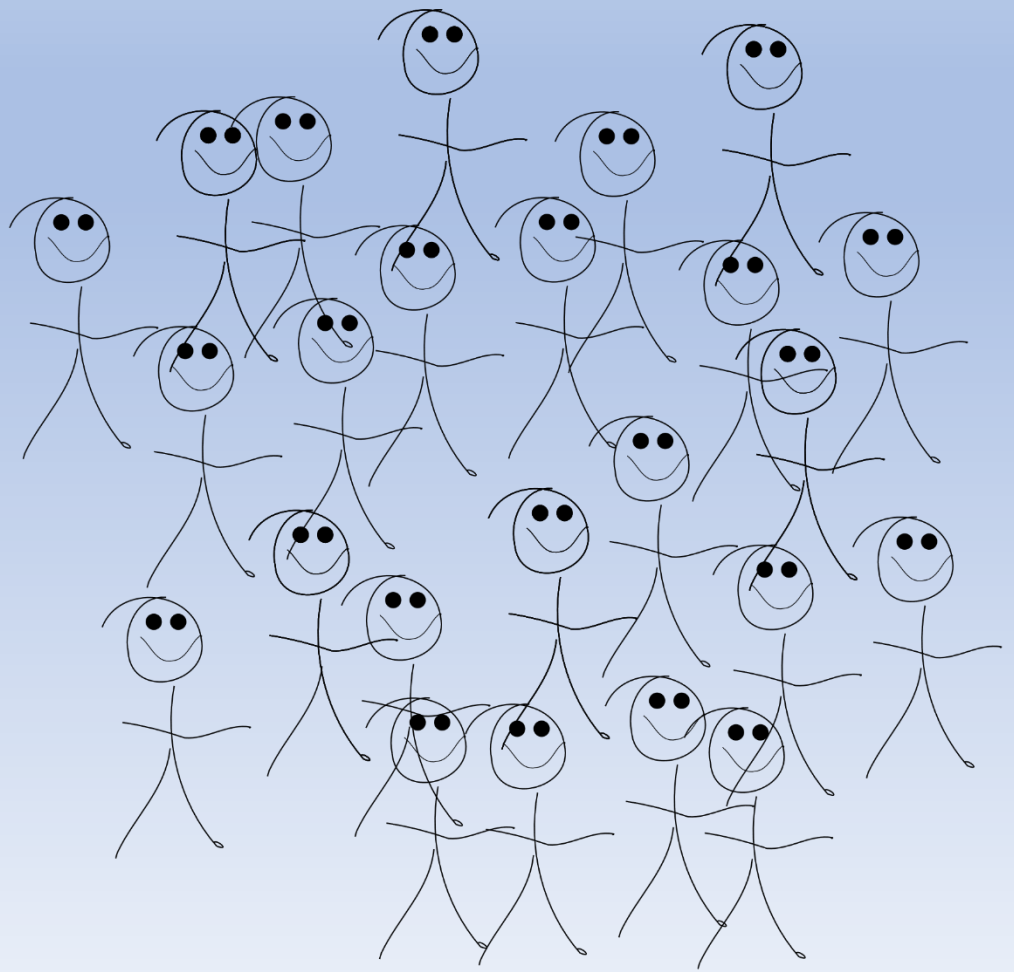
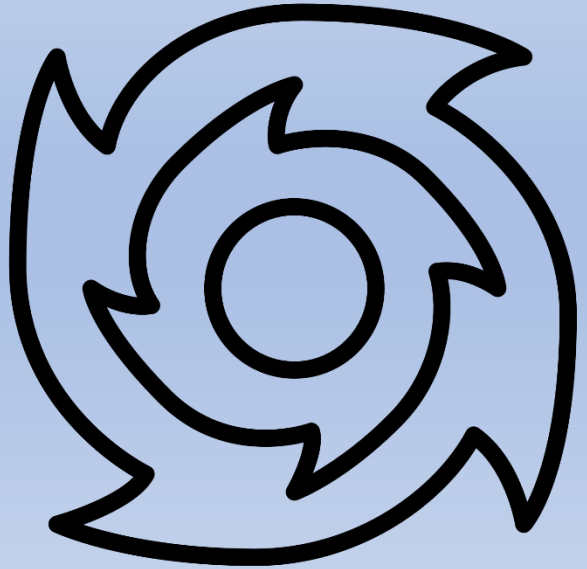
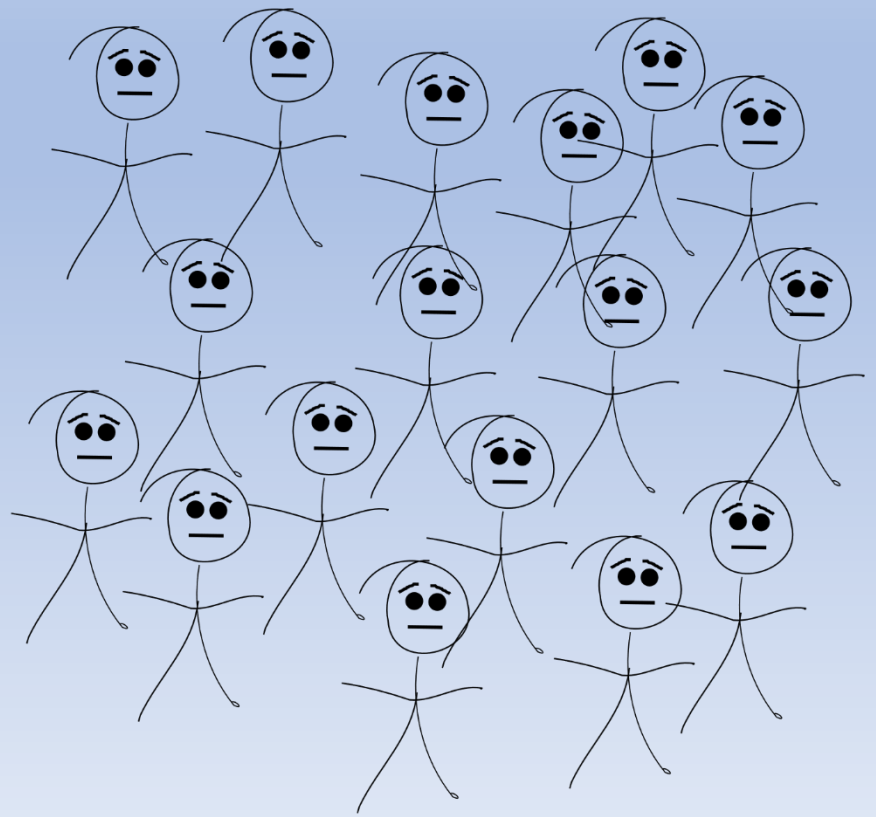
Can forecasters learn from the results of social science research on how people make decisions based on their forecasts?

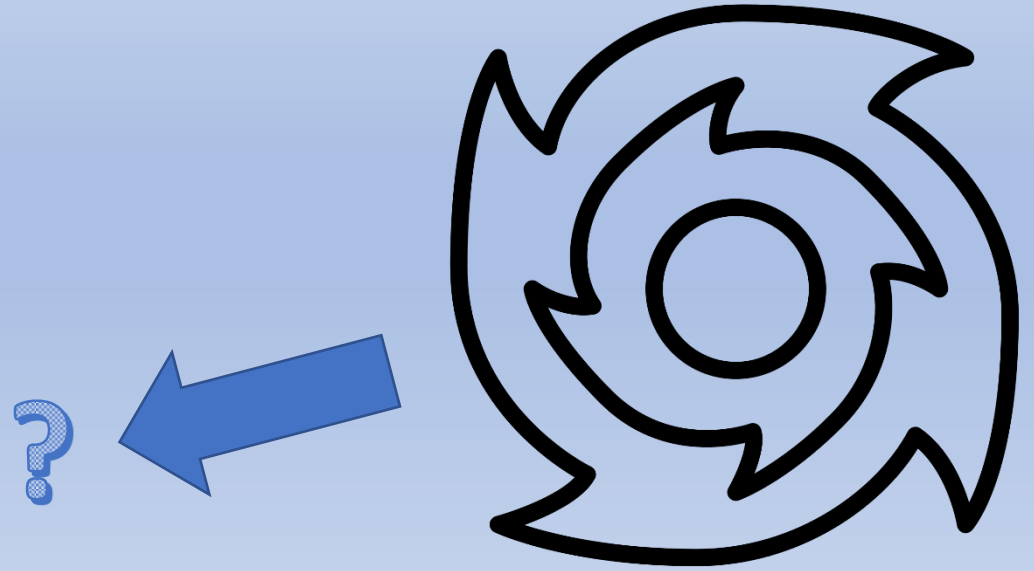
We hope the answer is “yes” because there is a large and diverse society of people making decisions in the face of an approaching cyclone.

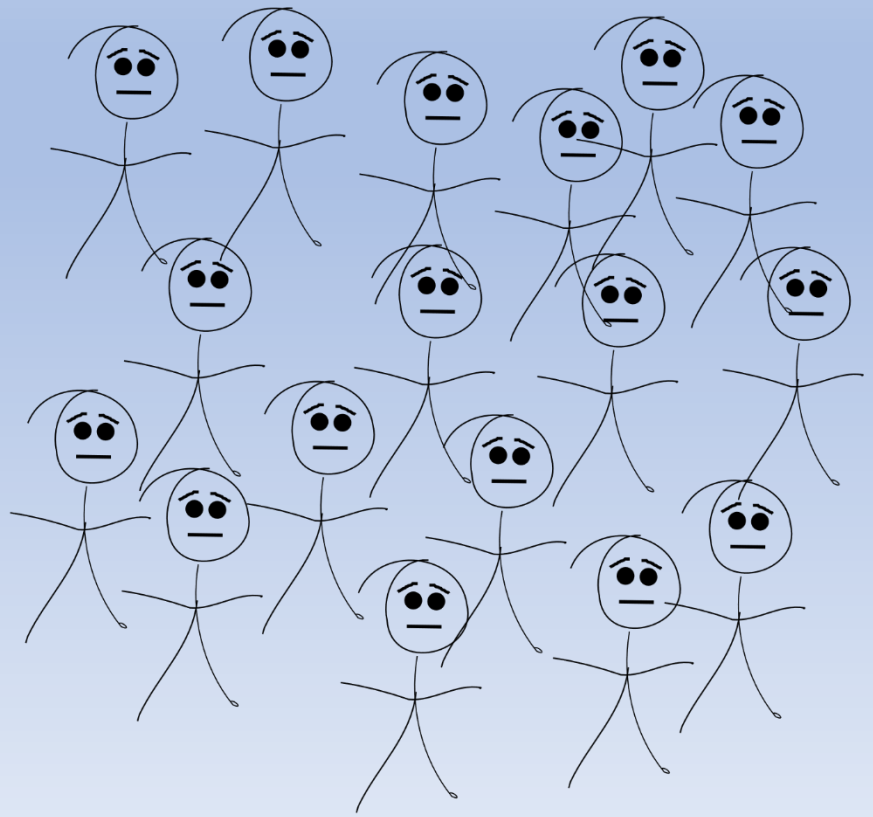


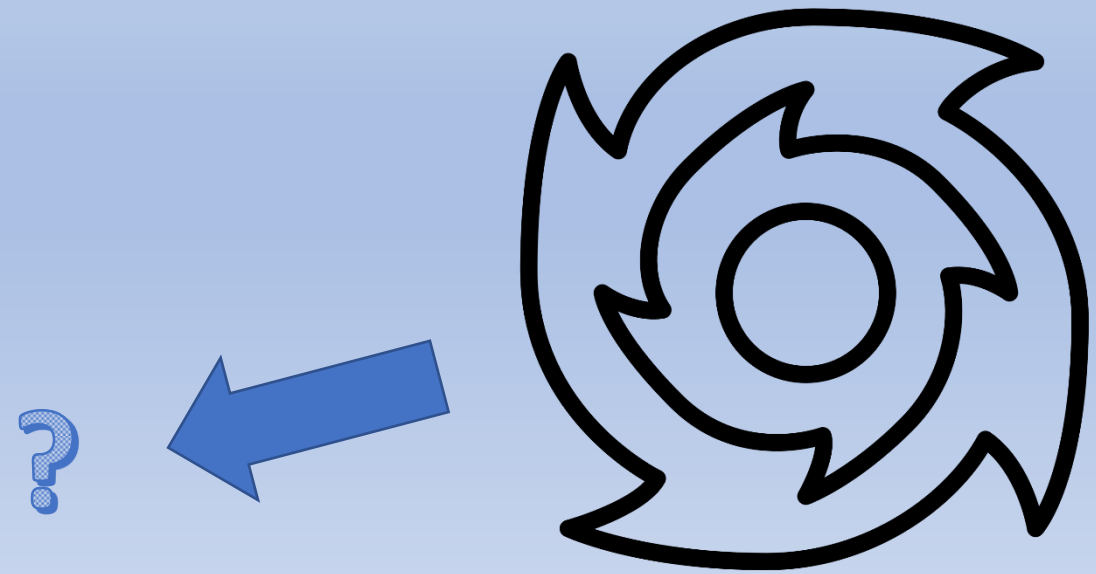


Hugh Gladwin gladwin@fiu.edu







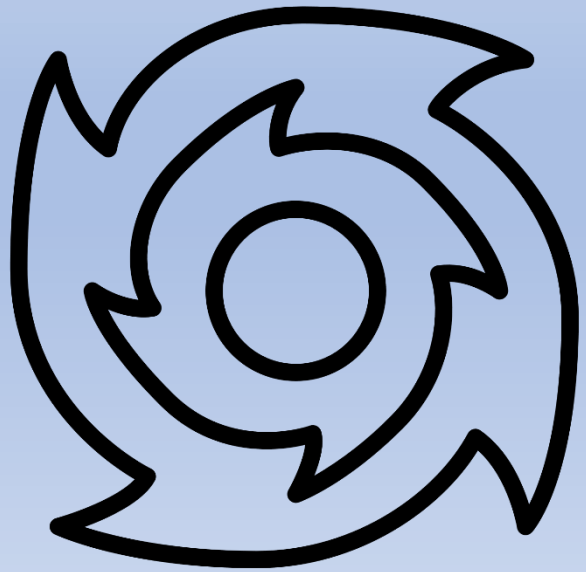


Who are the people relying on the forecast to make decisions?

Evacuating my property will be very expensive – do I have to evacuate?

Home should be safe from storm surge and probably wind—can I shelter in place ?

Home is low elevation near water and/or vulnerable to wind damage



Who are the people relying on the forecast to make decisions?

• Emergency managers
• Communications media – TV, radio, etc.
• People in business and government making decisions that have major financial consequences depending on what the hurricane does.
• Different groups of people at risk of death or loss of livelihood from the hurricane:
  ○ People at risk but relatively safe from surge and wind if they shelter in their homes
  ○ People at risk from storm surge or wind destruction if they stay in their homes
• Many other groups and institutions in addition to the above
	• Gerentes de emergencias
	• Medios de comunicación - TV, radio, etc.
	• Las personas en los negocios y el gobierno toman decisiones que tienen importantes consecuencias financieras dependiendo de lo que haga el huracán.
	• Diferentes grupos de personas en riesgo de muerte o pérdida del sustento debido al huracán:
	  ○ Personas en riesgo, pero relativamente seguras contra marejadas y vientos si se refugian en sus hogares.
	  ○ Personas en riesgo de marejada ciclónica o destrucción del viento si se quedan en sus hogares.
	• Muchos otros grupos e instituciones además de los anteriores.

These are different groups of people who depend on hurricane forecasts

Each of these groups needs different kinds of information over time as it becomes clearer where a hurricane will go and what impacts it will have.

Estos son diferentes grupos de personas que dependen de los pronósticos de huracanes.

Cada uno de estos grupos necesita diferentes tipos de información a lo largo del tiempo a medida que se aclare dónde irá un huracán y qué impactos tendrá.

Can forecasters learn from the results of social science research about how people make decisions based on their forecasts? About the kind of information different groups of people need?

What research has been done on this?

Many studies of behavior in response to hurricanes have been done since 1994. I will be mainly talking about what has been learned from relatively large sample (1000+ respondents) studies done following these hurricanes: Andrew 1994, Ivan 2004, Katrina 2006, Ike 2008, and Sandy 2012. Also FEMA hurricane evacuation studies

These studies employed extensive qualitative research leading to quantitative telephone surveys.

¿Pueden los meteorólogos aprender de los resultados de la investigación en ciencias sociales acerca de cómo las personas toman decisiones en función de sus pronósticos? ¿Sobre el tipo de información que necesitan los diferentes grupos de personas?

¿Qué investigación se ha hecho sobre esto?

Muchos estudios de comportamiento en respuesta a huracanes se han realizado desde 1994. Hablaré principalmente de lo que se ha aprendido de estudios de muestras relativamente grandes (más de 1000 encuestados) realizados después de estos huracanes: Andrew 1994, Ivan 2004, Katrina 2006, Ike 2008, y Sandy 2012.
También estudios de evacuación de huracanes de FEMA.

Estos estudios emplearon una extensa investigación cualitativa que condujo a encuestas telefónicas cuantitativas.

Qualitative research → quantitative telephone surveys

Qualitative in-depth interviews were used to understand the full range of behavior in response to forecast information.

Quantitative surveys based on probability/GIS based samples then enabled inferences to be made to the number of people in the population actually responding in different ways to the forecasts.

By looking at actual behavior of people responding to the threat of approaching hurricanes these studies can answer questions about factors leading people to make good vs bad decisions about what to do in response to forecasts, how long it takes people to make these decisions and act on them, and what their situation was after the storm.

Investigación cualitativa → encuestas telefónicas cuantitativas.

Se utilizaron entrevistas cualitativas en profundidad para comprender el rango completo de comportamiento en respuesta a la información del pronóstico.

Las encuestas cuantitativas basadas en muestras probabilísticas / basadas en SIG permitieron hacer inferencias sobre el número de personas en la población que respondieron de diferentes maneras a los pronósticos.

Al observar el comportamiento real de las personas que responden a la amenaza de huracanes que se aproximan, estos estudios pueden responder preguntas sobre los factores que llevan a las personas a tomar decisiones buenas o malas sobre qué hacer en respuesta a los pronósticos, cuánto tiempo demora la gente en tomar estas decisiones y actuar. A ellos, y cuál era su situación después de la tormenta.

However, like meteorology, social science is hard. Weather is very complex and so are people.

Meteorology has an advantage in that there is fairly strong agreement among meteorologists on the science and methods.

This is not the case in social science where there is much disagreement over theory and method among and within different social and behavioral fields such as psychology, sociology, and economics.

Fortunately one thing that makes the the social science easier is that we can focus on the **most important decisions people have to make, particularly the decision to evacuate or not evacuate.**

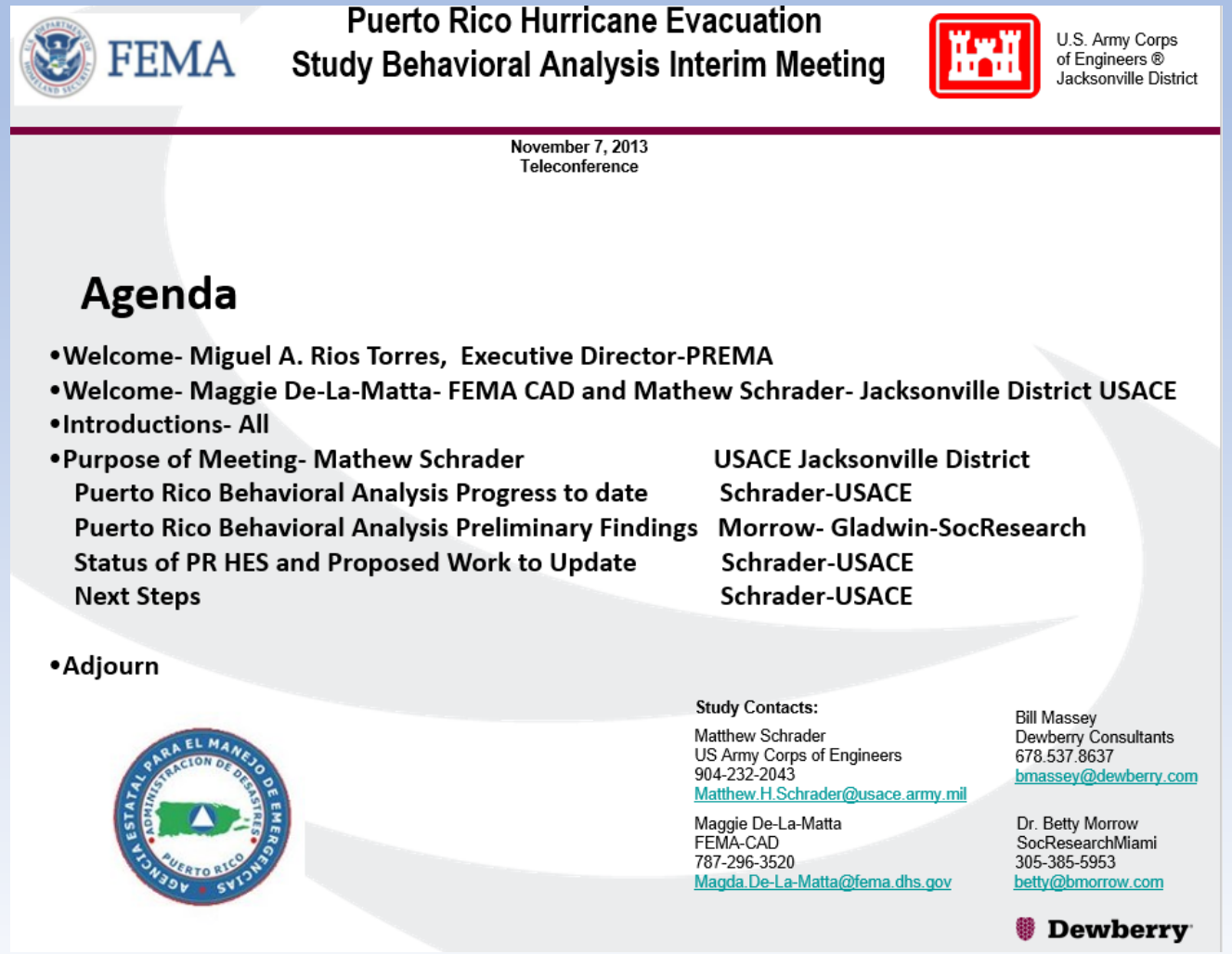
Sin embargo, como la meteorología, la ciencia social es difícil. El clima es muy complejo y también lo son las personas.

La meteorología tiene la ventaja de que existe un acuerdo bastante fuerte entre los meteorólogos sobre la ciencia y los métodos.

Este no es el caso de las ciencias sociales, donde existe un gran desacuerdo sobre la teoría y el método entre y dentro de diferentes campos sociales y de comportamiento, como la psicología, la sociología y la economía.

Afortunadamente, una cosa que facilita la ciencia social es que podemos enfocarnos **en las decisiones más importantes que las personas deben tomar, en particular la decisión de evacuar o no evacuar.**

Example: FEMA hurricane evacuation study -- Puerto Rico 2013
Cell phone telephone interviewing can now be done in most countries



FEMA

Puerto Rico Hurricane Evacuation Study Behavioral Analysis Interim Meeting

U.S. Army Corps of Engineers ® Jacksonville District

November 7, 2013
Teleconference

Agenda

- Welcome- Miguel A. Rios Torres, Executive Director-PREMA
- Welcome- Maggie De-La-Matta- FEMA CAD and Mathew Schrader- Jacksonville District USACE
- Introductions- All
- Purpose of Meeting- Mathew Schrader — USACE Jacksonville District
  - Puerto Rico Behavioral Analysis Progress to date — Schrader-USACE
  - Puerto Rico Behavioral Analysis Preliminary Findings — Morrow- Gladwin-SocResearch
  - Status of PR HES and Proposed Work to Update — Schrader-USACE
  - Next Steps — Schrader-USACE
- Adjourn

AGENCIA ESTATAL PARA EL MANEJO DE EMERGENCIAS ADMINISTRACION DE DESASTRES PUERTO RICO

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Dewberry

Will go through this quickly and can come back at end my talk if you have questions

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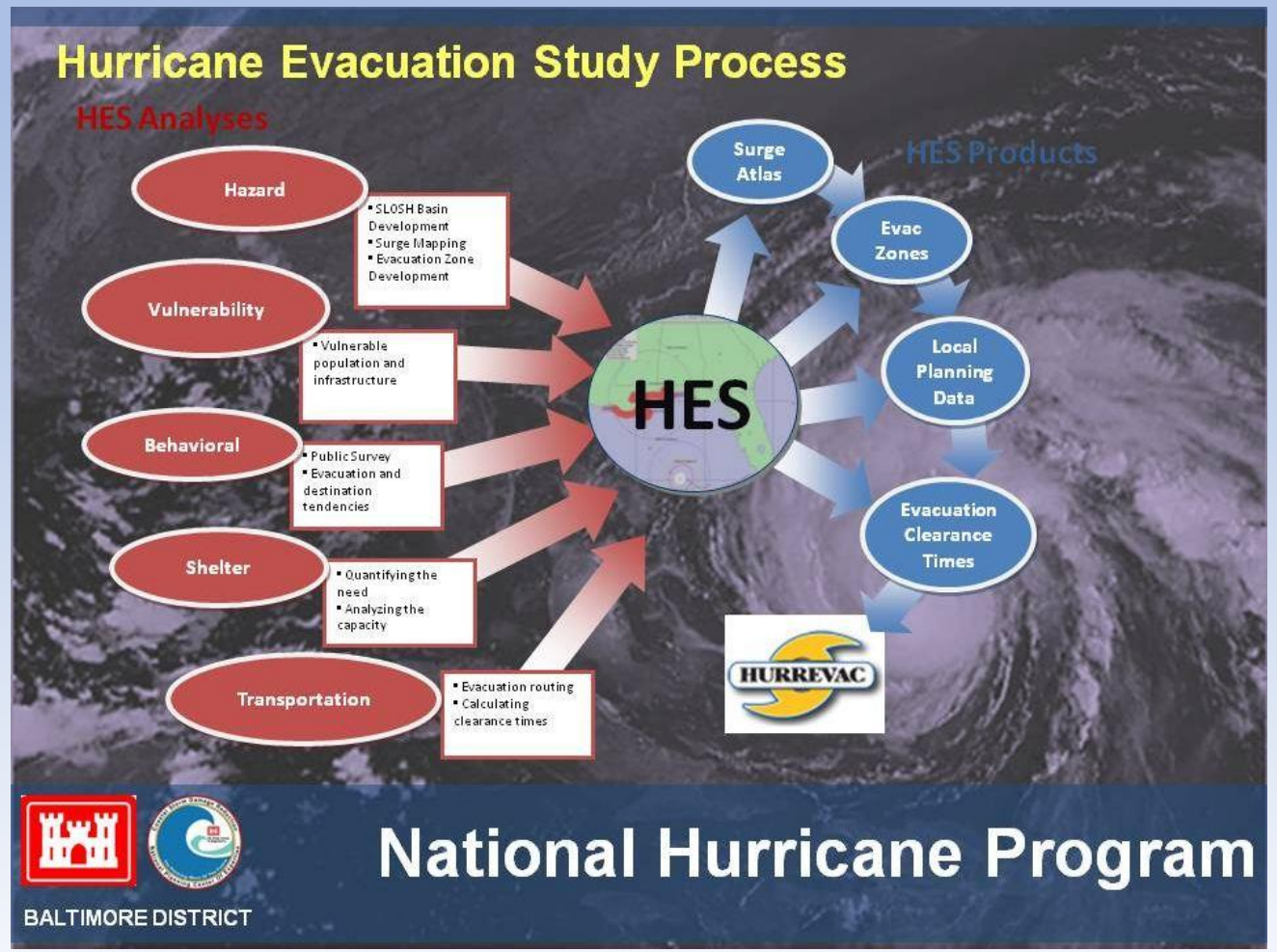

Behavioral Study Methodology

Questions designed to assess:

- Hurricane experience and response
- Level of concern regarding hurricanes and tsunamis
- Personal assessment of home's vulnerability to wind damage and flooding from storm surge and rainfall
- Evacuation decision process including level of trust of various information sources
- Evacuation intent in hypothetical situations varying by storm intensity and official recommendations/orders
- Evacuation conditions including likely place of refuge
- Housing Characteristics and Demographics

Behavioral Study Methodology

Sample Selection:

- Purchased telephone numbers (last 4 digits chosen randomly by computer)
- Eliminated non-working numbers, businesses, duplicates
- Screened for residents over 18 living in PR during hurricane season

Completed Interviews

	LANDLINE	CELL	TOTAL
PUERTO RICO	538	462	1000

63% Incidence rate for cell
59% Incidence rate for landline
Margin of Error = ± 3 Percent

Average Length: 24 minutes

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Puerto Rico Hurricane Evacuation
Study Behavioral Analysis Interim Meeting

U.S. Army Corps of Engineers ®
Jacksonville District

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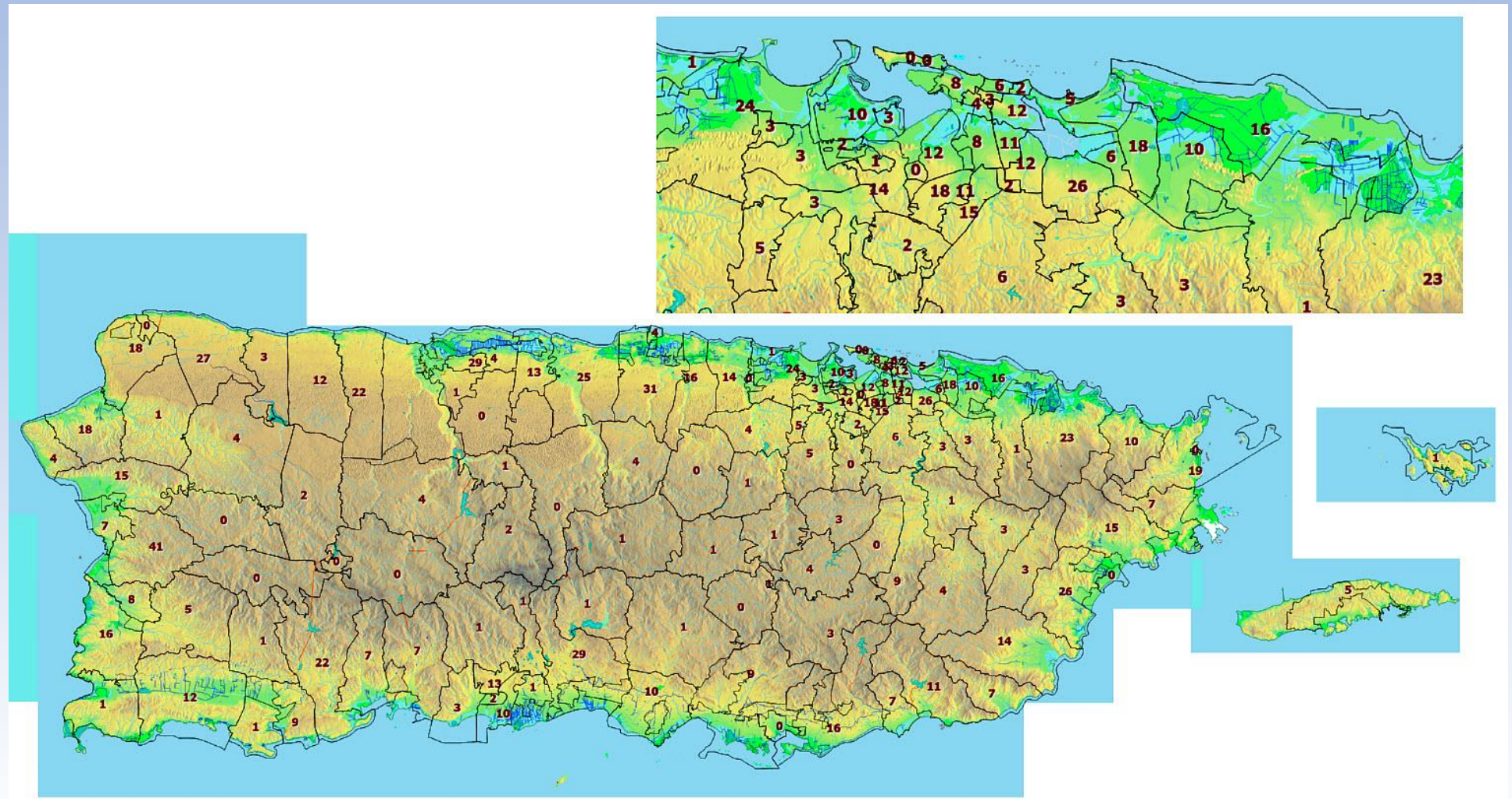
Sample Location – Puerto Rico



Comparison of Sample to Census Data

- Older
- More educated
- More women (64% compared to 52%)
- Lower household income
- More homeowners (84% compared to 64%)

TYPICAL FOR SURVEY RESPONDENTS

HOUSING CHARACTERISTICS OF SAMPLE

STRUCTURE

Mostly Wood	7%
Mostly Cement	86%
Both Wood & Cement	7%

ROOF

Cement	87%
Zinc or Aluminum	13%

NUMBER OF FLOORS

One	63%
Two	29%
Three or More	8%

FOUNDATION

Raised	26%
Stilts	19%
Neither	55%

STRUCTURE

Mostly Wood	7%
Mostly Cement	86%
Both Wood & Cement	7%

ROOF

Cement	87%
Zinc or Aluminum	13%

NUMBER OF FLOORS

One	63%
Two	29%
Three or More	8%

FOUNDATION

Raised	26%
Stilts	19%
Neither	55%

Tenancy and Evacuation Experience

- Median time in current home = 23 years
- Median time in community = 30 years
- 15% had evacuated before
  - 85% evacuated within their communities
    - Most to home of relative or friend
    - 10% to public shelter

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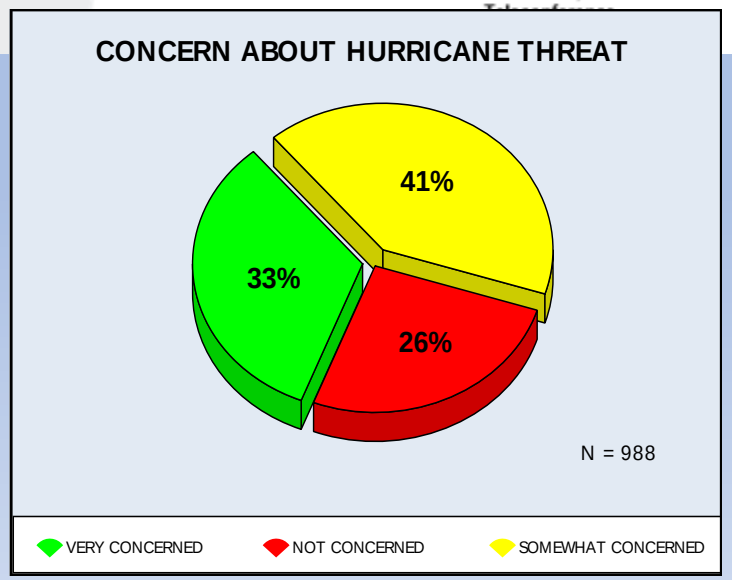
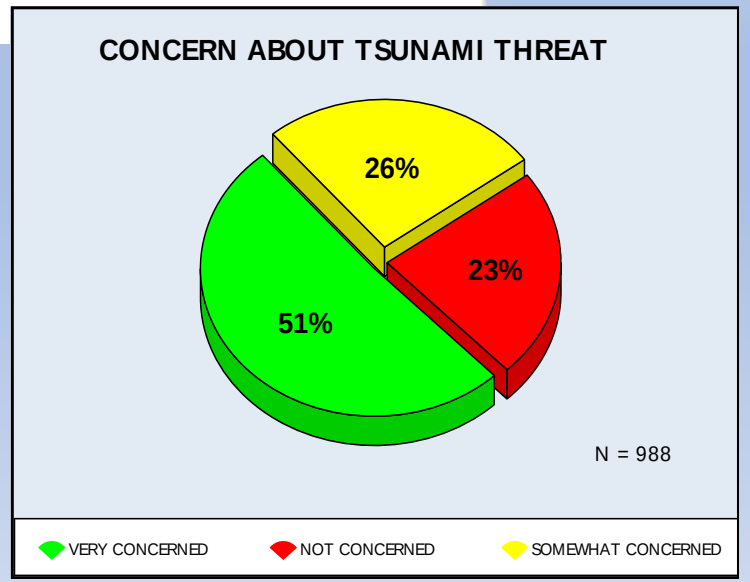
Puerto Rico Hurricane Evacuation Study Behavioral Analysis Interim Meeting

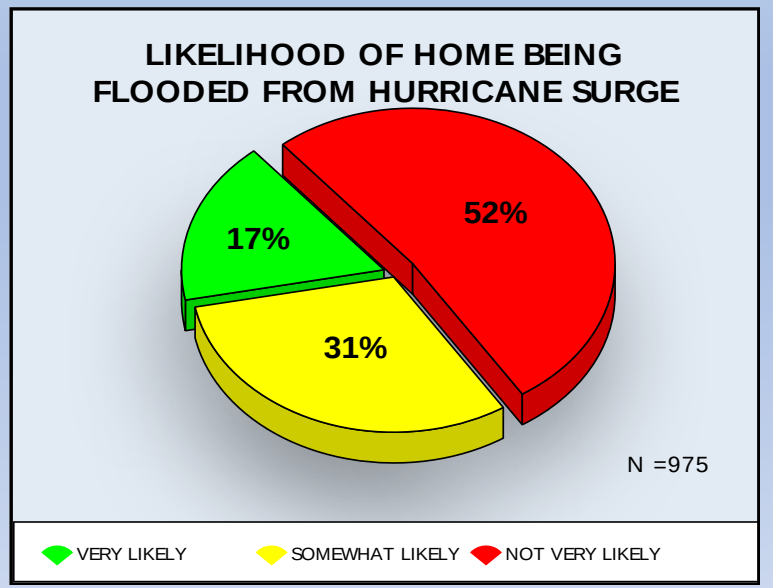
U.S. Army Corps of Engineers ® Jacksonville District

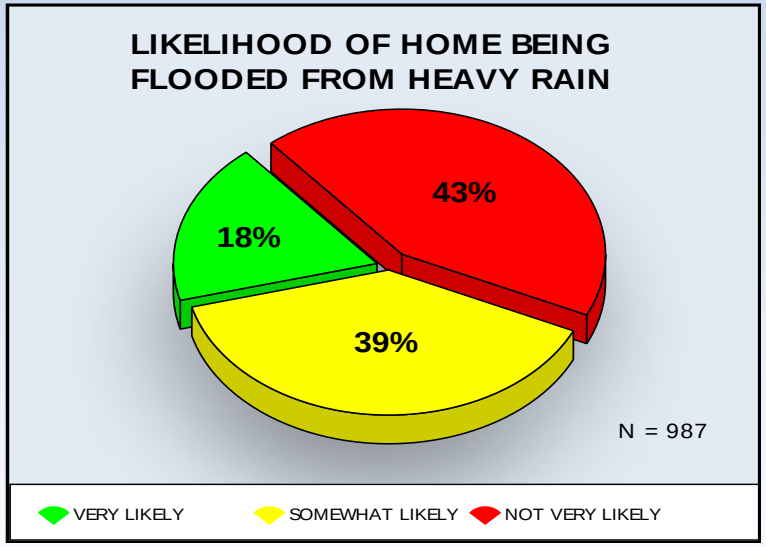
November 7, 2013

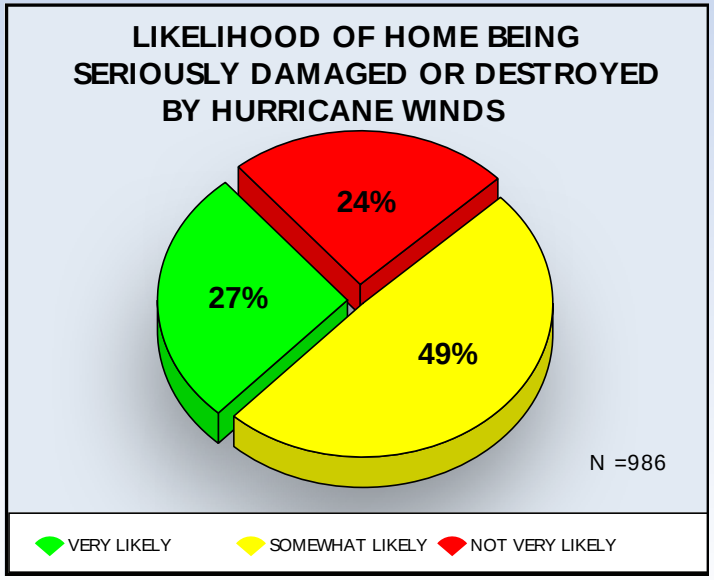
Some Early Results











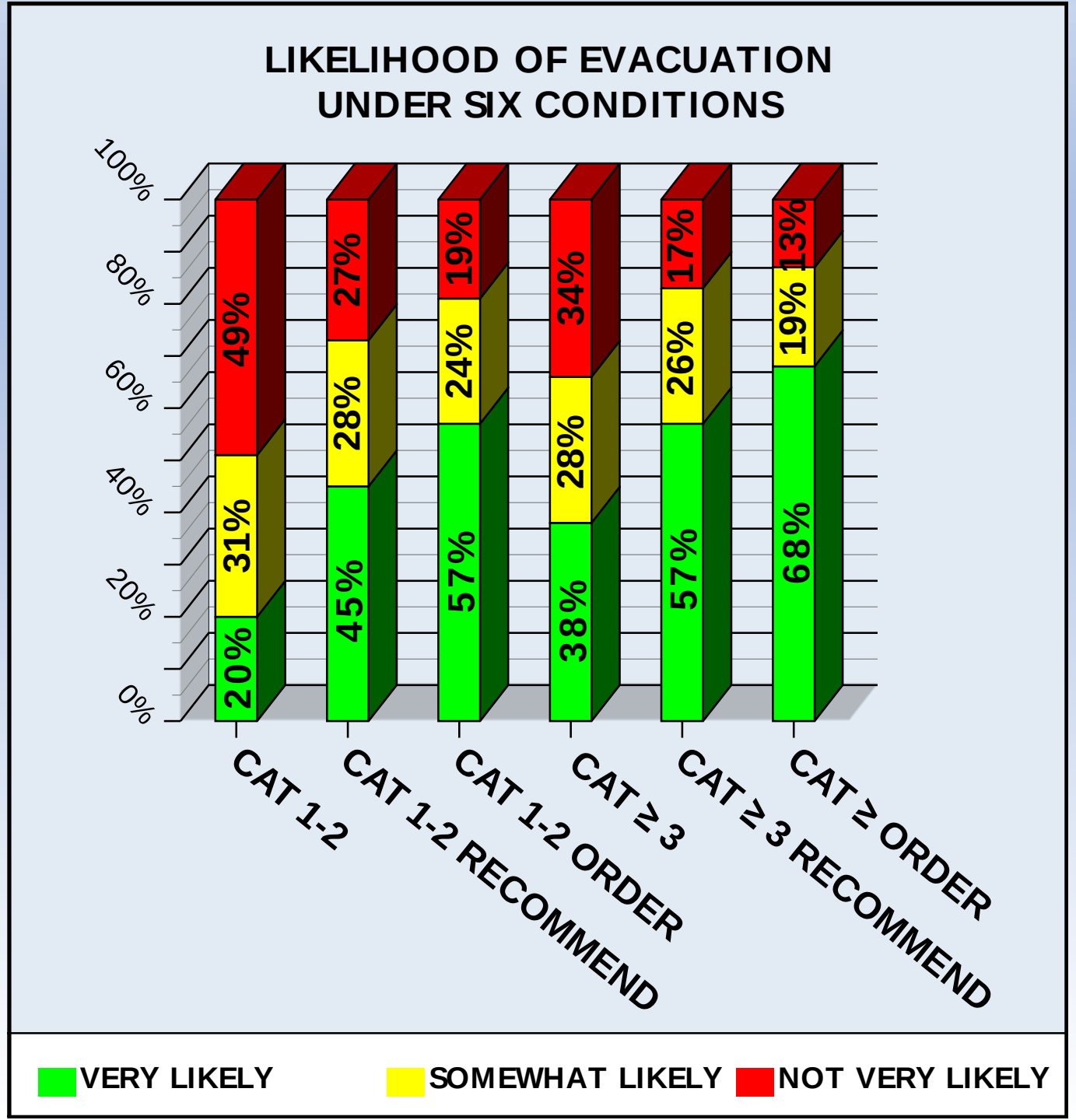
Most Important Hurricane Info Sources

SOURCE	
LOCAL RADIO	41%
NATIONAL TV	22%
LOCAL TV	20%
INTERNET	6%
WEATHER CHANNEL	1%
FRIENDS OR FAMILY	1%
CABLE OR SATELLITE TV	2%
NOAA WEATHER RADIO	1%
OTHER	5%

64% have Internet access in home

Level of Trust for Emergency Information

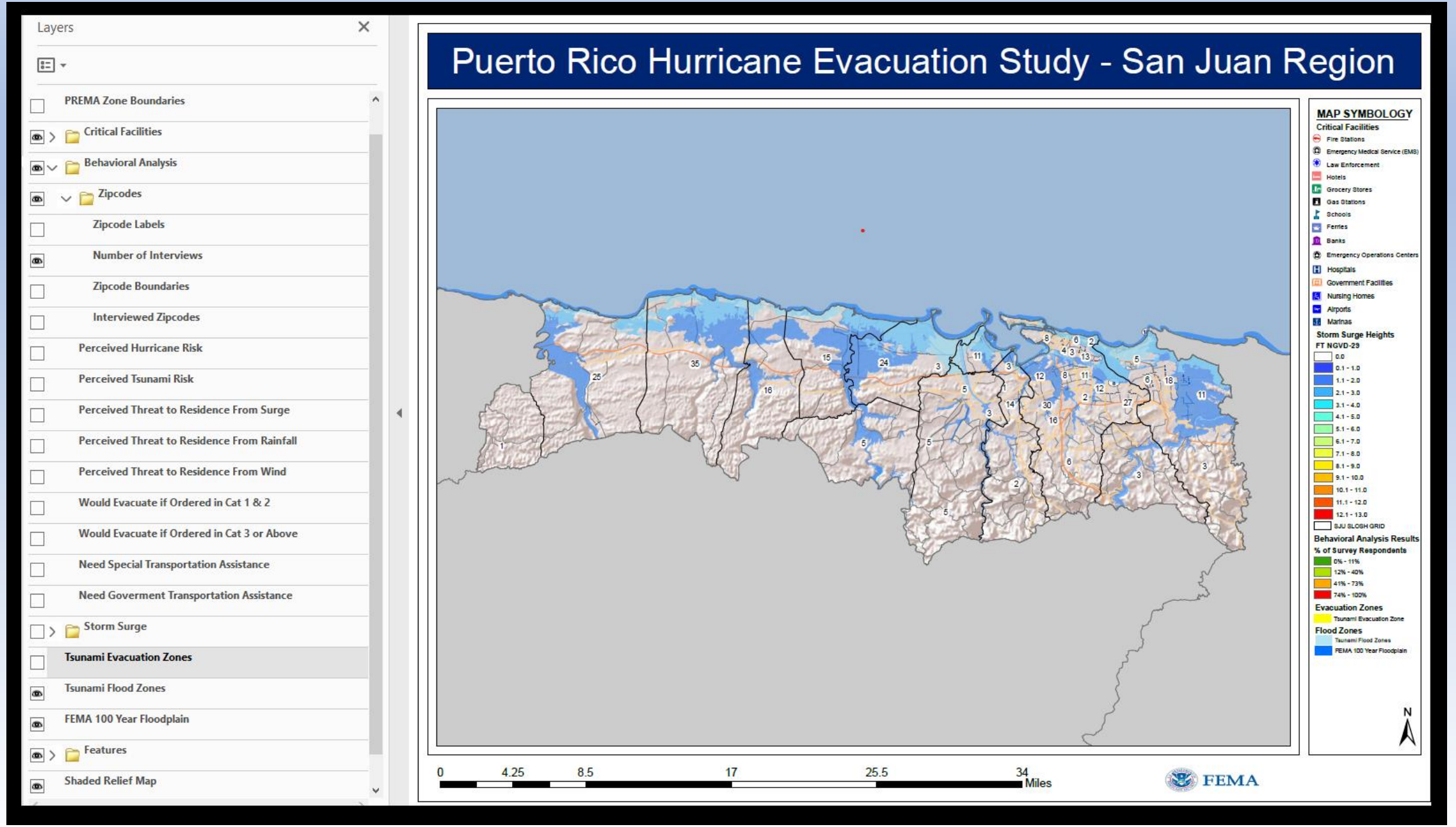
AGENCY OR OFFICIAL	ALWAYS OR USUALLY TRUST
National Hurricane Center	88%
National Weather Service	86%
Fire Department	82%
PREMA	82%
Municipality Emergency Mgt.	73%
State Police	72%
Municipality Mayor	67%
Governor	59%


LIKELIHOOD OF EVACUATION
UNDER SIX CONDITIONS
100%
80%
60%
40%
20%
0%
20%
31%
49%
45%
28%
27%
57%
24%
19%
38%
28%
34%
57%
26%
17%
68%
19%
13%
CAT 1-2
CAT 1-2 RECOMMEND
CAT 1-2 ORDER
CAT ≥ 3
CAT ≥ 3 RECOMMEND
CAT ≥ ORDER
VERY LIKELY
SOMEWHAT LIKELY
NOT VERY LIKELY

Plans for Analysis

Evacuation Conditions

- Time Needed to Get Ready
- How Many Would Leave
- How Many Vehicles Would Take
- Type of Refuge
- Destination
- When Expect to Return

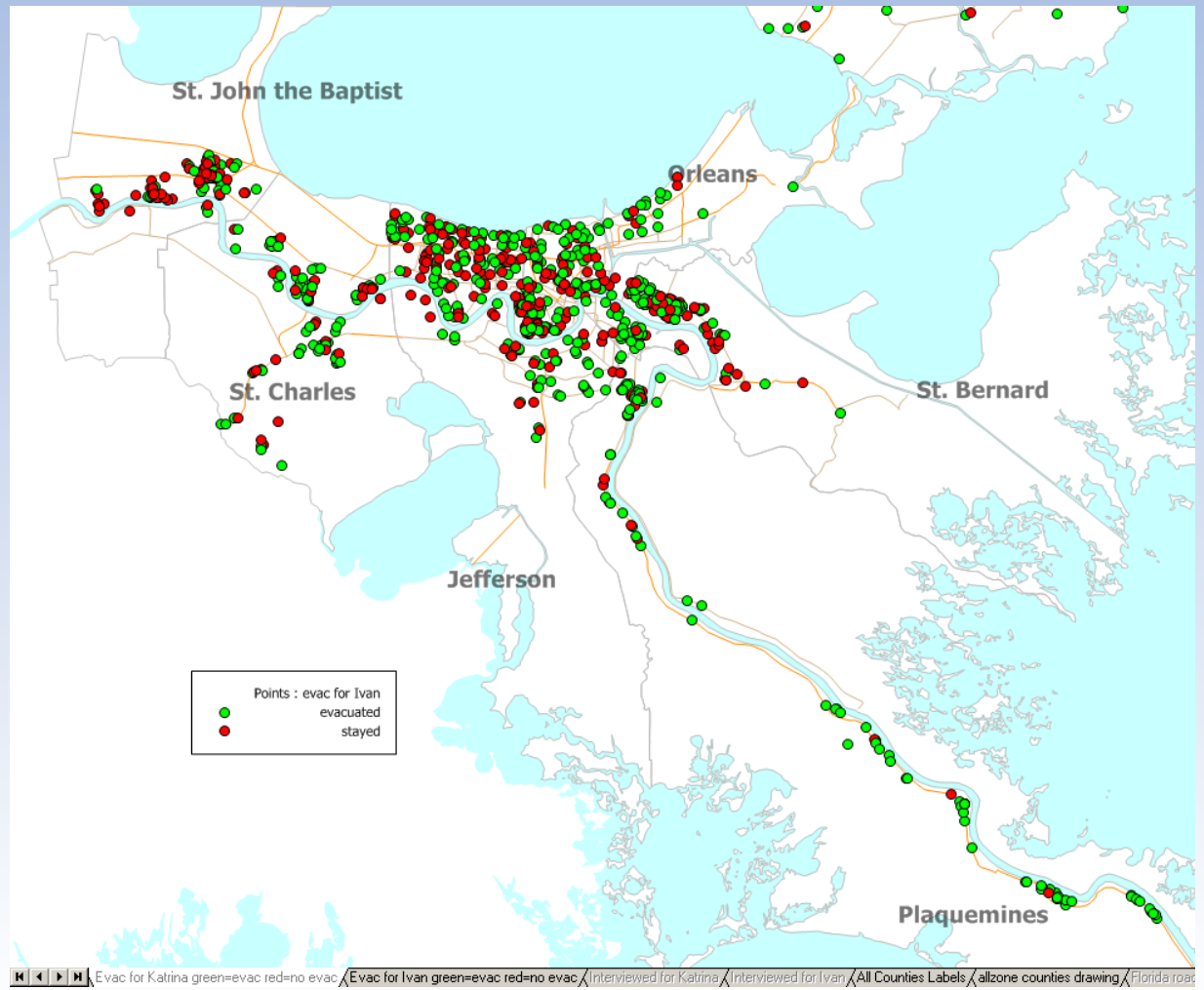

Layers
PREMA Zone Boundaries
Critical Facilities
Behavioral Analysis
Zipcodes
Zipcode Labels
Number of Interviews
Zipcode Boundaries
Interviewed Zipcodes
Perceived Hurricane Risk
Perceived Tsunami Risk
Perceived Threat to Residence From Surge
Perceived Threat to Residence From Rainfall
Perceived Threat to Residence From Wind
Would Evacuate if Ordered in Cat 1 & 2
Would Evacuate if Ordered in Cat 3 or Above
Need Special Transportation Assistance
Need Goverment Transportation Assistance
Storm Surge
Tsunami Evacuation Zones
Tsunami Flood Zones
FEMA 100 Year Floodplain
Features
Shaded Relief Map
Puerto Rico Hurricane Evacuation Study - San Juan Region
MAP SYMBOLOGY
Critical Facilities
Fire Stations
Emergency Medical Service (EMS)
Law Enforcement
Hotels
Grocery Stores
Gas Stations
Schools
Ferries
Banks
Emergency Operations Centers
Hospitals
Government Facilities
Nursing Homes
Airports
Marinas
Storm Surge Heights
FT NGVD-29
0.0
0.1 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0
7.1 - 8.0
8.1 - 9.0
9.1 - 10.0
10.1 - 11.0
11.1 - 12.0
12.1 - 13.0
SJU SLOSH GRID
Behavioral Analysis Results
% of Survey Respondents
0% - 11%
12% - 40%
41% - 73%
74% - 100%
Evacuation Zones
Tsunami Evacuation Zone
Flood Zones
Tsunami Flood Zones
FEMA 100 Year Floodplain
N
0 4.25 8.5 17 25.5 34
Miles
FEMA

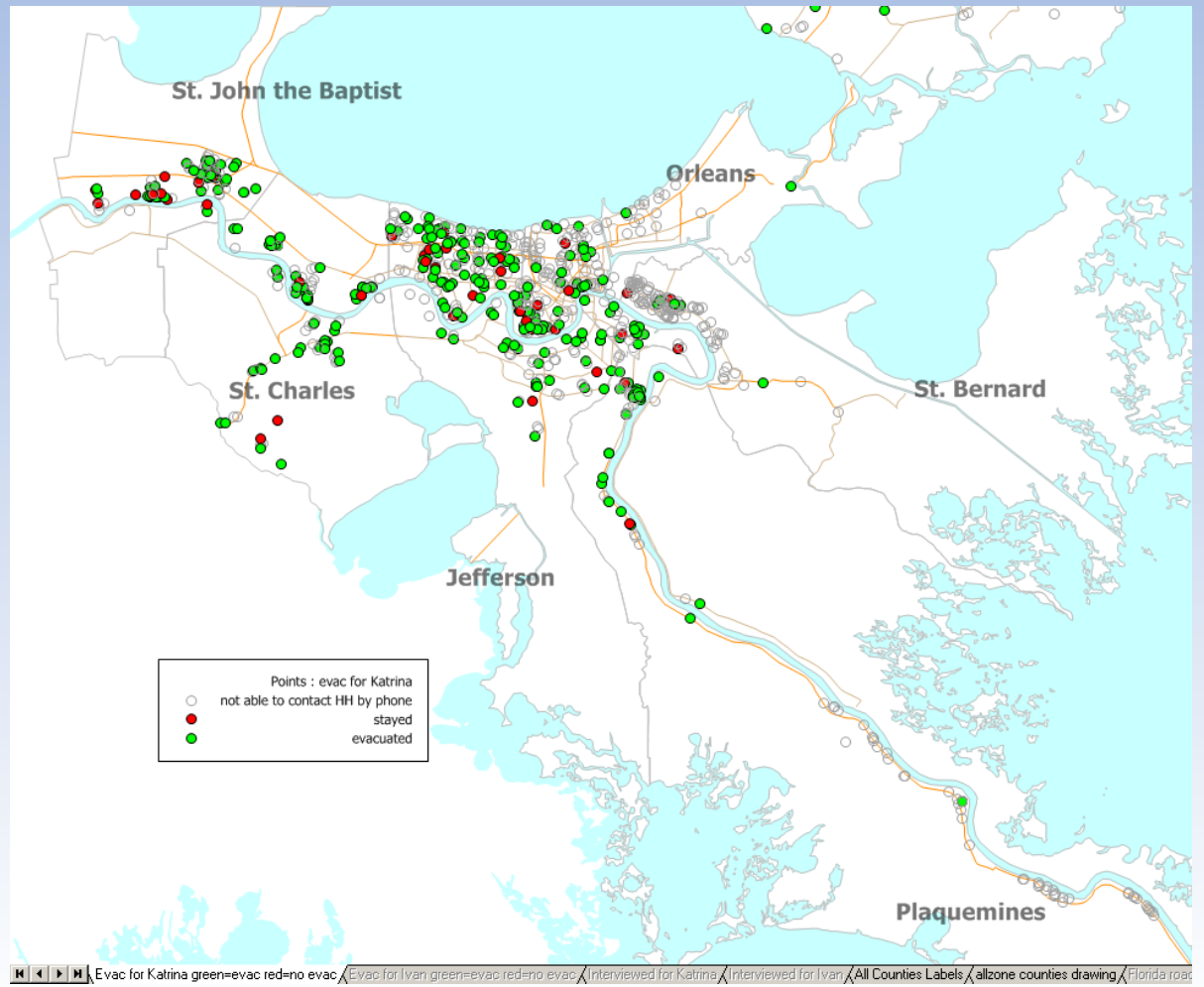
STUDIES OF ACTUAL HURRICANE BEHAVIOR: IMPORTANT PARTICULARLY FOR UNDERSTANDING ISSUES LIKE TIMING AND SHADOW EVACUATION

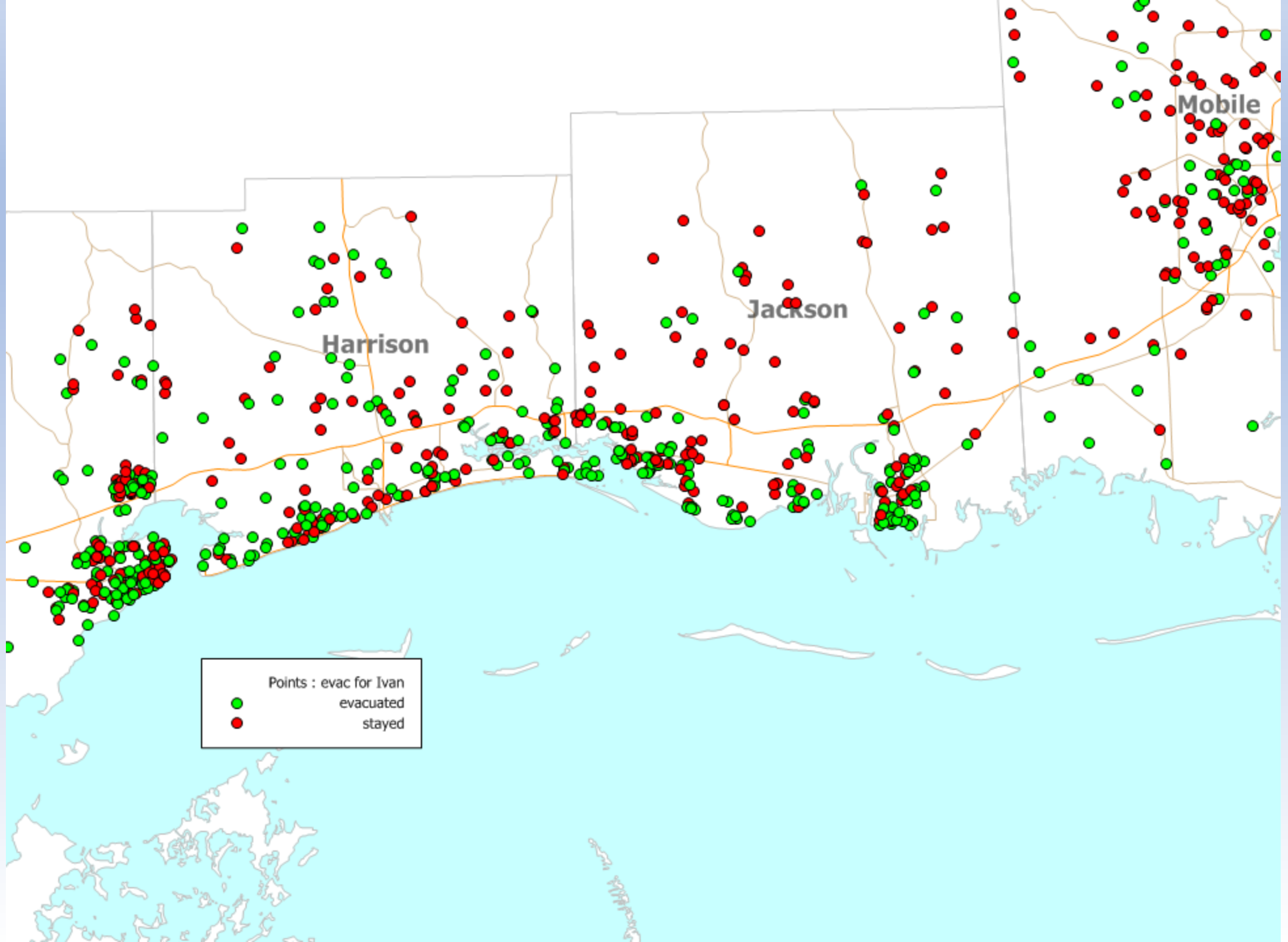
ESTUDIOS DEL COMPORTAMIENTO ACTUAL DEL HURACAN: IMPORTANTE EN PARTICULAR PARA ENTENDER LOS PROBLEMAS COMO EL TIEMPO Y “SHADOW EVACUATION”

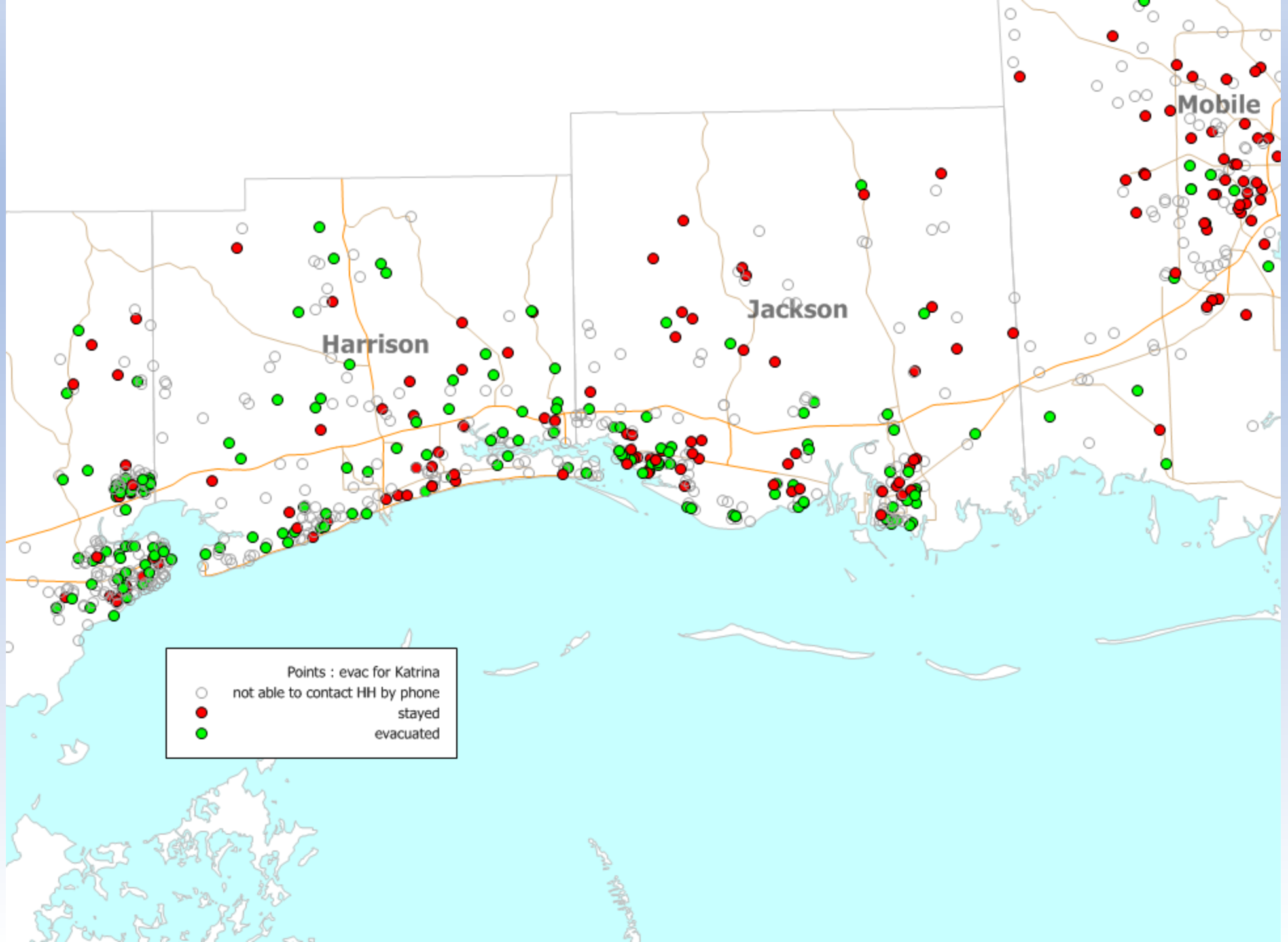
Hurricane Ivan (2004) study; 800 respondents were reinterviewed a year later after Hurricane Katrina

Huracán Ivan (2004; un año más tarde, 800 encuestados fueron entrevistados nuevamente después del huracán Katrina.



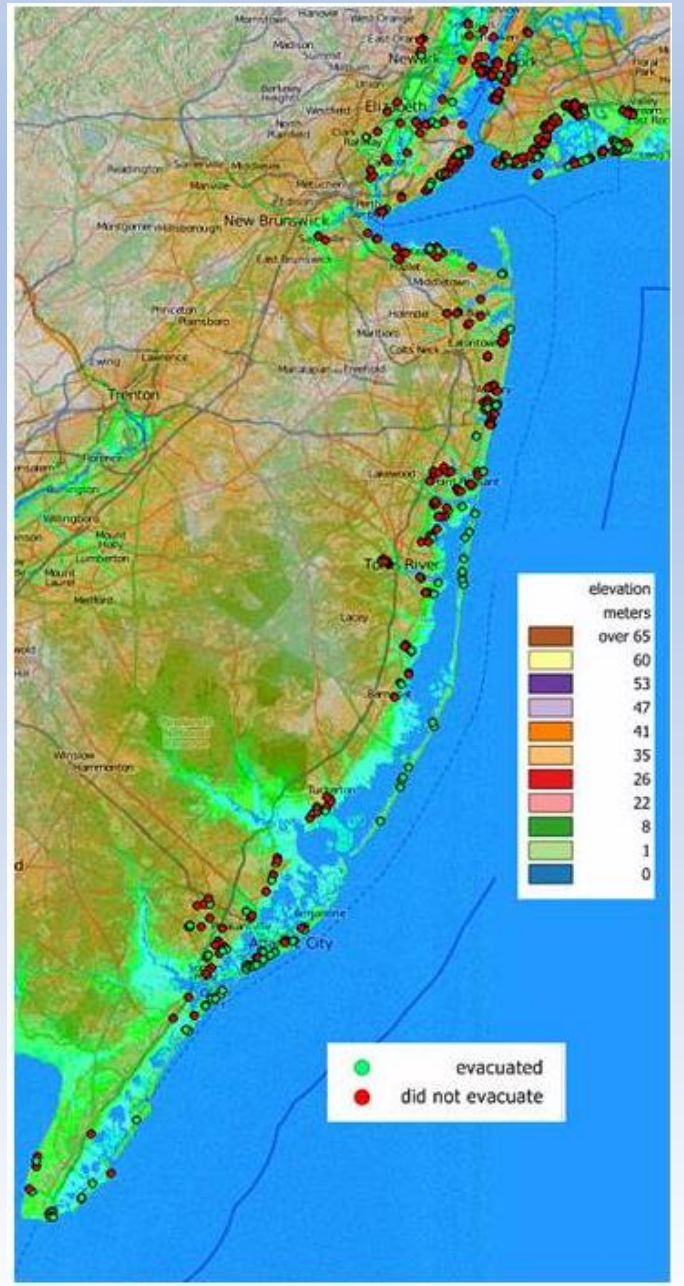


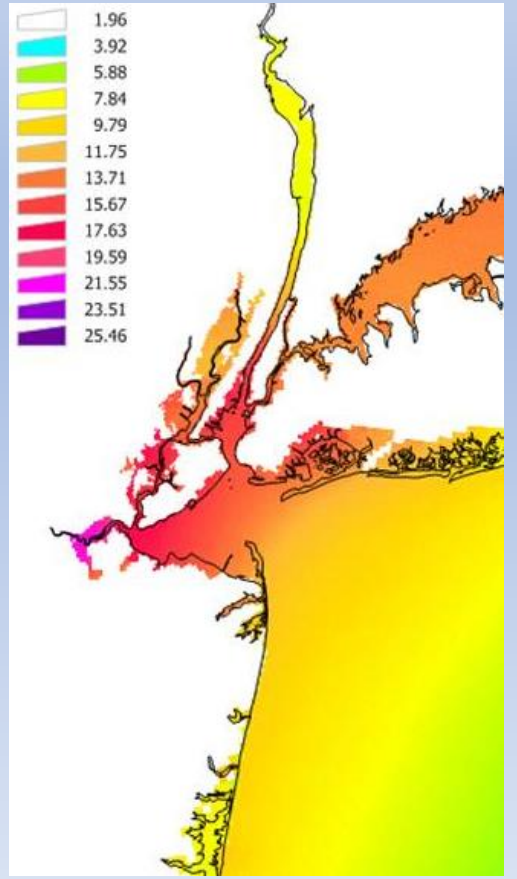

Mobile
Jackson
Harrison
Points : evac for Ivan
evacuated
stayed


Harrison
Jackson
Mobile
Points : evac for Katrina
not able to contact HH by phone
stayed
evacuated

In these studies interview locations are located for geographic analysis and respondents are asked when they decided on evacuation and when they left home if they did evacuate.

En estos estudios, los lugares de la entrevista se ubican para el análisis geográfico y se les pregunta a los encuestados cuándo decidieron sobre la evacuación y cuándo abandonaron su hogar si lo hicieron.





Logistic Regression: Sandy evacuation decision

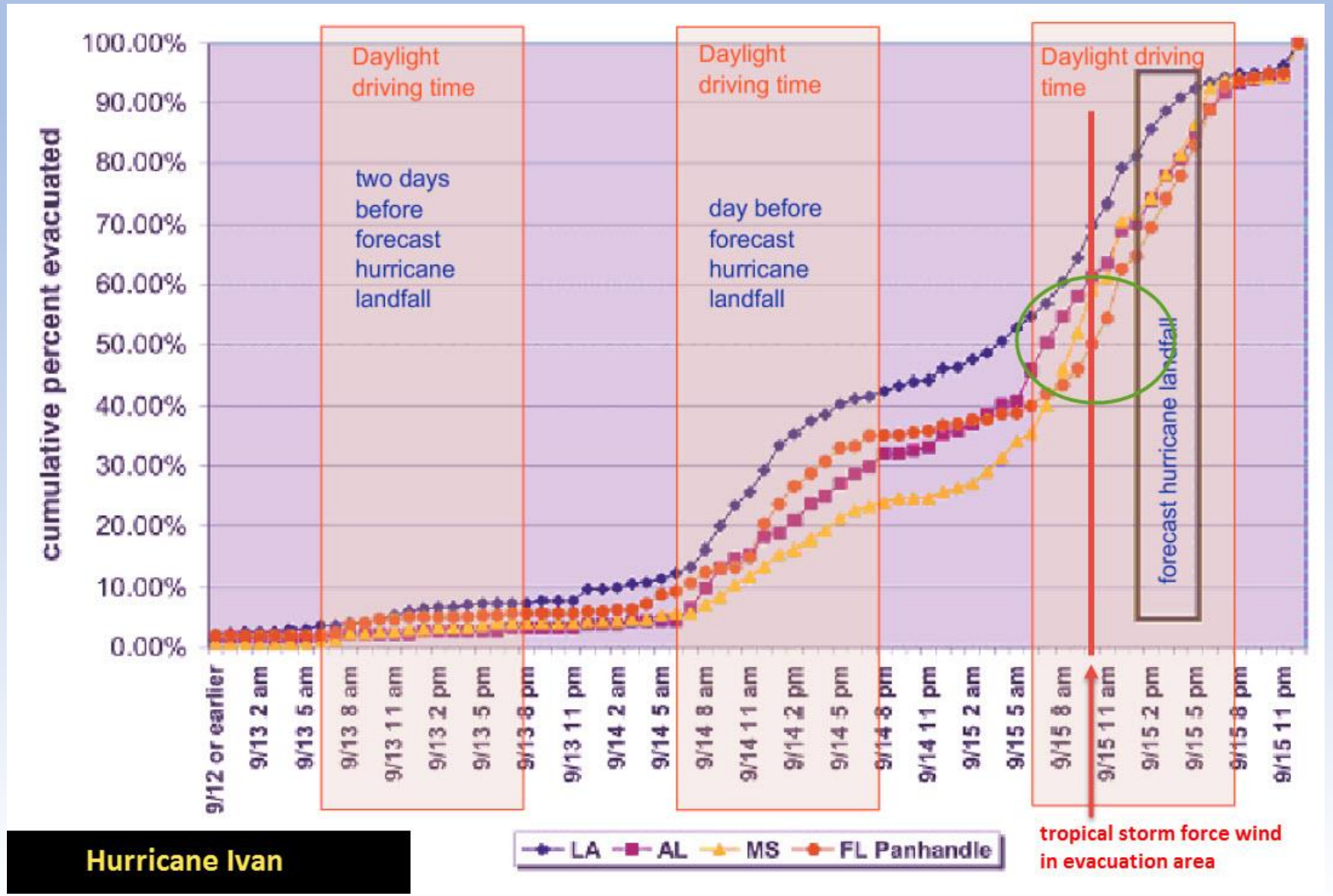
dependent variable: value 1 = evacuated for Sandy, 0 = did not evacuate. Cells in table show odds of evacuating

odds greater than one = variable increases likelihood of evacuating

odds less than one = = variable reduces likelihood of evacuating

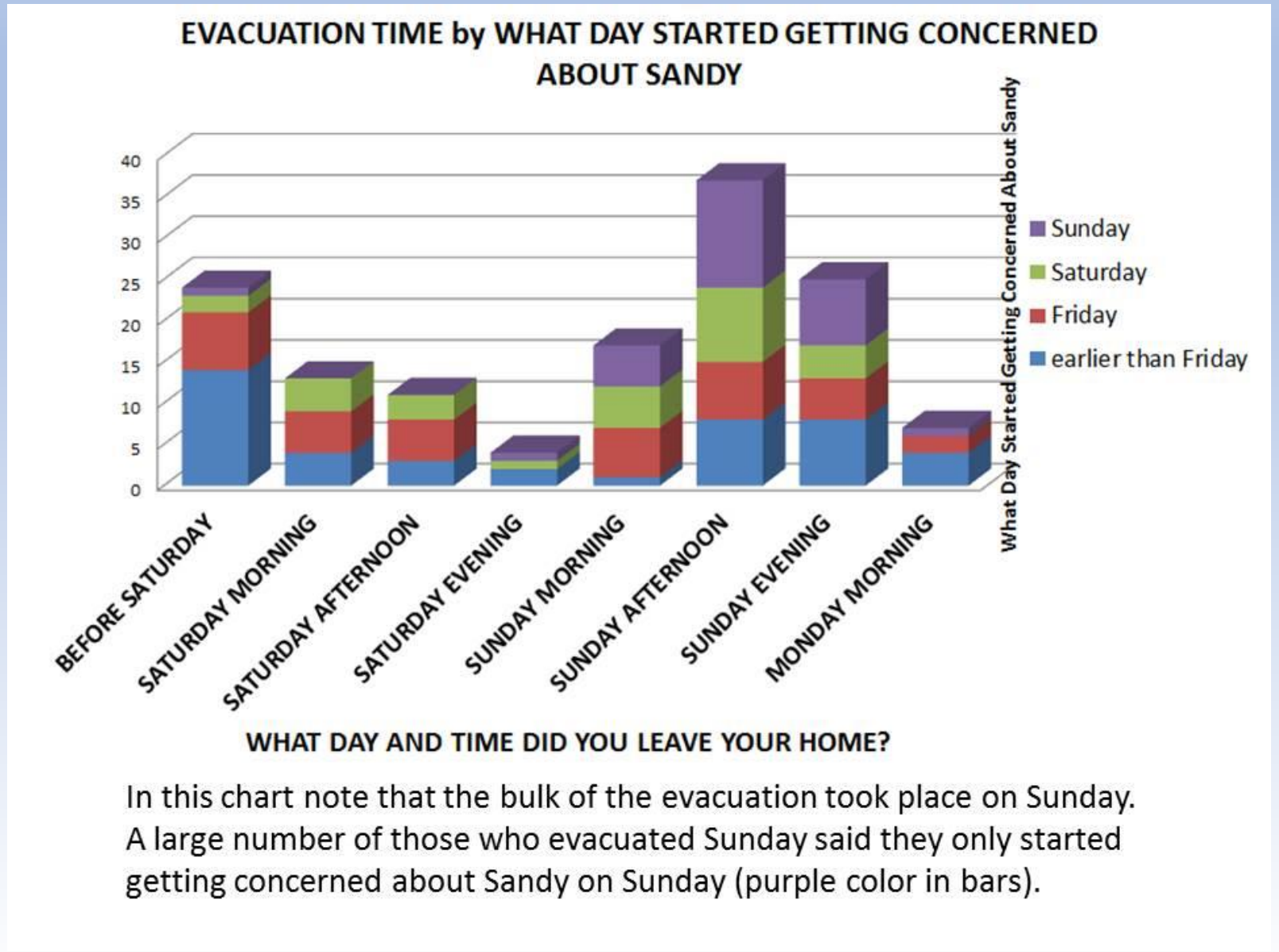
	LATITUDE+LONGITUDE	LOCATION RISK	PERCEIVED RISK	EVACUATION ORDERED OR RECOMMENDED	DEMOGRAPHIC FACTORS	ALL INDEPENDENT VARIABLES
Pseudo R^2	*0.025*	*0.066*	*0.033*	*0.123*	*0.019*	*0.234*
LATITUDE	0.365					0.400
LONGITUDE	1.508					0.903
ELEVATION OF INTERVIEW HOUSEHOLD		0.854				0.917
DISTANCE FROM TIDAL WATER BODY		0.759				0.694
THOUGHT SANDY WAS GOING TO AFFECT WHERE I LIVE			1.321			1.171
WAS CONCERNED ABOUT STORM SURGE BEFORE SANDY			1.779			2.426
WAS CONCERNED ABOUT RAIN FLOOD BEFORE SANDY			1.023			0.728
WAS CONCERNED ABOUT WIND DAMAGE BEFORE SANDY			0.872			1.190
WAS CONCERNED ABOUT HIGH WAVES BEFORE SANDY			1.375			1.061
ORDERED BY OFFICIALS TO LEAVE				7.200		5.286
RECOMMENDED BY OFFICIALS TO LEAVE				2.835		2.497
INCOME					0.811	0.733
COLLEGE EDUCATED					1.414	1.376
SINGLE FAMILY HOME					1.000	1.015
UNDER 12 LIVING IN HOUSEHOLD					1.190	1.365
65 OR OLDER LIVING IN HOUSEHOLD					1.298	1.312

Ivan respondents who evacuated – when they left
Ivan encuestados que evacuaron - cuando se fueron



Hurricane Ivan

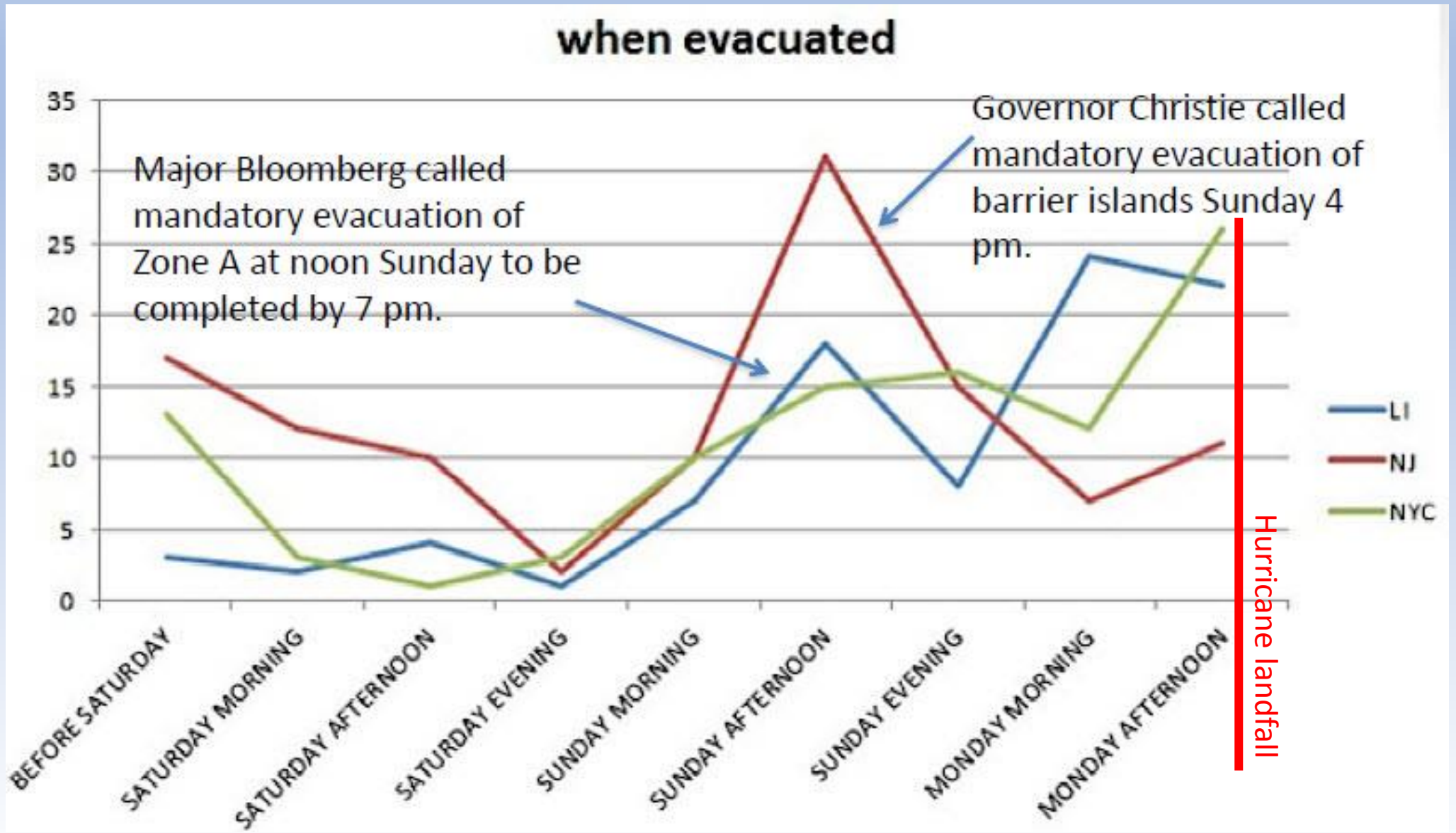
Hurricane Sandy survey



In this chart note that the bulk of the evacuation took place on Sunday. A large number of those who evacuated Sunday said they only started getting concerned about Sandy on Sunday (purple color in bars).

Hurricane Sandy survey

Hurricane Sandy survey



Why do people take so long to evacuate?

¿Por qué la gente tarda tanto en evacuar?

HURRICANE ANDREW (1994) EVACUATION DECISIONS

International Journal of Mass Emergencies and Disasters
August 2001, Vol. 19, No. 2, pp. 117-143

Modeling Hurricane Evacuation Decisions with Ethnographic Methods*

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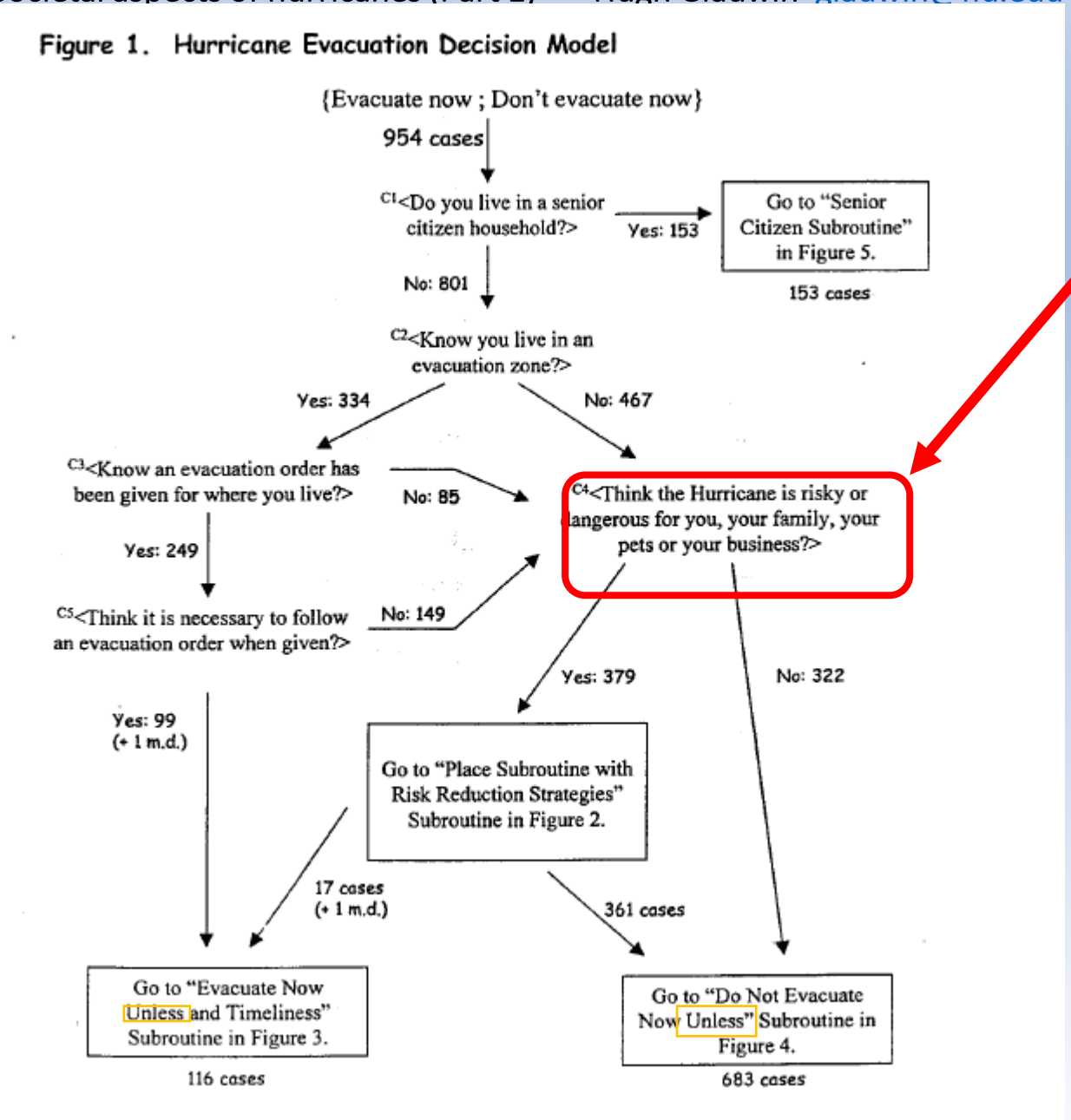
Methodology: inductive interviews to find household reasons for evacuation choice. Reasons compiled into "decision tree" format (same procedure as big data random forests).
60 two-hour long qualitative interviews with households in Hurricane Evacuation areas.
Followed by 100 one-hour long semi-structured qualitative interviews to determine most common decision paths.
Then model of most common decision paths tested with 954 structured quantitive interview random sample telephone survey.

Metodología: entrevistas inductivas para encontrar razones domésticas para la elección de evacuación. Razones compiladas en formato de "árbol de decisión" (el mismo procedimiento que los "bosques aleatorios" de datos grandes).
60 entrevistas cualitativas de dos horas de duración con hogares en áreas de Evacuación de Huracanes.
Seguido por 100 entrevistas cualitativas semiestructuradas de una hora de duración para determinar las rutas de decisión más comunes.
Luego, el modelo de las rutas de decisión más comunes probadas con 954 entrevista cuantitativa estructurada de muestra aleatoria encuesta telefónica.



Note "unless" = process cycles giving reason for delay

PROBLEM IS HOW HAZARD/RISK DETERMINATION WAS MADE

EL PROBLEMA ES CÓMO SE HIZO LA DETERMINACIÓN DEL PELIGRO / RIESGO

- **Economic expected utility risk vs risk of loss of life and/or livelihood**
- **Difficulties people have in making good judgments about risk**
- **Risk spatially and temporally located in smaller parts of the hurricane forecast area**

- **Riesgo económico esperado de la utilidad frente al riesgo de pérdida de vida y / o medios de vida**
- **Dificultades que tiene la gente para hacer buenos juicios sobre el riesgo.**
- **Riesgo espacial y temporalmente ubicado en partes más pequeñas del área de pronóstico de huracanes**