

# Heterogeneity of Households' Risk Assessments in Affecting Evacuation Decisions during Hurricane Ike

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## Introduction

### Objective

This study aims to examine whether different information-processing and risk assessment approaches (measured by the level of interrater agreements [ $r_{wg}$ ]) would affect the effects of informational, contextual, and psychological variables on individuals' hurricane evacuation decision.

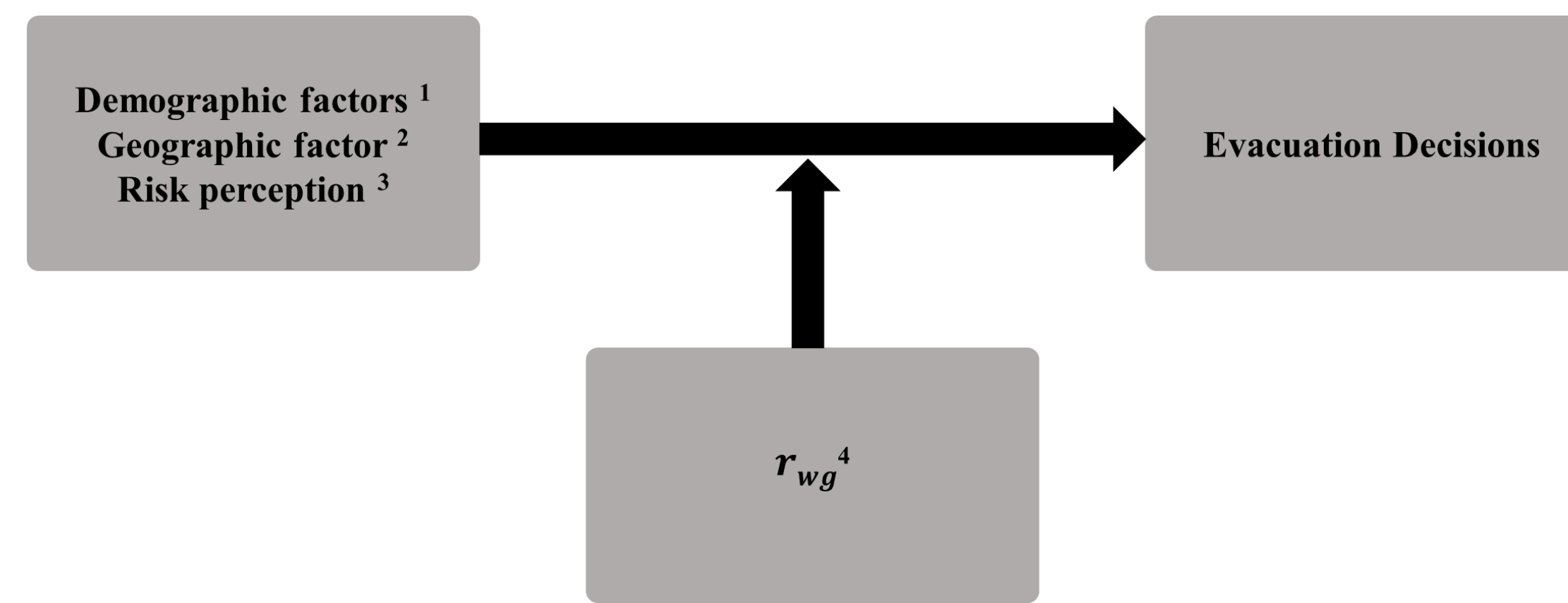
### Research Gap

While many hurricane evacuation studies acknowledge that individuals' evacuation decisions are influenced by their cognition, the existing empirical research is limited in examining the effects of contextual and psychological factors on decision-making, while the role of residents' intellectual processes is often overlooked. For example, empirical evidence only confirms the strong correlation between residents' risk perceptions and evacuation decisions. Nonetheless, it remains unclear whether inconsistent worries also play a significant impact. Furthermore, if these modes matter, their specific function in the decision-making process remains unclear as well.

### Background of Study

This study reanalyzed Hurricane Ike Survey Data collected by Hazard Reduction and Recovery Center (HRRC), TAMU in two Texas study areas five months after the hurricane landfall (February ~ June, 2009).

## Framework



1. Demographic Variables: age, gender, minority, marital status, household size, education, income, home ownership, mobile home resident
2. Geographic Variables: proximity to the costal line (risk area)
3. Risk Perception Variables: storm character, expected personal impacts, social environment and warning, evacuation impediments
4. Risk Assessment Approaches: Classified by the consistency of worry levels among risk perception variables measured by  $r_{wg}$

$$r_{wg} = 1 - \frac{s^2_x}{\sigma^2_{EU}}$$

$s^2_x$  is the variance of the respondents' ratings,  
 $\sigma^2_{EU}$  is the variance of uniformly distributed error,  $(A^2 - 1)/12$ ,  
 A is the number of response alternatives.

$rwg$  ranges from -1 to +1: A high of  $rwg = +1$  when all raters give the same ratings, through  $rwg = 0$  when the ratings are uniformly distributed, to  $rwg = -1$  when there is a bipolar distribution.

## Methodology

### Mail survey

- The Texas A&M University Hazard Reduction & Recovery Center conducted a mail survey
- Galveston Study Area(GSA) and Slake Sabine Study Area(SSA)
  - Risk areas A, B, C in GSA & inland areas of Harris County
  - Jefferson County in SSA
- 562(of 808) households returned valid questionnaires (39.4%)

### Factor Analysis

- Twenty psychological-related items were reduced into nine scales, namely *storm characteristics, rapid onset, expected impacts, job disruptions, service disruptions, social warning, previous experience, crying wolf, and evacuation impediments.*

### Multivariate Analyses

- Regressions had been conducted by entering variables indicated in the Lindell and Perry's PADM plus risk assessment approaches (i.e.,  $r_{wg}$ ) to determine the main effect(s) of the evacuation decision-making.

### Interaction Analyses

- Generalized liner model was conducted to examine the moderating effect of  $r_{wg}$  between other variables and evacuation decision.

### Calculating $r_{wg}$ of risk perception variables

- $r_{wg} = 1 - \text{variance}/(c^2-1)/12$
- Equal worries ( $r_{wg}$  was significantly different from 0) = 1
- Diverse worries ( $r_{wg}$  was not significantly different from 0 or smaller than 0) = 0

## Regression

Variable	Model 1			Model2		
	B	S.E.	Exp(B)	B	S.E.	Exp(B)
Age	0.02*	0.01	1.02	0.02*	0.01	1.02
Home ownership	-0.88*	0.41	0.42	-0.89*	0.41	0.41
Risk Area	-0.62***	0.10	0.54	-0.62***	0.10	0.54
RapidOnset	-0.45***	0.12	0.64	-0.49***	0.13	0.61
Job disrupted	-0.15*	0.08	0.86	-0.14	0.08	0.87
Wolf crying	-0.35***	0.09	0.71	-0.36***	0.09	0.70
ExPerImp	1.15***	0.17	3.16	1.11***	0.17	3.04
Soc_Warn	1.00***	0.14	2.71	1.02***	0.14	2.78
EvacImp	-0.35***	0.12	0.70	-0.36***	0.12	0.70
rWG3_ExpPerImp				-1.13*	0.66	0.32
Constant	-0.79	0.83	0.45	0.34	1.07	1.41
$\chi^2$	256.48***			259.71***		
df	9.00			10.00		
Nagelkerke R <sup>2</sup>	0.50			0.50		

\*  $p < .05$ , \*\*  $p < .01$  \*\*\*  $p < .001$  <sup>a</sup> p-value is close to .05

- Evacuation decision Model 1 (without control of  $r_{wg}$ ) showed that expected personal impacts ( $OR = 3.16$ ), social environments & official warnings ( $OR = 2.71$ ) had significant positive coefficients.
- Evacuation impediments ( $OR = 0.70$ ), rapid onset ( $OR = 0.64$ ), job disruption ( $OR = 0.86$ ), and wolf crying experience ( $OR = 0.71$ ) had significant negative coefficients.
- Among demographic and geographic factors, only age ( $OR = 1.02$ ), home ownership ( $OR = 0.42$ ), and risk area ( $OR = 0.54$ ) had significant coefficients.
- When entering  $r_{wg}$  into the model (Model 2),  $r_{wg}$  did not receive a significant effect, and neither did it affect the significance of other variables on evacuation decision.

## Interaction Effects

Dependent Variable: Evacuation Decisions			
Variables	df	Mean Square	F
<b>Corrected Model</b>	85	0.71	<b>4.66***</b>
<b>Intercept</b>	1	21.81	<b>142.74***</b>
Age * $r_{wg\_ExpPerImp}$	73	0.12	0.76
Homeownership * $r_{wg\_ExpPerImp}$	1	0.15	0.95
RiskArea * $r_{wg\_ExpPerImp}$	4	2.14	<b>14.01***</b>
RapidOnset * $r_{wg\_ExpPerImp}$	1	1.89	<b>12.35***</b>
JobDisrupt * $r_{wg\_ExpPerImp}$	1	0.10	0.68
UnnecEvac * $r_{wg\_ExpPerImp}$	1	1.13	<b>7.42**</b>
ExPerImp * $r_{wg\_ExpPerImp}$	1	5.70	<b>37.34***</b>
Soc_Warn * $r_{wg\_ExpPerImp}$	1	9.32	<b>61.03***</b>
EvacImp * $r_{wg\_ExpPerImp}$	1	1.15	<b>7.55**</b>
<b>Error</b>	472		
<b>Total</b>	558		
<b>Corrected Total</b>	557		
R <sup>2</sup>	0.46		
Adj R <sup>2</sup>	0.36		

\*  $p < .05$ , \*\*  $p < .01$  \*\*\*  $p < .001$

Test assessing the interaction effects of  $r_{wg}$  of expected personal impacts and nine variables on evacuation decisions showed six variables produced significant interactions: risk area ( $F = 14.01$ ,  $p < .001$ ), rapid onset ( $F = 12.35$ ,  $p < .001$ ), wolf crying ( $F = 7.42$ ,  $p < .01$ ), expected personal impacts ( $F = 37.34$ ,  $p < .001$ ), social environment & official warning ( $F = 61.03$ ,  $p < .001$ ), and evacuation impediments ( $F = 7.55$ ,  $p < .01$ ).

## Takeaways

- As expected, entering *risk assessment approach* as an additional predictor of the evacuation decision did not yield a significant change. Specifically, the main effects of other variables observed previously remained in effect. This result suggests that individuals' evacuation decisions were primarily influenced by the overall perceived level of risk, rather than the specific approach used to process risk information.
- The results of significant interaction with inverse effects of risk assessment approach crossing *risk area* and *social warning* are noteworthy. These findings suggest that individuals residing in high-risk areas might choose not to evacuate due to their perception of the risk being controllable, or because they weigh other associated problems against the potential direct impacts engaged with the hurricane. Conversely, individuals located outside the risk-prone may opt to evacuate due to their perception of a specific vulnerability.
- The interactions between risk perception variables (i.e., expected personal impacts and expected evacuation impediments) and the risk assessment approach are important. While it was expected that inconsistent ratings of risk perception items would diminish overall ratings and subsequently reduce the likelihood of evacuation, the findings indicated that the inconsistent concerns regarding threats and consequences rendered the effects of risk perception variables on evacuation decisions statistically insignificant. One possible explanation for this outcome is that respondents assigned varying levels of importance to different risk perception items, and only the selected concerns played a role in their decision-making process. However, it is also possible that the complex nature of the risk assessment process itself created hesitation among respondents, affecting their decision-making.
- The results of this study have the potential to enhance our understanding of behavioral responses to hurricane evacuation and their implications. These findings may also play a crucial role in the development of more precise simulation models through computer-based studies. However, it is important to note that this study only presented the preliminary test results. To gain a deeper comprehension of the various information-processing behaviors and their functions, future studies with more intricate designs are necessary.
- This study is subject to several limitations that need to be addressed. First, the skewed distribution of the respondents may introduce bias in the findings concerning demographic and geographic variables. It is important to acknowledge that the sample may not be representative of the overall population, which limits the generalizability of the results. Next, the use of  $r_{wg}$  as a measure for risk assessment approaches requires further validation to ensure its accuracy and reliability in capturing risk assessment outcomes. As a result, the internal validity of the interaction effects reported in this study needs to be further examined.