The Public's Prioritization of Probability and Intensity in Tornado Risks

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Introduction

The Storm Prediction Center (SPC) created the convective outlook to communicate storm risks across the continental United States using both categorical risk and probability. The categorical risk information is based almost exclusively on the probability of storms with little to no attention to their intensity. Traditional categorical convective outlooks can be confusing to less experienced end users such as the general public. Recently, the SPC has considered including more intensity information to their outlooks but there is limited research on how people define a risk using probability and intensity information.

The objective of this project is to determine what information presented in the SPC convective outlook (e.g. probability/intensity) is prioritized more by public users to help improve risk management and communication. Understanding what information is prioritized by the public will help the SPC determine if more information, such as intensity, would make a beneficial impact on people's risk perception and severe weather preparation habits.

NOAA Severe Thunderstorm Risks Categories

LEVEL	CATEGORY	DETAILS	SUMMARY
	General Thunderstorm	Although severe weather is not expected, ***all*** thunderstorms can produce deadly lightning, gusty winds, and small hail.	No severe thunderstorms expected
1	Marginal (MRGL)	Some storms could be capable of damaging winds and severe hail. Localized tornado threat could develop.	Isolated severe storms possible
2	Slight (SLGT)	Increased confidence that some storms will contain damaging winds, severe hail, and/or tornado potential. *A few severe storms could be significant*	Isolated to scattered severe storms expected
3	Enhanced (ENH)	High confidence that several storms will contain damaging winds, severe hail, and/or tornadoes. *Several severe storms could be significant*	Scattered to numerous severe storms expected
4	Moderate (MDT)	High confidence that many storms will contain damaging winds, severe hail, and/or tornadoes. *Several severe storms likely to be significant*	Scattered to numerous severe storms expected
5	High (HIGH)	High confidence that an outbreak of storms will contain tornadoes, damaging winds, and/or severe hail. *Tornado outbreak and/or widespread damaging winds*	Numerous severe storms expected

"Understanding Severe Thunderstorm Outlook Categories" | infographic | *spc.noaa.gov*

TABLE 1. Survey Response and Categorization Examples

Category	Assigned Risk Word	Participant Responses
Probability	Slight Risk	"Less than 20% chance"
	Moderate Risk	"Low possibility"
	High Risk	"That there is a potential for hail and damaging winds heavy rains along with lightning"
Intensity	Slight Risk	"Slight risk to me means that there is a risk but not as extreme as a warning"
	Moderate Risk	"Some hail damage, heavy winds"
	High Risk	"Cause severe damage"
Probability & Intensity	Slight Risk	"could be severe storms that could have tornadoes"
	Moderate Risk	"Storm or tornado outbreak is expected. ... The likelihood of tornadoes, often strong and/or long-lasting"
	High Risk	"Could lose it all"
Something Else	Slight Risk	"Just prepare"
	Moderate Risk	"Be ready to listen to info"
	High Risk	"Very risky"

Data & Methods

- **Data for this study was obtained from the Severe Weather and Society Survey (WX) developed by IPPRA**
- **Survey data from the 2017 and 2019 surveys were used for analysis**
- **Estimation sample demographically represents U.S. population**
  - **2017 (n = 2,009) and 2019 (n = 3,006)**
- **Data analyzed using bar plots and linear regression models on R Studio**

Survey Questions:

1. When thinking about the risk of tornadoes, is probability (the likelihood that a tornado will occur) more important than intensity (the strength and size of the tornado)? Or, is intensity more important than probability?
2. What does it mean if there is a [SLIGHT RISK | MODERATE RISK | HIGH RISK] of tornadoes in your area tomorrow evening. Please provide a sentence or two interpreting the phrase [SLIGHT RISK |MODERATE RISK | HIGH RISK].
3. Forecasters might consider the probability and intensity of extreme weather events when communicating information and risk. For example, a 1% chance of a severe (EF-3) tornado may be less risky than a 10% chance of a moderate (EF-2) tornado. Or a 2% chance of a devastating (EF-4) tornado may be more risky than a 90% chance of a light (EF-0) tornado. We would like to know how YOU weigh the probability and intensity of extreme weather events.

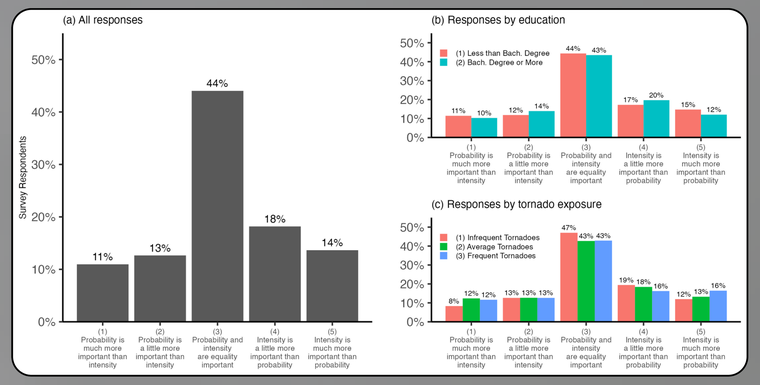

FIG. 1. Bar plots display the proportion of survey respondents who selected a response 1-5. All responses (a) are also analyzed by education level (b) and tornado exposure (c).

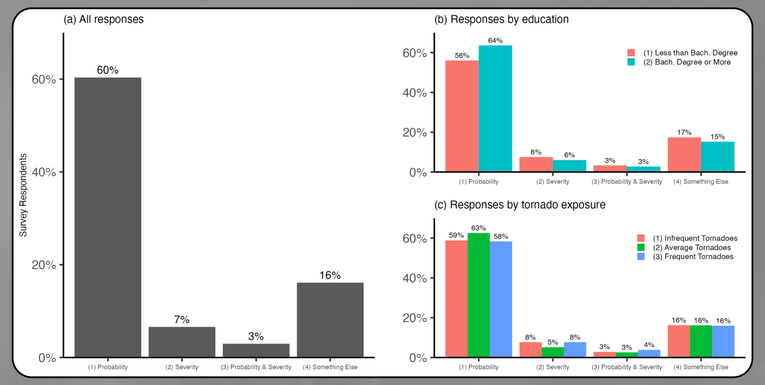

FIG. 2. Survey responses are categorized by which set of information (probability, intensity, both, or something else) influences one's risk phrase interpretation.

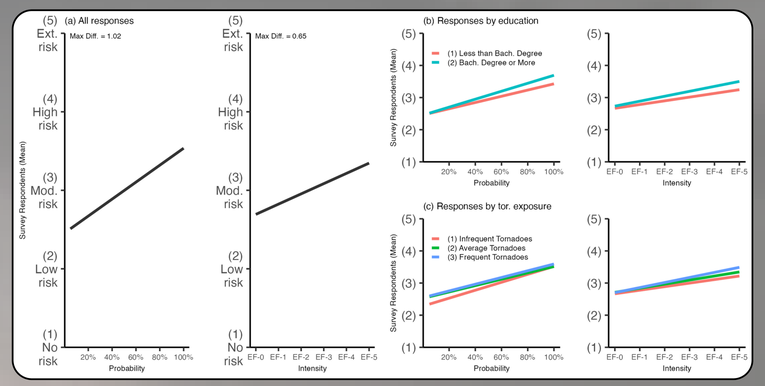

FIG. 3. The slope of the relationship between the level of presented information (probability or intensity) and the level of a respondent's risk perception. The line indicates the relationship between probability value vs. risk level chosen by respondents (left) and intensity level vs. risk level (right).

Quantitative/Qualitative Results

*All data is sorted by three variable parameters used for comparisons and further analyzation:
a) All Responses
b) Responses by education
c) Responses by tornado exposure

FIG. 1

- **44% of all respondents considered probability and intensity information as equally important to assess when thinking about the risk of tornadoes**
- **Data followed similar distribution regardless of sorting method**

FIG. 2

- **Data followed a bimodal distribution with most responses categorized under "probabilistic" or "something else"; distribution was similar across each sorting method**
- **Majority (60%) of all respondents used probabilistic language to explain given categorial risk terms**

FIG. 3

- **Increase in probability value and/or intensity increases ones risk perception**
- **Slope relationship of probability vs. risks is steeper meaning probability information had a greater impact on ones' risk perception**
- **Data followed similar ditribution regardless of sorting method**

Conclusion & Implications

The majority of the public uses both probability and intensity information equally when interpreting categorical risks.

- Quantitative measurements revealed that probability and intensity are equally important, and both are used to discern risks
- Qualitative analyses further revealed that probability comes to mind more frequently than intensity in the general public's interpretations

We suggest the SPC should include more explicit intensity information to enhance the efficiency of the convective outlook.

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