Messaging the Threat:
Forecaster Difficulties Prioritizing Compound Hazards During Hurricane Florence

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Abstract: Hurricanes threaten communities in nuanced ways due to storm characteristics, geography, demographic, and cultural factors. Risks to people in the path of these storms are compounded when wind and water hazards co-occur. For NWS forecasters, messaging these co-occurring threats poses many challenges, including the prioritization of those likely to have the greatest impacts. This research focuses on Hurricane Florence, a Category 1 hurricane that produced large floods across the mid-Atlantic coast in September 2018. Through inductive, qualitative analysis of 33 semi-structured interviews with NWS forecasters responsible for issuing alerts during Florence, the intricacies of messaging these evolving, compound threats were examined. Analysis showed that forecasters aimed to amplify messaging for flood threats over wind threats during Florence, yet they expressed concern that this prioritization was not grasped by the public. One reason for this disconnect may be the emphasis placed on the Saffir-Simpson Hurricane Wind Scale as a metric of hurricane severity.

Hurricanes are complex weather events that involve multiple hazards at once. The National Hurricane Center (NHC) associates storm surge and storm tide; heavy rainfall and inland flooding; high winds; rip currents; and tornadoes with landfalling hurricanes (NHC, 2022). The concurrent nature of these hazards adds to the complexity of decision-making during hurricanes (Cegan et al., 2022), including the decisions that influence National Weather Service (NWS) messages. However, there is a gap in understanding how the public interprets these messages, which means that attempts within the NWS to improve threat communication during weather events may not solicit the intended understanding and action from the public (Bostrom et al., 2018). To improve hurricane warnings, links between how they are crafted and how they are perceived therefore must be made. This paper examines these challenges through 33 interviews conducted with NWS employees who worked during Hurricane Florence, which caused multiple types of hazards and historic flooding. Findings provide insight into how NWS employees navigate messaging for the complex hazards posed by hurricane events, including how they judge the most pressing threat, how they elevate this threat, and how their framing of threats is informed by what they think the public thinks about them.

Effective messaging allows those in the NWS to fulfill on their mission to protect life and property. Overall, the NWS has been successful at this, with the number of direct deaths due to hurricanes trending downward over the past few decades (NWS, 2022a) and the amount of monetary damage staying roughly the same when adjusted for inflation (Weinkle et al., 2018). However, compound hazards complicate these practices and must be accounted for to continue this positive trend, particularly in the context of a rapidly changing world due to climate change, globalization, and other factors of modernity (Cegan et al., 2022). Although

there is still discussion about what climate change means for the trends in hurricanes along the U.S. Atlantic and Gulf coasts (Wu et al., 2022), it is likely that their severity and intensity will increase (Pfeiderer et al., 2022). This could lead to a concurrent increase in the associated compound hazards, including heavier rainfall due to increases in sea surface temperature (Reed et al., 2022). Understanding how to message for overlapping hazards may therefore be integral for continued effectiveness of NWS hurricane watches and warnings.

Background

Hurricane Florence made landfall in Wrightsville Beach, North Carolina on September 14, 2018, where it caused extensive floods, produced winds of up to 106 mph, and spawned over 44 tornadoes. According to the NHC report on Florence, the impacts of these threats resulted in 22 direct deaths and over $24 billion in damages (Stewart & Berg, 2019). Originally forecasted on September 11 as a category 4 hurricane, windshear soon slowed Florence's winds significantly. Wind speed continued to decline until Florence made landfall as a slow-moving Category 1 hurricane three days later. It then proceeded to move at an incremental pace, hovering over North Carolina, South Carolina, and parts of Virginia until September 17, when it became extratropical north of western West Virginia. During this time Florence set tropical cyclone rainfall records in both North Carolina and South Carolina, dumping 34.95 and 23.63 inches in each state, respectively, and produced large storm surge along the coasts, with some parts of North Carolina seeing highs of 11 feet. The extreme precipitation and surge caused most of the damage and necessitated more than 5,300 water rescues (Stewart & Berg, 2019).

Literature Review

In the paragraphs that follow, three types of literature are discussed. First is literature about NWS forecasters messaging practices during hurricanes, with specific attention to how overlapping threats affect messaging. This literature is connected to research on the public view of threats during hurricanes to contextualize the space that NWS messages operate within. Secondly, a review of disaster vulnerability literature explains how the public response to disaster is influenced by factors other than messaging, again with an emphasis on overlapping threats. Finally, literature that provides the context of the Saffir-Simpson Hurricane Wind Scale (SSHWS)—including a brief history of its policy and use as well as an overview of the critiques that have been leveled against it—communicates the background needed to understand one of the complications of messaging during overlapping hazards that the participants in this study experienced.

NWS Messaging and Public Perception of Compound Threats During Hurricanes

NWS forecasters are some of the many actors who directly influence the public's knowledge of potential disasters (Demuth et al., 2012). They do this by issuing watches and warnings for hazards, as well as advice for protective action ahead of severe weather events (NWS, 2022b). However, there is a gap in the literature between how NWS messages are created by those within the agency and how the public comprehends what they are being told (Bostrom et al., 2018). Attempts have been made to rectify this gap. For example, Morrow et al. (2015) did a study in collaboration with the National Oceanic and Atmospheric Administration (NOAA) that utilized interviews and surveys with both weather professionals and members of the public to gauge the effectiveness of messaging products (hereafter referred to as "products") on storm surge risk. This study informed the creation of experimental storm surge

products that had been vetted to enhance communication between the expert community and the public (Morrow et al., 2015).

Processes that incorporate the perspectives of different stakeholders into how dangerous weather is messaged matter because it has been found that NWS products and practices may unintentionally amplify one threat over another within multi-hazard scenarios (Henderson et al., 2020). This amplification could then be compounded by the fact that members of the public may not interpret these messages in the same way that those issuing them do. In hurricanes, which are events where multiple threats occur at once, "end-to-end understanding of the processes involved in forecasts and warnings" (Bostrom et al., 2018, p. 106) is therefore critical to understand how messaging can be improved.

How the public does or does not understand compound hazards is one space where more insight could assist NWS messaging. Studies from across areas susceptible to floods during hurricanes have shown that the public tends to heighten the threats from wind above those from water (Bostrom et al., 2018; Morss & Hayden, 2010). This occurs even when forecasters understand the danger from threats differently; for example, if the storm surge from a specific event will have a much greater impact than straight-line winds (Bostrom et al., 2018). For the amplification of wind threats during hurricanes, it has been posited that the disconnect may be rooted in the widespread use of the SSHWS as representative of the danger posed by a hurricane (Morss & Hayden, 2010), which may also inform evacuation decisions (Glass et al., 2021; Losee et al., 2017). These examples will be revisited in depth in the section on literature relevant to the SSHWS.

Research into the public directly affected by Florence also showed that decisions about preparative actions for a storm are influenced by factors other than NWS messages (Brassell et al., 2019; Mongold et al., 2021; Yum, 2020). For example, Mongold et al. (2021) showed the influence of geography on evacuation by finding that 55% of those who live in a coastal county evacuated during Florence, while only 24% of those who live in an inland county did the same. Moreover, those who fell into the latter category were less likely to know if they were under an evacuation order to begin with (Mongold et al., 2021). Another study on the population who experienced Florence showed that although many people base their evacuation actions on their location in or outside of an evacuation zone, a significant number of others are more influenced by factors like their belief in the threat or their personal resources (Brassell et al., 2019). Human sentiment and culture have also been revealed to play a role in the way the public interpreted the threats during Florence (Yum, 2020). These results demonstrate how context factors into the ways that NWS messages are received by the public and make a case for the need to incorporate this context into how messages are formulated ahead of disaster.

Disaster Vulnerability in the Context of Compound Hazards

Social vulnerability to disaster describes the degree to which a community is able to prepare for, respond to, and recover from hazardous events (Centers for Disease Control and Prevention [CDC], 2022). The creation of the CDC's Social Vulnerability Index (SVI) tool demonstrates the importance that this concept has come to occupy in the discussion of preparation for and response to disaster (DiGrande et al., 2019). The SVI uses U.S. Census data to map communities across the country according to 15 different variables of vulnerability grouped within four larger categories. Some of these, including no vehicle, ability to speak

English, and age and disability demographics (CDC, 2022) are readily applicable to the conversation about evacuation ahead of hurricanes (Song, 2020). For example, older people may struggle more with the logistics of evacuation, making them a particularly vulnerable group (Glass et al., 2021). It is important to pay attention to these factors of vulnerability because they do not always interact in a linear way. Instead, vulnerability can multiply so that those who have the highest vulnerabilities are subject to situations that expose them to greater threats and impacts during disaster (Brassell et al., 2019; DiGrande et al., 2019). The compounding nature of vulnerability is perhaps even more important during events like hurricanes, which have impacts that may be greater than the sum of the individual threats (Cegan et al., 2022).

Vulnerability during disasters exists within the context of both social and environmental variables and is the result of the interactions that occur within the social-ecological systems that emerge (Adger, 2006). Vulnerability therefore becomes a function of the relationships between the many variables involved, which may be social, cultural, geographic, meteorological, or temporal in nature. However, the various wind and water hazards that occur during hurricanes tend to be siloed in the way they are communicated to the public, which may obscure the actual threat level. Cegan et al. (2022) tie the siloed nature of hurricane threats more explicitly to vulnerability through their compounding threat framework, which shows that not accounting for the composite nature of hazards when calculating risk makes it difficult to adjust preparation tactics to the actual needs of the situation. In other words, when hazards are siloed, threats are underestimated, which leads to greater vulnerability within already vulnerable populations.

Critique of the SSHWS

The SSHWS is a standard product issued by the NHC when tropical cyclones reach hurricane force winds. It categorizes storms on a scale from 1-5 based on the peak 1-minute wind speed taken at standard meteorological height over unobstructed exposure and qualifies each category in terms of the resulting damage that will occur (NHC, 2021). The information provided by the SSHWS is important for understanding the potential wind threats posed by a hurricane. However, wind is the only hurricane hazard represented within this scale, limiting its ability to communicate all potential threats or their compounding effects. Despite this, there is evidence that the SSHWS category is used by members of the public as the most important determining factor for what action to take ahead of a hurricane (Glass et al., 2021; Losee et al., 2017), and that confusion around this scale persists. Camelo and Mayo (2021) note, "When coastal residents consider storm surges, the perceived magnitude of risk is often directly related to the intensity of the SSHWS Category, despite the best efforts of scholars and emergency managers" (p. 4).

In an experiment that measured how the category of a hurricane affects people's choice to evacuate, Losee et al. (2017) found strong correlation between higher category storms and evacuation intention. Interestingly, this study also found that hurricanes that started as Category 5 before being downgraded to Category 1 prompted more evacuations than those that started and stayed at the lower category. This demonstrates that the presence of a high category forecast at any point during the life of a storm may make it seem more severe. A similar emphasis on category was found by Glass et al. (2021), specifically within the context of Hurricane Florence, when they noted a tendency among some older retirees to take higher category storms more seriously. However, since hurricane category is only tied to its winds,

high severity threats are not singularly tied to high category storms, a fact that Hurricane

Florence illustrated well.

The NHC (2021) also acknowledges that the SSHWS does not provide a comprehensive

picture of hurricane threats, which resulted in previous changes to what this scale measures.

The original scale, called Saffir-Simpson Hurricane Scale, quantified potential storm surge

alongside winds. However, storms like Hurricane Ike, a Category 2 hurricane that created 20-

foot storm surges in 2008, demonstrated that high winds and high surge do not always co-

occur, as a storm's size, speed, and angle, as well as the geography of the coast, all affect the

depth of storm surge. The NHC (2021) therefore removed storm surge in their reformulation of

the SSHWS to ensure that it was more scientifically accurate and in hopes of reducing confusion

among the public.

To reorient hurricane severity away from wind, some researchers have proposed

alternatives to the SSHWS (Bloemendaal et al., 2020; Bosma et al., 2019; Song et al., 2020). By

including other variables, like rainfall amounts, in the numerical value of a hurricane, these

alternatives demonstrate that the way hurricanes are currently categorized isn't necessarily

optimal (Bosma et al., 2019). Bloemendaal et al.'s (2020) Tropical Cyclone Severity Scale offers

a particularly intriguing reconceptualization of hurricane category. Storms are still organized on

1-5 numerical scale. However, arriving at this number requires the separate quantification and

subsequent consolidation of all potential threats. Using this method, Hurricane Florence was

upgraded from a Category 1, based solely on its winds, to a Category 5, due to its storm surge

and precipitation (Bloemendaal et al., 2020).

Methods

This paper reports the results from the inductive analysis of 33 semi-structured interviews with individuals who work within three NWS Weather Forecast Offices (WFO) that were affected by Hurricane Florence. Participants were selected based on whether they worked during Hurricane Florence so that they could provide insight into the practices, challenges, and concerns that shaped this disaster event from the perspective of the NWS forecast community. Participants were identified using purposive sampling methods and all interviews were conducted in-person by three researchers from University of Colorado Boulder in August and September of 2019, one year after Hurricane Florence made landfall.

Interviews were audio recorded and then transcribed by a professional transcription service. Transcripts from all three offices were then thematically analyzed through inductive coding processes in NVivo. Coding involved an iterative process, beginning with codes that were refined throughout multiple readings to generate themes of analysis. A total of 42 codes and subcodes were created and included categories such as challenges with messaging, concerns for people, forecaster perspectives, forecaster practices, compound hazards, physical and atmospheric processes, and vulnerability. The author coded all interview transcripts in Fall 2021.

Results

Several themes emerged that provide insight into which threat NWS forecasters thought was most pressing during Hurricane Florence, how they attempted to elevate this threat within their messaging, and what they believe the public understood about these communications. These results also provide insight into how NWS concerns for specific threats are integrated

into their messages, including the use of the SSHWS as a primary tool for communicating hurricane severity.

NWS Employees' Prioritization of Threats

Participants made it clear that the prioritization of the different threats during Florence evolved with the storm. Many mentioned that before landfall, Florence was a Category 4 on the SSHWS. They saw this as a serious issue because, as one participant stated, "As much as we preach that it's the water that kills you, it's not the wind, initially we were looking at a Category 4 storm; 140 mile per hour winds. We've never seen that before, so that was scary." However, Florence's downgrade and resulting slow pace reprioritized forecasters to the threat of flooding. Three-quarters of participants explicitly mentioned flooding from precipitation and storm surge as their and their WFO's primary concern as the storm approached.

Prioritization of flood threats did not mean that the other threats could be ignored, because, as one forecaster pointed out, every hurricane is different, and each individual's experience will vary. For example, tornadoes may cause isolated but highly destructive damage to a few people compared to flooding, which is often more widespread but does not cause severe damage to everyone who experiences its impacts. As one participant noted:

"For that one person that may be in a mobile home in a path of that tornado, they may have the greater chance of dying from the tornado because maybe they're not in the flood plain. So, you don't want to minimalize the threat of the tornado. But in general, from a wide lens, that's going to be less of a threat to life than everybody's ability to drive into water."

The nuance in messaging compound hazards therefore lies in how to heighten one threat without minimizing others. The next two sub-sections explore the general themes of fatalities and practice, including how those in the NWS make decisions about which threat to prioritize and how they achieve this prioritization.

Fatalities Shape Threat Prioritization

Over two-thirds of participants explicitly spoke about fatalities and the threats that can cause them. Of those who mentioned fatalities, 86% pointed to flooding as the threat that poses the greatest risk to life; more specifically, driving into flooded roadways is the most common way that people die during hurricanes. "Most of our deaths occur not from the initial flood, but from people driving into washed out roads or into water itself," one participant explained. Another way that hurricanes may threaten life is storm surge, which was mentioned as posing a high potential for casualties but did not actually cause any during Florence. The fatalities from the wind and tornado threats during Florence were also discussed, including a story about a mother and baby who died after a tree fell on their house. However, the threats from water were unequivocally seen as the most dangerous. "The biggest threat…was the potential for very heavy rainfall which always has been the thing that we've highlighted to say the water usually does—ends up creating the most fatalities," a participant explained. This shows that the prioritization of threats by the NWS is directly tied to which threat staff see as putting the most lives at risk.

Threat Prioritization in Practice

Although participants made it clear that it was not their job to tell members of the public what to do, they want their messaging to inform which threats the public pays attention

to. Forecasters used several tactics to highlight the flooding threat during Florence. One was the use of superlatives like "catastrophic" or "historic" flooding, which had to be balanced with issues of accuracy and consistency across all NWS offices. Referring to crosstalk between the NHC and WFOs, a respondent said, "There's always discussion about…what word do we use?" This collaboration occurs because forecasters understand that superlatives elevate the message and are therefore difficult to backtrack on. As one noted, when using these words, they try to "project the scope, the duration, and the severity of how this would be impacting people." Forecasters do not prefer to use words like "unprecedented" or "extreme" unless these terms are truly accurate. Another forecaster cautioned: "You don't want to go too early because then if it [the storm] backs off, you're crying wolf." Once the forecast for Florence began to solidify, however, multiple participants explained that using these types of superlatives became the clear choice. "Unlike some other storms, I'd say this one in some respects was easier in the fact that it was a clear-cut catastrophic flood event," one forecaster said.

Another important aspect of elevating one threat over another was how the hazards are ordered within products. Participants explained that some products can be adjusted so that the threats anticipated with a specific event are ordered from most to least impactful. Furthermore, consensus indicated that this would be the logical way of ordering products. However, forecasters also admitted that this ordering did not always happen, and in some cases during Florence the wind threat continued to be listed first although the forecasters were more concerned about the flooding from storm surge and rainfall. One forecaster noted, "I wish that we had shifted some of this around, but you get in a rhythm doing these things and sometimes you don't catch it." In an attempt to draw attention to the massive amount of

precipitation expected, one office further emphasized the rainfall flooding threat in the design of their graphic. This was done without moving the order of flood threat from the bottom of the graphic to the top, however, which was acknowledged as being potentially confusing. "From a communications perspective you would want to make your top threat the top of the graphic so it's the first thing you see. And with that logic, the [emphasis] is kind of confusing," a participant explained.

A final tactic used to heighten one threat over others was to compare the predicted hurricane to previous storms that have affected the area. For example, Hurricane Matthew was evoked as a hurricane with similar flooding impacts. As a forecaster explained, "Matthew happened two years earlier and that was still fresh on everyone's mind…We were definitely using the verbiage that Florence is going to be worse than [Matthew] in terms of rainfall and flooding." Views on the use of this approach were mixed. Some found it to be a helpful way to give the public a concrete perspective on what the flooding threat could entail and saw it as a tactic that can spur action, including evacuations. However, others acknowledged it as being potentially problematic since "everybody's experience is different depending on the storm. So we really need to avoid, 'this is gonna be worse than Matthew'…because for some people it will and other people it won't."

NWS Beliefs About Public's Understanding of Threats

Since the current research did not involve interviews with members of the public, it is not possible to make any conclusive statements about the public perception of Hurricane Florence. However, many of the participants provided insight into how they believe the public interpreted the multiple threats that occurred during this storm. Participants' ideas varied on

how well the public understands the different hazards that they may encounter during a

hurricane. For example, for flooding threats, one said they think members of the public "know

what water's gonna do," while another answered, "I don't think a lot of people know what flash

flooding is." The high diversity in these answers may be a reflection of the varied roles

respondents play within their communities, making it difficult to draw any conclusions about

how members of the public view individual hurricane threats. However, there were some

common themes in how respondents think the public views compound hazards, which are

detailed in the following two sub-sections.

Compound Hazards Increase Complexity

Just as the compound nature of threats during hurricanes makes them more difficult to

message, overlapping hazards may make it more difficult for the public to understand their risk.

One participant explained this by saying:

> "I think people do get confused, because usually if we have a tornado, that's the main
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> threat of the day, is tornadoes…So, if the hurricane breaks anything, it's the whole…
>
> you've got tornado threats, you've got flooding, you've got storm surge threats, you've
>
> got wind threats…it's quite a bit of impacts to throw at people, and it's a lot to digest."

As mentioned above, no hurricane is the same. In some storms the winds may be the

most dangerous threat, while in others, as was the case with Florence, it is the storm surge or

flooding. However, many participants noted that members of the public may not see different

threats in the same way that forecasters do. For example, multiple participants mentioned how

members of the public will often view damage from straight-line winds as tornado damage. This

issue also exists for hydrology, where the official definitions of different types of flooding,

including flash flooding, river flooding, and aerial flooding, all differ, but how each of these types of floods play out on the ground may be perceived similarly by the public. It is therefore possible that the increase in complexity leads to breakdowns in communication, as the different threats messaged by the NWS are not understood by those who receive these messages.

Comparing the Compound Hazards of Wind and Water

Although participants viewed water threats, particularly flooding, as the most hazardous during Florence, they expressed concern that the public saw those from wind as more dangerous. For example, when ranking threats during a storm, forecasters often viewed tornadoes as having the lowest potential impact. However, respondents also believed that tornadoes are viewed as more dangerous by the public. "A tornado is a much higher perceived damage – a threat," one forecaster explained, citing the weather education and outreach the NWS does within the community as the source of this insight. Another described public perception of tornadoes as "…sexier. It's dramatic, it's news-worthy" in the eyes of the public; because of that perception, tornadoes invoke more emotion. This coincides with another participant's description of flash flooding as "not sexy." Later in their interview this same person also remarked on the fact that people chase tornadoes, not flash floods. As one put it: "People feed off of excitement and extremes. I think that the damage that a tornado can tear up your house…people gravitate toward the wind part of hurricanes and tornadoes."

As demonstrated in the previous sections, the threat prioritization and resulting messaging practices used by NWS forecasters during Hurricane Florence aimed to highlight flooding, while these same forecasters expressed concern that the public was paying more

attention to the wind. In this section, the theme of the SSHWS is examined as an example of a

NHC product that automatically heightens wind threat over water threats during hurricanes.

The analysis outlined above is consolidated here by looking at the ways forecasters think the

public interprets the use of this scale along with how this perception impacted their messaging

practices. One participant explained this issue, saying:

> "I think that's probably as an agency our biggest challenge, is getting people away from
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> the Saffir-Simpson Scale. I'm not advocating another scale. But I think…the right
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> strategy, in my opinion, is use the Saffir-Simpson Scale when you need to but don't even
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> mention the darn thing when you know you've got other significant impacts."

Later in the interview, this participant described an instance where wording in a graphic left out

mention of the SSHWS and instead used "wind impacts," indicating that these concerns

motivated specific messaging practices.

Other participants also spoke about the issue presented by an emphasis on SSHWS

category within the context of their messaging tactics. They tried to heighten flooding within

their graphics and communications products because "the biggest challenge was without a

doubt…people relate their perception of threat to the category of the storm, which is only

wind-related." Some saw this tendency play out in on social media, when they would post a

message about the threats and get responses that dismissed the danger due to the low

category. One strategy to counter this misinformation was actively monitoring and responding

to comments on social media. Participants also tried to concentrate their communications on

the threats and impacts rather than the category or the track. As one said, "Threats are more

diverse than just the category."

The importance of reorienting hurricane threats away from wind reflected forecasters' concern that people base their evacuation decisions entirely on the category of the storm, even though, "Water is usually what evacuates people. [Emergency management will] say hide from the wind, run from the water." One reason participants believed members of the public may not take lower category hurricanes seriously was that they have experienced them in the past and therefore believe them to be "no big deal." More generally though, the participants see this disposition as tied to the idea that the category of the hurricane is a full representation of its threat. Some even explained that the overblown emphasis on category may have had a positive effect on evacuation, since Florence was originally a Category 4 storm. As one participant described:

> "I think if it had been Category 1 the whole time and [emergency management] said 'county-wide evacuation,' [the public] would say 'huh?' But the fact that it came in as a 4…it gave people lots of time. We had tons of time to leave and prepare and all that. And it got people scared enough that they left."

The influence that the SSHWS seems to have on the public shows that the messaging chosen by the NWS to provide information on hurricane threats matters. Moreover, when hurricanes primarily pose threats other than wind, it could be that the SSHWS is not effective for communicating severity or danger. As one forecaster put it, "I remember at one point even saying out loud 'this isn't a hurricane, this is a flood event.'" As a product that provides no insight into water threats, it may therefore be worth questioning the use of this scale during hurricanes like Florence.

Discussion & Conclusion

Results show that the qualities of the forecasts and warnings created by the NWS are influenced by both forecasters' personal perception of threats, as well as their perception of the public's perspective of threats. This indicates that forecasters understand that the way they comprehend weather may be different from the ways that the public does. These differences in comprehension between weather experts and laypeople has been confirmed by past research (Morrow et al., 2015) and is important to pay attention to since understanding of threats directly influences the ways people will prepare for and respond to disaster (Brassell et al., 2019). This research therefore offers direct examples of how forecasters attempt to overcome differences in threat prioritization between themselves and the public through specific framing tactics. These include the use of superlatives to describe the most dangerous threat; the ordering of threats from most impactful to least within products; and the creation of comparisons between the current disaster and past ones. The utilization of such strategies within NWS messaging is important because lack of understanding can prevent individuals from taking proper precautions ahead of disaster (Mongold et al., 2021). To achieve the goals of protecting life and property, these messages must therefore be both as accurate as possible and understood by their target audience.

To illustrate the complications that can arise within NWS messaging, this research showed that forecasters are concerned that the use of the SSHWS has created an environment where the public naturally heightens the threat from winds over the threats from water during hurricane events. These concerns persisted despite the forecasters reporting a clear prioritization of flood threats within the context of Florence. This prioritization influenced how they crafted the products for this storm, which attempted to rectify forecasters' perceptions of

the public's concentration on wind threats. In this way, what forecasters think the public thinks about different threats has a direct influence on how they frame those threats within their messages. It is unclear whether the public understands that the preoccupation with category during hurricanes means that they are emphasizing wind over water; it is possible that the category is simply a convenient number that has come to work as a proxy for severity within the collective consciousness. Knowing how the public understands hurricane category could help the NWS resolve the emphasis on winds during these storms, but more research is needed on this front before this can be said with certainty.

Resolving this issue is made more complicated by the policies of the NWS, which dictate which offices issue which warnings. In this structure, the NHC is responsible for forecasting hurricanes ahead of landfall and for categorizing them on the SSHWS (NWS, 2022b). However, the critiques of this scale reported in this paper come from NWS employees who work within WFOs. The individuals who participated in this study therefore have no control over how a hurricane gets categorized. The policy and procedure of the NWS therefore also play a role in the ways that overlapping hazards are messaged. While the SSHWS is an essential part of the meteorological justification for naming a storm a hurricane and offers pertinent information for the public in decision making (NHC, 2021), it may unduly amplify a single threat. Future research should examine how ingrained hurricane categories are within infrastructures, policies, and decisions within both expert and public spaces. It may also be worth investigating the utility of scales like Bloemendaal et al.'s (2020) Tropical Severity Scale, which incorporate hurricane threats other than wind into the quantification of category and offer an institutionalized solution to this problem.

The heightening of wind threats over water threats during hurricane events is just one of the many ways individual threats may be miscalculated during compound hazard weather events. More research is needed to understand other types of environmental, weather, and public health hazards, such as COVID-19, that may impact how people make decisions about risks (Cegan et al., 2022). Within the context of overlapping hurricane threats, more research into how the public perceives the different threats they may encounter during these events would add insight into which ones they take seriously. More specifically, there is a need for research that qualifies the ways in which the public comprehends the SSHWS and its categories, because although there is much conjecture and anecdotal evidence that this scale elevates wind threats (Camelo & Mayo, 2021; Glass et al., 2021; Morss & Hayden, 2010), there is little empirical evidence. Research into this topic would reveal if NWS forecasters are accurate in their assessments of public perceptions, which would assist in the framing of messages. It would also help to fill in missing pieces in the complex picture that is the NWS weather forecast and warning system, thereby strengthening the lines of communications between the NWS and the public and improving the utility of this system in the process.

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