

### Local Emergency Management Agencies' Hurricane Evacuation Decision Making and Population Warning

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## Think about through the slides



**1.** Is the information accurate that can represent your county?

2. What else information do you want to know, that we can do for next steps?

3. How can academia collaborate with you to answer questions /solve problems?





Little research on the process by which state and local officials decide whether, how, and when to issue such warnings

## **Research Questions**

### **For LEMAs**



- RQ1. What are LEMAs' sources of information about approaching hurricanes?
- RQ2. What are the processes by which LEMAs decide to issue official evacuation warnings?
- RQ3. What are the channels through which LEMAs issue official evacuation warnings to their jurisdictions?
- RQ4. Do LEMAs have templates for their evacuation warning messages and, if so, what are the elements of those templates?
- RQ5. What percentage of the risk area population do LEMAs expect to receive an official evacuation warning within one hour?
- RQ6. What are LEMAs' perceptions of informal warning networks?

### **For Householders**

- RQ1. What are householders' sources of information about approaching hurricanes?
- RQ2. What factors trigger or hinder householders' decision to evacuate during a hurricane?
- RQ3. How do householders use informal warning channels to receive and share information about an approaching hurricane?
- RQ4. What are householders' primary considerations regarding hurricane evacuation preparedness and plans?
- RQ5. What are householders' main concerns about risk communication of hurricanes and hurricane evacuation?

## **Method and Data Collection**



Identify target audiences – Hurricane-prone Counties (HURREVAC & ArcGIS shoreline analysis)

Collect Local Emergency Management Agencies' (LEMAs') contacts

Distribute online questionnaire for LEMAs' (21 questions) and Householders' use (29 questions)

## **Overview – LEMA Survey**



LEMAs' Response Count by State (N = 44).



Summary LEMAs' Survey (N = 44).

Audience size	238			
Data Collection Period	Period May to June 2024			
<b>Distribution Waves</b>	4			
Valid Response	44			
Valid Response Rate	20.7%			
States with Responses	11 out of 17			

#### Table 2. LEMAs' Response by State (N = 44).

	Posponso	Sampla	Number of	Statewide
	frequency	Sample	coastal	response
	irequency	percent	LEMAs	rate
Texas	11	25.0%	39	28.2%
Louisiana	7	15.9%	22	31.8%
North Carolina	6	13.6%	19	31.6%
Florida	5	11.4%	41	12.2%
Virginia	5	11.4%	20	25.0%
South Carolina	3	6.8%	9	33.3%
Maine	2	4.6%	8	25.0%
Maryland	2	4.6%	14	14.3%
Massachusetts	1	2.3%	9	11.1%
New Jersey	1	2.3%	14	7.1%
Rhode Island	1	2.3%	3	33.3%

## **Overview – LEMA Survey**



### Summary LEMAs' Survey (N = 44)

Audience size	238
Data Collection Period	May to June 2024
<b>Distribution Waves</b>	4
Valid Response	44
Valid Response Rate	20.7%
States with Responses	11 out of 17

90.9% of the respondents are in Emergency Management agencies

70% of the respondents have 10 or more years of experience in emergency management

32 (72.7%) of them have been involved in activation of their jurisdiction's EOP when a hurricane evacuation warning was issued.

## **Overview – Household Survey**





Householders' Response Count by County. Total count (N = 159)

### Summary of Householders' Survey (N = 680)

Audience size	3145
Data Collection Period	May/24/2024 to Jun/24/2024
Valid Responses	680
Valid Response Rate	23%
<b>Counties with Responses</b>	159 out of 222
Engaged Counties Rate	71.6%
Data Collection Period	May/24/2024 to Jun/24/2024

## **Overview – Household Survey**



**Statewid** 

Householders' Response by State (N = 680).

	Minnesota			2			12	Brunswick	
	Minneapolis			Lake		Ottawa	ME. 3	1.35	
		Wisconsin		Huron	5	ALL 2	- Carlor		
eat Plains			Milwaukee Grand Ra	npids	Buffalo	aw York Lachian N. N.	1 Martin		
	Iowa		Chicago	Detroit		CT, 24	MA, 17		
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Householders' Response Count by State (N = 680)

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State	Response Frequency	Sample percent	Number of Engaged Counties	Number of coastal counties	e response rate based on county
Texas	175	25.7%	19	20	95.0%
Florida	117	17.2%	27	44	61.4%
Louisiana	98	14.4%	25	26	96.2%
North Carolina	58	8.5%	19	21	90.5%
South Carolina	42	6.2%	9	9	100.0%
New Jersey	34	5.0%	14	17	82.4%
New York	25	3.7%	4	4	100.0%
Connecticut	24	3.5%	4	4	100.0%
Alabama	20	2.9%	2	2	100.0%
Georgia	20	2.9%	6	6	100.0%
Massachusetts	17	2.5%	6	8	75.0%
Mississippi	15	2.2%	3	3	100.0%
Virginia	12	1.8%	7	22	31.8%
Maryland	11	1.6%	6	17	35.3%
Rhode Island	5	0.7%	3	5	60.0%
Maine	3	0.4%	2	9	22.2%
Delaware	2	0.3%	1	3	33.3%
New Hampshire	2	0.3%	2	2	100.0%



# SECTION 1: Overview SECTION 2: RESULTS OF LEMAs SECTION 3: RESULTS OF HOUSEHOLDERS

### RQ1 What are LEMAs' sources of information about approaching hurricanes?



Hurricane Information Source	Frequency	Percent
HURREVAC	42	95.5%
NHC website	36	81.8%
Local NWS Weather Forecast Office	33	75.0%
NWS Chat/Slack	28	63.6%
Weather.gov	25	56.8%
Weather Channel	19	43.2%
Local ABC station	16	36.4%
Local NBC station	15	34.1%
Local CBS station	13	29.6%
Storm Radar	13	29.6%
AccuWeather	11	25.0%
Local FOX station	10	22.7%
Other	10	22.7%

- 6.30 sources used on average
- Max 13, min 1
- Substantial variation in source utilization.

## **RQ2 What are the processes by which LEMAs decide to issue official evacuation warnings?**



<b>Factors</b>	to c	onsi	der?
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	Frequency	Percent
National Hurricane Center Watches and Warnings	41	93.2%
Storm surge forecast	41	93.2%
Storm intensity (Saffir-Simpson Category)	40	90.9%
Evacuation time estimate	37	84.1%
Hurricane track uncertainty cone	34	77.3%
Storm forward speed	31	70.5%
Rainfall forecast	29	65.9%
Storm swath	22	50.0%
Evacuation decision arc	21	47.7%
Concern about "false alarms" causing an unnecessary evacuation	11	25.0%
Other	5	11.4%
Evacuation cost to government	4	9.1%
Evacuation cost to businesses	4	9.1%
Evacuation cost to households	4	9.1%

- 7.41 decision criteria are considered on average
- Substantial variation in the number of criteria considered
- Max = 13, Min = 1

# **RQ2** What are the processes by which LEMAs decide to issue official evacuation warnings? (cont.)



- One-third reported referring to NHC Watch or Warning
- 64% chose 'depends on the situation':

a. Forecast storm conditions

b. Warning issuance timing/phrased evacuation, and early warnings for vulnerable populations

c. Warnings based on ETEs (e.g., before a Hurricane Watch due to limited evacuation route capacity or after a Hurricane Watch due to limited population at risk)

d. Actions of adjacent jurisdictions and SEMA recommendations

### **Evacuation Warning Issuance Timing (N = 44).**

Initiating Condition	Frequency	Percent
Before an NHC Hurricane Watch	1	2.3%
After a Watch but before a Warning	8	18.2%
After an NHC Hurricane Warning	7	15.9%
It depends on the situation	28	63.6%

# **RQ2** What are the processes by which LEMAs decide to issue official evacuation warnings? (cont.)



### Relationship Between EOC Staff and CEO/CAO (N = 44).

	Frequency	Percent
The CEO/CAO would endorse an EOC staff recommendation with few or no questions.	15	34.1%
The CEO/CAO would thoroughly discuss the need for an evacuation warning before approving the EOC staff recommendation.	15	34.1%
The CEO/CAO would consider an EOC staff recommendation but also consider additional criteria before making a decision.	9	20.5%
Other	2	4.6%
The CEO/CAO would choose one or more alternatives among a set presented by EOC staff.	2	4.6%
The CEO/CAO would allow the EOC staff to issue an evacuation warning without being consulted.	1	2.3%



Expected Duration of Evacuation Warning Approval Process (N = 44)

# RQ3 What are the channels through which LEMAs issue official evacuation warnings to their jurisdictions?



	Frequency	Percent
Agency Facebook page	39	88.6%
Local TV stations	38	86.4%
Local radio stations	38	86.4%
FEMA Wireless Emergency Alert (WEA)	35	79.6%
Local emergency alert system	31	70.5%
Agency X/Twitter posts	30	68.2%
NOAA Weather Radio	26	59.1%
FEMA Emergency Alert System (EAS)	25	56.8%
Local newspapers	17	38.6%
Autodial telephone system	17	38.6%
Door-to-door notification	10	22.7%
Route alert (loudspeakers on emergency vehicles)	10	22.7%
Other	7	15.9%
Sirens	2	4.6%

• 7.39 channels of usage on average

- Substantial variation: Man 13, Min 1
- 8 channels are used by over half of respondents

## **RQ4** Do LEMAs have templates for their evacuation warning messages and, if so, what are the elements of those templates?



	Frequency	Percent
Warning message source (e.g., the city mayor)	32	97.0%
Areas to be evacuated	31	93.9%
Expected time of landfall	26	78.8%
Sources of additional information (e.g., LEMA website)	24	72.7%
Recommended evacuation routes	21	63.6%
Saffir-Simpson Category	20	60.6%
Provisions for evacuation assistance (e.g., pickup points for carless households)	20	60.6%
Also issued in languages other than English	20	60.6%
Expected landfall location	19	57.6%
Also issued for hearing-impaired (e.g., American Sign Language)	12	36.4%
Other	5	15.2%

### • 75% have a template

- 7 message elements included in template on average
- Substantial variation for message elements included, Max 10, Min 3

## **RQ5 What percentage of the risk area population do LEMAs expect to receive an official evacuation warning within one hour?**





Expected Percentage of Households Receiving an Official Evacuation Warning Within One Hour (N = 42).

- Only 10 counties expect 100% reception of households within one hour
- 17 -> 75% 99%
- 5 -> 50% or fewer

# **RQ6** What are LEMAs' perceptions of informal warning networks?





Expected Percentage of Risk Area Population Receiving Hurricane Evacuation Warnings Only Via Informal Channels (N = 42)

- Almost half of the respondents (49%) believe that only 25% of the risk area population would receive an evacuation warning through informal communication channels rather than through official channels or the news media.
- A majority of respondents (72%) believe that this is true for less than 50% of the risk area population.

# RQ6 What are LEMAs' perceptions of informal warning networks? (cont.)





The extent of the impact of informal communication channels on evacuation times(N = 38)

Prevalence of Rumors/Misinformation In Informal Communication Channels (N = 43)

	Frequency	Percent	Cumulative Percent
Not at all	1	2.3%	2.3%
Slight extent	10	23.3%	25.6%
Moderate extent	18	41.9%	67.4%
Great extent	11	25.6%	93.0%
Very great extent	3	7.0%	100.0%

Perceived Impact of Informal Communication Channels (N = 44).

	Frequency	Percent
Mostly helpful	16	36.4%
Somewhat helpful	21	47.7%
Neither helpful nor harmful	6	13.6%
Somewhat harmful	0	0.0%
Mostly harmful	1	2.3%



Understanding and Modeling the Informal Warning System to Enhance Community Resilience



https://okstate.az1.qualtrics.com/jfe/form/SV\_9TwAPu1sdaFd4FM



# SECTION 1: RECAP OF TASK 1a SECTION 2: RESULTS OF LEMAs SECTION 3: RESULTS OF HOUSEHOLDERS

### **Demographic Summary of Householders'**

**Demographic Information of Questionnaire for Householders' Use (N = 680).** 



		Frequency	Percent
	18 - 25 years old	70	10.4%
	26 - 35 years old	94	14.0%
<b>A</b> <i>r</i> o	36 - 45 years old	129	19.2%
Age	46 - 55 years old	126	18.8%
	56 - 65 years old	108	16.1%
	More than 65 years old	144	21.5%
	Female	440	65.3%
Conder	Male	230	34.1%
Gender	Prefer not to say	2	0.3%
	Prefer to self-describe	2	0.3%
	Caucasian	469	69.6%
	African American	117	17.4%
De se (sthuisite	Hispanic	64	9.5%
Race/ethnicity	Asian/Pacific Islander	11	1.6%
	Other	9	1.3%
	American Indian/Alaskan Native	4	0.6%
	0	425	66.2%
	1	135	21.0%
Over 65 years People in household	2	79	12.3%
	3	3	0.5%

### **Demographic Information of Householders (cont.)**





120.0%

Years Living in current community (a, N = 672) and home (b, N = 665)

Type of Structure of Householders' home(N = 675).

	Frequency	Percent
Detached single family home	402	59.6%
Multi-family, 1-2 stories	107	15.9%
Multi-family, 3 or more stories	67	9.9%
Mobile or manufactured home	66	9.8%
Other	33	4.9%

### **Previous Experience with Hurricanes or Hurricane Evacuation (N = 669)**

	Frequency	Percent
I have had hurricane damage to my property	330	49.3%
I have evacuated for a storm that did not strike my neighborhood	218	32.6%
I do not have any experience of hurricanes nor hurricane evacuation	59	8.8%
Other	62	9.3%

# **RQ1 What are householders' sources of information about approaching hurricanes?**



	Frequency	Percent
On-air broadcast for national news networks (e.g., ABC, CBS, FOX, NBC)	492	72.4%
National Hurricane Center website	366	53.8%
On-air broadcast for local TV stations (e.g., ABC, CBS, FOX, NBC affiliates)	358	52.6%
On-air broadcast for local radio stations	341	50.1%
Website for national news networks (e.g., ABC, CBS, FOX, NBC)	306	45.0%
Cable broadcast for cable networks (e.g., CNN, FOX, MSNBC, Newsmax, News	272	40.0%
Nation, Weather Channel)		-10:070
Website for local TV stations (e.g., ABC, CBS, FOX, NBC affiliates)	265	39.0%
Website for cable networks (e.g., CNN, FOX, MSNBC, Newsmax, News Nation,	100	27 6%
Weather Channel)	100	27.070
Website for local newspapers	179	26.3%
Website for local radio stations	145	21.3%
Print edition for local newspapers	74	10.9%
Other	74	10.9%

- 4.5 sources used on average
- Max 12, min 1
- SD 2.70, Variance 7.26
- Substantial variation in source utilization

**GOVERNOR'S HURRICANE CONFERENCE®** 

# **RQ2 What factors trigger or hinder householders' decision to evacuate during a hurricane?**



- 3.9 sources used on average
- Max 11, min 1
- SD 2.13, Variance 4.56
- Moderate extend of Variation

### Strom characteristics impact on evacuation

Household



**LEMA** 

Frequency Percent Frequency Percent Hurricane forecast showing the "best estimate" of Storm surge forecast 41 93.2% 430 63.4% the hurricane track Storm intensity (Saffir-Simpson Category) 417 61.5% Storm intensity (Saffir-Simpson Category) 90.9% 40 **Expected time of hurricane landfall** 59.1% 401 Evacuation time estimate 37 84.1% 49.4% **Rainfall/inland flooding forecast** 335 Hurricane track uncertainty cone 34 77.3% **Storm surge forecast** 44.7% 303 Storm forward speed 259 38.2% **Rainfall forecast** 65.9% 29 Hurricane storm swath 170 25.1% Storm swath 22 50.0% Hurricane ensemble forecast ("spaghetti plot") 151 22.3% **Evacuation decision arc** 21 47.7% showing the results of different models Hurricane forecast uncertainty cone 20.8% 141

# **RQ2** What factors trigger or hinder householders' decision to evacuate during a hurricane? (cont.)



Factors Triggering Evacuation Action (N = 68	30).
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	Frequency	Percent
Local official's mandatory evacuation order	504	74.1%
Likely loss of basic services (water, electric power, telecommunications)	378	55.6%
National Hurricane Center watches and warnings	354	52.1%
Likely wind damage to my home	351	51.6%
Likely inland flood damage to my home	346	50.9%
Likely surge damage to my home	283	41.6%
Local official's voluntary evacuation order	233	34.3%
Other	20	2.9%

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	Frequency	Percent
Evacuation travel cost (e.g., gas, food, lodging in hotel/motel)	384	56.8%
Evacuation traffic jams	356	52.7%
Looting of my home while I am evacuated	267	39.5%
Storm damage to my home while I am evacuated	220	32.5%
Evacuation traffic accidents	215	31.8%
Lost income while evacuating	161	23.8%
Infections by a contagious disease (e.g., COVID-19) while I am evacuated	89	13.2%
Other	61	9.0%

Factors Hindering Evacuation Decisions (N = 676).

- 3.6 factors chosen on average
- Max 8, min 1
- SD 1.82, Variance 3.32
- Relatively low extent of variation

- 2.6 factors chosen on average
- Max 8, min 1
- SD 1.49, Variance 2.21
- Relatively low extent of variation

# **RQ2 What factors trigger or hinder householders' decision to evacuate during a hurricane? (cont.)**



Householders' Evacuation Proceeding Timing (N = 680).

	Frequency	Percent
before the National Hurricane Center issues a Hurricane Watch	44	6.5%
after the National Hurricane Center issues a Hurricane Watch but before a Hurricane Warning	130	19.1%
after the National Hurricane Center issues a Hurricane Warning	280	41.2%
I would leave for reasons other than a National Hurricane Center Hurricane Watch or Warning	97	14.3%
It depends on the situation (Please explain in the text entry below)	129	19.0%



Timing Comparison of LEMAs Issue a Hurricane Evacuation Warning vs. Householder Proceed a Hurricane Evacuation

**RQ3 How do householders use informal warning channels to receive and share information about an approaching dangerous hurricane?** 



Perceived of Informal Warning Channels ( $N = 677$ ).			
	Frequency	Percent	
Mostly helpful	306	45.2%	
Somewhat helpful	273	40.3%	
Neither helpful nor harmful	76	11.2%	
Somewhat harmful	20	3.0%	
Mostly harmful	2	0.3%	



Comparison of LEMAs' and Householders' Perceived of Informal Warning Channels.

**RQ3 How do householders use informal warning channels to receive and share information about an approaching dangerous hurricane?** 



**Expected Information Received from Peers via Informal Channels During Hurricane Evacuation Decisions (N = 679).** 

	Frequency	Percent
Recommended evacuation routes	466	68.6%
Recommendations about the best time to leave	383	56.4%
Recommended evacuation destinations	375	55.2%
Recommendations for items to take during evacuation (e.g., food, water, medications)	321	47.3%
Offers to let you stay with them during the evacuation	307	45.2%
Other	13	1.9%

- 2.7 message elements expected to receive
- Max 5, min 1
- SD 1.37, Variance 1.89
- Relatively low extent of variation

## **RQ3 How do householders use informal warning channels to receive and share information about an approaching dangerous hurricane? (cont.)**



Warning and Communication About Approaching Hurricanes with Community and Family (N = 678).

	Frequency	Percent
No	111	16.4%
Yes	567	83.6%
Total	678	100.0%

- 84% will inform or warn their family friends, and neighborhoods
- Most respondents, 42% will inform 2 5
- 11% indicated that they will inform 10



Number of Householder Expected to Inform or Warn about an Approaching Dangerous Hurricane (N = 415).

**RQ3 How do householders use informal warning channels to receive and share information about an approaching dangerous hurricane? (cont.)** 



### Channels Used to Inform and Communicate with Family,

Friend and Neighborhood (N = 568).

	Frequency	Percent
Call or Facetime them on the phone	478	84.2%
Send them a text	449	79.0%
Go to their home and talk to them face-to-face	175	30.8%
Post a message on a social media platform (e.g., Twitter/X)	159	28.0%
Send them an Instant Message (e.g., Twitter/X)	117	20.6%
Send them an email	103	18.1%
Other	3	0.5%

- 2.6 channels of usage on average
- Max 7, min 1
- SD 1.24, Variance 1.55
- Respondents' selections are clustered around the mean with less variability

Problems Encountered with Informal Warning Channels in Past Hurricanes (N = 677).

	Frequency	Percent
No	627	92.6%
Yes	50	7.4%

# **RQ4** What are householders' primary considerations regarding hurricane evacuation preparedness and plans?

### Householders' Hurricane Evacuation Plan Preparedness (N =

679).			
	Frequency	Percent	
Yes	420	61.9%	
No	259	38.1%	

- 2.3 message elements included in evacuation plan on average
- Max 8, Min 1
- SD 1.41, Variance 1.99
- Respondents' answers are clustered around the mean with less variability

Content Elements of Householders' Emergency Plan for Hurricane Evacuation (N = 420).

	F	requency	Percent
Emergency kit with essential items (food, water, prescription medicines, important documents)		364	86.7%
Planned evacuation route		288	68.6%
Evacuation accommodations in relative's/friend's home		223	53.1%
Alternate evacuation route if the planned route is too crowded		189	45.0%
Evacuation destination: Which city or county?		127	30.2%
Evacuation accommodations in a commercial facility (e.g., hotel or mote	I)	114	27.1%
Evacuation accommodations in a public shelter		55	13.1%
Evacuation accommodations in another facility (e.g., vacation home)		36	8.6%
Other		10	2.4%

# **RQ4** What are householders' primary considerations regarding hurricane evacuation preparedness and plans? (cont.)



**Frequency of Respondents' Vehicles Taking in Evacuation (b)** 

Number of Registered Vehicles (a, N = 593) and Planned Evacuation Vehicles (b, N = 590).

# **RQ4** What are householders' primary considerations regarding hurricane evacuation preparedness and plans? (cont.)

### Is your home in a....

	Risk Area/Evacuation Zone (N=679)		FEMA Flood Zone Status (N=678).	
	Frequency (a)	Percent (a)	Frequency	Percent
Yes	294	43.3%	209	30.8%
Unsure	214	31.5%	216	31.9%
No	171	25.2%	253	37.3%





Estimated Travel Time to Destination by Using Preferred Hurricane Evacuation Route by the Overall Householders (N = 674) and Householders Live in a Risk Zone (N = 338)

### **Household's Evacuation Time Estimate by States**



# **RQ5** What are householders' main concerns about risk communication of hurricanes and hurricane evacuation?



Householders' Suggestions for LEMAs to Improve Risk Communication on Social Media (N = 280)

		Frequency	Percent
	Timely, Frequent, and Continuous Communication Alerts/Warnings	40	14.3%
Information (37.9%)	Accurate and comprehensive Information	20	7.1%
	Trusted/credible and transparent Communication	27	9.6%
	Coverage, accessibility, and availability of risk information	19	6.8%
Even water Management $(0, 6\%)$	evacuation routes, destination, and order	18	6.4%
Evacuation Management (9.6%)	Shelter, available assistance, and resources	9	3.2%
Communication and Interaction (19.6%)	Strengthen communication and coordination between government agencies, tv, and social media	39	13.9%
	Strengthen communication with public and community	7	2.5%
	educate the public	2	0.7%
	Strengthen the Role of Cellphones or other electronic devices in Risk Communication	7	2.5%
Social Equity and Justice (4.6%)	Vulnerable Populations	9	3.2%
	Pet and Livestock Care	4	1.4%
Trusting Official Channels Over social media (12.9%)	Distrust of social media or Embracing Old School Communication Styles	36	12.9%
No additional recommendation (17.6%)	Satisfied with LEMAs' effort	43	15.4%



## **Questions and Discussion**

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LEMA Survey: Understanding and Modeling the Informal Warning System to Enhance Community Resilience









