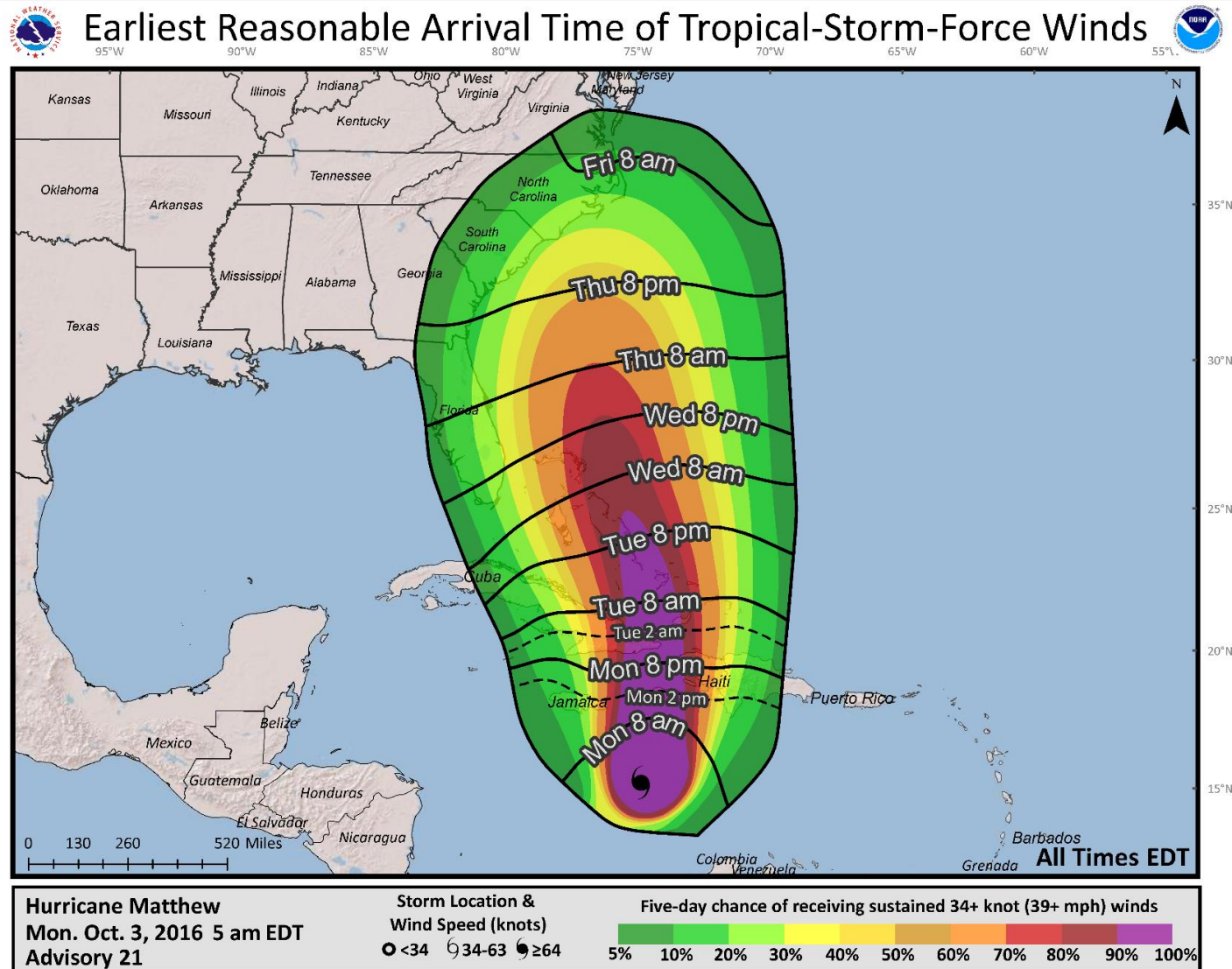
Note: Some indication that people pay more attention to legends when at lower left

Other Surge-Related Findings

- Use Above Ground Level datum
 - Describe how derived and what it includes
- Refer to HEIGHT, not depth, when describing levels
 - “1 to 3 feet high”



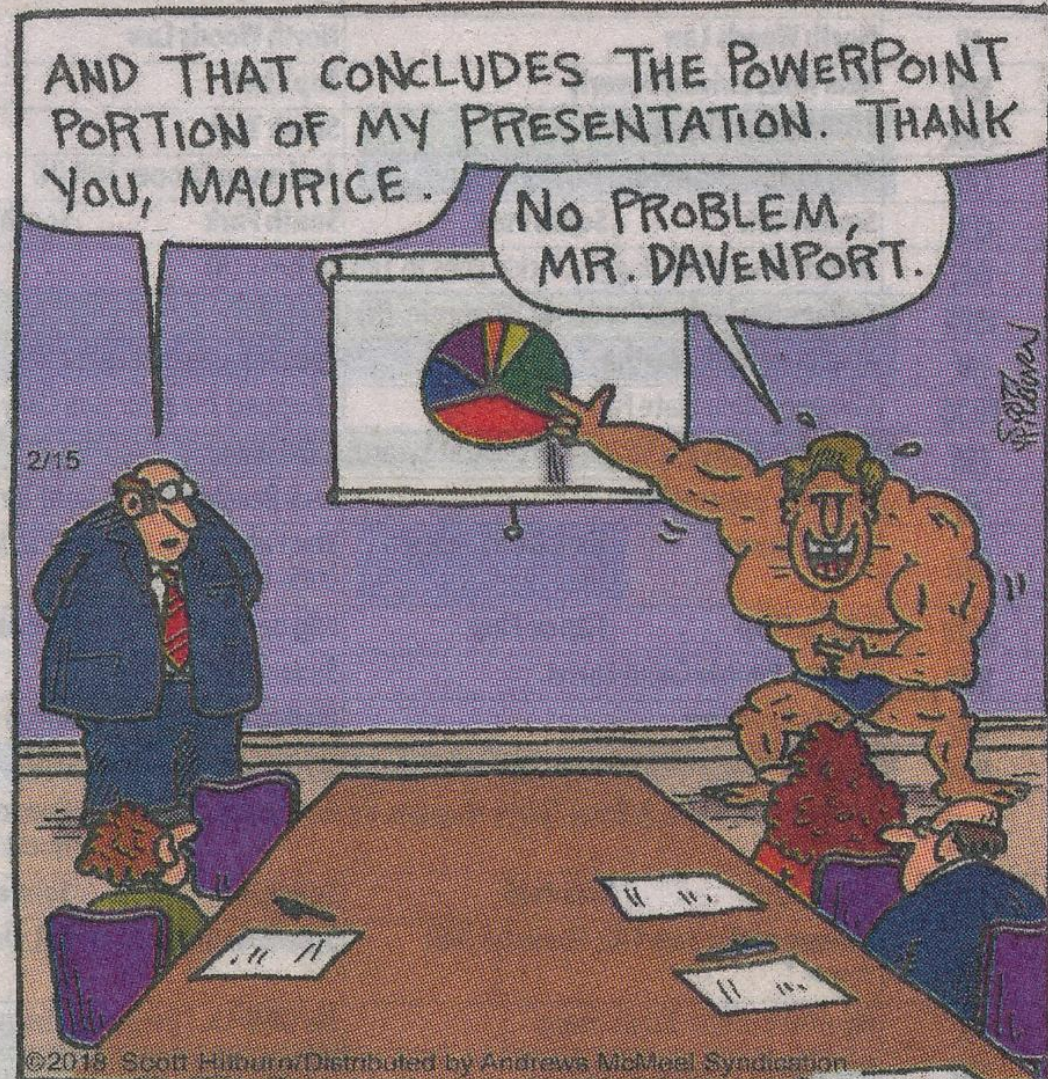
Another Product Under Development Using Social Science



Bottom Line:

- Risk perception and response is very complex
- Forecast only as good as the extent to which it results in appropriate response
- Only scientific way to know how stakeholders interpret and use is to test messages
- Ideal model is an iterative testing process using rigorous social science methodologies during message development with periodic retesting

THE ARGYLE SWEATER



Comments or Questions?

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