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Risk Management and Biases in How Drivers Respond to Nuisance Flooding

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Abstract

Nuisance flooding, or recurrent flooding, occurs during high tide and may be exacerbated when combined with other events such as heavy precipitation, strong winds, or storm surge. Sea level rise has contributed to increased frequency and duration of nuisance flooding in low-lying coastal areas and is causing community-specific impacts such as transportation disruption, road closures, compromises to life and property, overwhelmed storm water systems, and infrastructure damage. This chapter focuses on how drivers respond during nuisance flooding events.

Specifically, we discuss how drivers in the Hampton Roads region of southeastern coastal Virginia obtain information about road flooding, how they respond, and the factors that influence their responses. The chapter builds on risk perception research and recognizes that risk management is influenced by the perceived ability to efficaciously address risks. The chapter's practical discussion focuses on implications of (1) how individuals gather information about a potential risk, (2) how they attempt to use that information to manage the risk, and (3) how current information sources appear to be inadequate for helping individuals to gauge the extent of real risk and take effective adaptive measures. Challenges for risk communication purveyors (e.g., public officials, media outlets, local businesses) are also noted.

Introduction

Nuisance flooding, or recurrent flooding, occurs during high tide, and it may be exacerbated when it is combined with other events such as heavy precipitation, strong winds, or storm surge. Sea level rise has contributed to the increased frequency and duration of nuisance flooding in low-lying coastal areas, and it causes community-specific impacts such as the disruption of transportation, the closing of roads, compromises to life and property, overwhelmed storm water systems, and infrastructure damage. This chapter focuses on how drivers respond during nuisance flooding events. Specifically, we discuss the way in which drivers in the Hampton Roads region of southeastern coastal Virginia obtain information about road flooding, how they respond to that information, and the factors that influence their responses. Utilizing the Risk Perception Attitude (RPA) framework, the chapter builds on risk perception research and recognizes that individuals' risk management decisions are influenced by their personal sense of their own ability to efficiently address risks.

This chapter focuses on several implications: (1) how individuals gather information about a potential risk, (2) how they attempt to use that information to manage the risk, and (3) the way in which existing information sources may be inadequate in helping individuals to gauge the extent of real risk and to take effective adaptive measures. Challenges for risk communicators (e.g., public officials, media outlets, local businesses) are also noted.

Nuisance Flooding and Challenges for Drivers

Floods are a serious threat to the current infrastructure, especially to the network of roads. More frequent and prolonged flooding can damage road pavement, disrupt traffic, and increase highway incidents, putting additional strains on a heavily used and increasingly congested

transportation system. Often, in low-lying communities, some roads are lower in elevation than the surrounding areas; this can result in water's draining onto the roads, causing flooding.

Nuisance flooding, the focus of this study, is flooding that occurs on a frequent basis during high tide events, wind events, small storms and related storm surges, or because of precipitation. Some of the impacts of nuisance flooding include public inconvenience related to road closures, transportation disruption, damage to property and vehicles, overwhelmed storm water systems, damage to infrastructure, and financial strain on local municipalities. Nuisance flooding can severely disrupt several aspects of a community, such as businesses, schools, and homes, by hampering residents' mobility and accessibility. Low-lying roads are vulnerable to nuisance flooding that can disrupt travel across the region and can increase drivers' exposure to other related risks, such as damage to (or loss of) personal property.

The Mid-Atlantic region, in particular, is experiencing a significant increase in nuisance flooding, largely due to geophysical conditions, which include land subsidence (i.e., the sinking of land) and accelerated sea level rise (Kopp, 2013; Sallenger et al., 2012). Found within the Mid-Atlantic, the Hampton Roads region of southeastern coastal Virginia (located in the lower Chesapeake Bay) has experienced a 577% increase in the mean number of hours per year of nuisance flooding, from 1991-2013 as compared to 1971 (Ezer & Atkinson, 2014).

Risk Perception, Risk Management, and Communication

It is generally accepted that change is a given; what is more complicated is that the level of change – its pace, extent, and visibility – can be ambiguous, and this can lead to complexities in the area of risk. Regester and Larkin (1998) point out that *risk* is a “measure of the adverse effect” of a particular dynamic and that it reflects a multi-faceted assessment of the hazards

versus the rewards (p. 21). In determining risk perception, individuals combine data and perspectives to analyze the way in which potential disadvantages may be counterweighed by the advantages of taking particular actions.

Risk management, therefore, is about noticing and identifying the nature of a risk, analyzing its pertinent aspects, and determining approaches for minimizing the unacceptability of that risk (Lerbinger, 2012). Risk management applied theories focus on coping with one central aspect: uncertainty (Palenchar & Heath, 2002; Sellnow & Seeger, 2013); the focus of risk communication is on preventing uncertainty from mushrooming into crisis. However, says Appel (1993), such efforts are fraught with the difficulty of proving that certain actions designed to manage risk have actually prevented harm. Still, the field of risk management has developed several approaches to attempt to successfully cope with uncertainty, and communication remains a critical component. In the field, the *precautionary principle* calls for (1) widespread communication and discourse with individuals who may be affected by potential threats; (2) encouraging them to articulate, using their local knowledge, their acceptability of the uncertainty this threat presents; and (3) clearly articulating to these audiences the range of options available to address this uncertainty (Maguire & Ellis, 2009). Risk management theorists have recognized that effective argumentation can lead to a better ability to cope with risk. For example, the concept of *convergence* affirms that a multiplicity of claims and counterclaims about risk results in some areas of overlap that, in turn, lead to the public's perception that there is agreement on some facts, details, and approaches; this is conducive in the efforts to manage uncertainty (Perelman & Olbrechts-Tyteca, 1969). However, convergence may not always help to facilitate such agreement; risk managers may have to use warrants—or clear discussion about how

elements of a risk directly applies to members in the community—to move past individuals' reluctance to take initiatives to address risk (Douglas & Wildavsky, 1982; Venette, 2008).

Given the expected increase in the frequency and severity of flooding on roads due to climate change, it is important to develop a better understanding of how drivers manage the risks associated with the flooding of roads. Pearson and Hamilton (2014) contend that such efforts must be designed to induce attitudinal change, to strengthen social disapproval strategies, and to challenge people's beliefs about their ability to perform or to avoid the behavior. Such knowledge can have practical implications in strengthening efforts to reduce the negative consequences of road flooding (e.g., travel disruptions and damage to vehicles).

Risk Perception Attitude (RPA), Optimistic Bias, and Normalization Bias

League (2009) categorized drivers into two categories: (1) *situational drivers*, who drive on flooded roads because they have a specific place to get to, such as work or school, and (2) *intentional drivers*, who traverse flooded roads for fun or to film the flooding. This chapter focuses solely on situational drivers -- those who are challenged in reaching their particular destination because of road flooding, partially because situational drivers, unlike intentional drivers, may be less aware of road, flood, and weather conditions.

Research on risk perception has only recently begun to focus on nuisance flooding. Some scholars have found that communities may not clearly see the link between recurrent nuisance flooding and risks to the communities' wellbeing (Allwood et al., 2014). Other scholars have found that communities, by using their own local knowledge and various adaptive strategies, have come to see flooding as a way of life (Tewari & Bhowmick, 2015).

Wagner's (2007) study of respondents in the Bavarian Alps found that individuals formed a mental model of risk perception of flooding that came primarily from (1) experiences with flooding, and (2) visible imagery of flooding. Siegrist and Gutscher (2008) also found that experience was a key factor in forming the risk perception of floods. Conversely, they also found that those who had never been exposed to flooding did not have a realistic risk perception of the hazards of flooding. Another study found that, for individuals to perceive the risk of floods, they must sense vulnerability and feel that their safety, security, and their ability to meet their obligations is at risk (de Boer et al., 2015).

One of the more complicating aspects of the public perception of risk as it relates to nuisance flooding is apparent in the observation that "People do not perceive danger in the familiar. People avoid questioning the safety of their neighborhood, job, or way of life. Familiar objects ... are hard to fear" (Lerbinger 2012, p. 81). Instead, individuals are more prone to perceive risks that are seen as episodic and dramatically disruptive. These are known as "dread risks" – events or processes that feature a "perceived lack of control, dread, catastrophic potential, fatal consequences and the inequitable distribution of risks and benefits" (Slovic, 1987, p. 283).

In contrast, many coastal communities, including those in Hampton Roads that experience frequent and repetitive nuisance flooding throughout the year, face the daunting prospect that residents and drivers, habituated to such climate-based disruption, minimize the risk of recurrent flooding precisely because of its non-dramatic, repetitive nature. Ropeik (2012, p. 32-33) notes that this risk perception process takes place in the part of the human brain that is "hardwired to rely on feelings" for initial risk perception and then draws upon "a set of subconscious mental shortcuts" that help individuals further "frame" or characterize the risk. The

Center for Research on Environmental Decisions (2009, p. 4) describes such shortcuts as resting within “mental models,” in which individuals perceive risk by first trying to make it congruent with what they already believe about the world around them, relying on confirmation bias to situate information about risk in a way that is “consistent with what they already think, want, or feel.” An individual bolsters this system of shortcuts by turning to experts (e.g., journalistic news reports, policy makers, local experts in the community) whose understanding of the facts concerning the risk is both credible and, perhaps more importantly, agreeable to that individual’s worldviews (Kahan et al., 2009; Zhao et al., 2011). Additionally (and most pertinent for our understanding of risk management in the context of nuisance flooding) is that one’s overall framing of risk is also greatly influenced by one’s perceived ability to efficiently address that risk.

Scholars have pointed to a Risk Perception Attitude (RPA) framework in which individuals’ perceptions of risks, when coupled with their perceived ability to respond to the risk, lead to their falling into one of four attitudes about risk: *responsive*, *avoidance*, *proactive*, and *indifference* (Mead et al., 2012; Rimal & Real, 2003). Using that same RPA framework, we suggest that drivers’ perceptions of risks, when coupled with their perceived ability to respond to flooding, lead to drivers falling within one of four categories: (1) *responsive*, where drivers are knowledgeable of the risks and believe they have the skills to take adaptive measures and, therefore, they are most likely to take adaptive action when they encounter flooded roads; (2) *avoidant*, where they are knowledgeable of the risks but do not believe they have sufficient adaptive skills and, therefore, are less likely to be motivated to adapt or respond; (3) *proactive*, where drivers do not believe there is an imminent risk but believe they have high adaptive abilities and, therefore, are likely motivated to use their capacities to adjust to the situation

(sometimes in maladaptive ways); and (4) *indifferent*, where drivers do not perceive a risk and do not believe they have sufficient adaptive skills and, therefore, are likely to be the least motivated to adapt or to respond.

The concepts of *optimistic bias* and *normalization bias* also contribute to understanding how drivers may underestimate risk and overestimate their ability to adapt. Becker et al. (2015) argue that risk perception may be influenced by optimistic bias (Weinstein, 1989) and normalization bias (Mileti & O'Brien, 1992). Optimistic bias results in a miscalculation of the risk and of the speed and power of the moving water, and an overestimation of one's ability to persist that is evident in the case of driving into flood water (Becker et al., 2015; Ruin et al., 2007). Franklin et al. (2014) found that a majority of people report that the lack of awareness or the lack of knowledge about the hazards of driving through flood water is a major reason for their taking such a risk. People who do not know or understand the dangers that flash flooding presents to vehicles, and those who have not experienced a flood, are significantly more likely to drive through flood water (Drobot et al., 2007).

In the case of nuisance flooding, underestimation of risk usually does not come from any miscalculation about the severity of flooding – that is, the speed and power of the moving water – but more it is more likely due to a lack of knowledge about the potential damage such flooding can cause, especially if the flood water is brackish in nature. Certain drivers, especially long-time residents or those with extensive prior experience or familiarity with the surrounding environment, may also overestimate their ability to respond in flooding situations. Optimistic bias is generally associated with the belief that others are more susceptible to risk, and a focus on the potential of immediate risks over the longer-term risk of damage to property or threats to safety (Pearson & Hamilton, 2014).

Becker et al. (2015) also point to a normalization bias in which drivers miscalculate the risks based on their innocuous experiences with (or their innocuous understanding about) flooding. Specifically, individuals who had previously driven into floodwater and experienced no negative impacts would be prone to expect the same outcome and would try to minimize the extent of the risk. Normalization bias does not need to be based on personal experience; in fact, some drivers may base their assessment of risk on the experiences of others. For example, drivers who observe others who are successfully traversing flooded roads may underestimate their own risk in taking a similar action.

Study of Drivers' Perceptions and Responses to Nuisance Flooded Roads in Hampton Roads

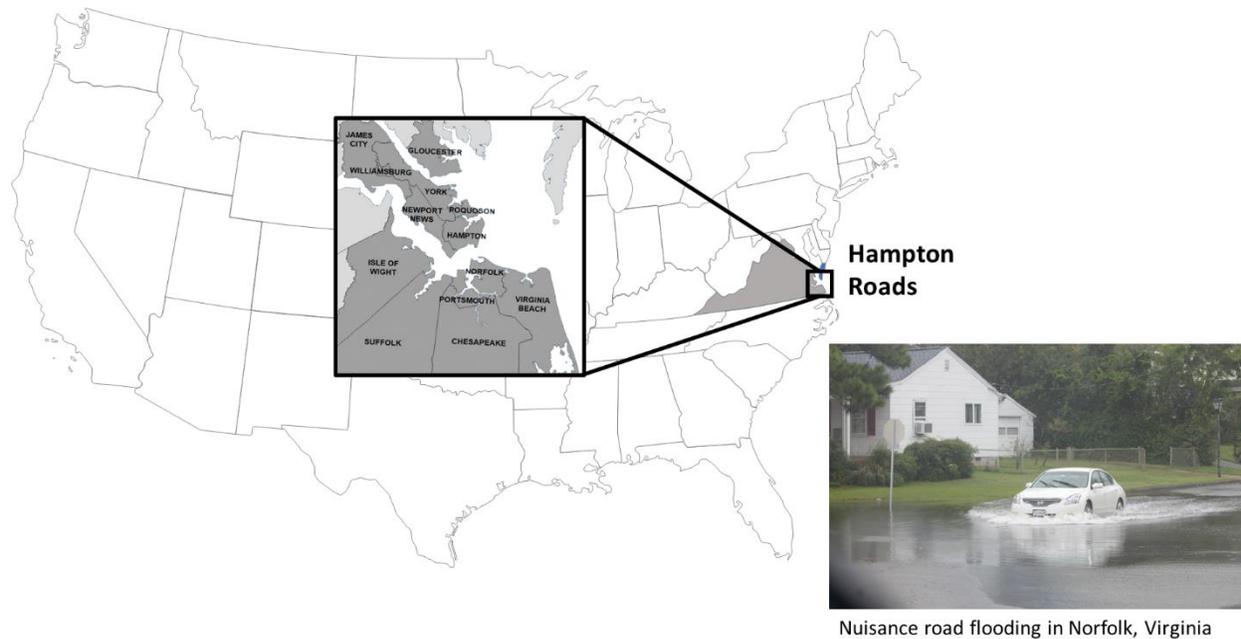
We examine drivers' responses to nuisance flooding on roads, with a particular focus on their perceptions regarding the risks of driving on flooded roads and their subsequent actions during encounters with flooded roads. We do so by using a sample of urban drivers from the Hampton Roads region of southeastern coastal Virginia.

The Hampton Roads region of Virginia is located at the mouth of the Chesapeake Bay on the eastern seaboard of the U.S.A. (see Figure 1). It comprises 17 municipal districts, many of which are bordered by water bodies including the Atlantic Ocean, the Chesapeake Bay, the Elizabeth River, the James River, and the Nansemond River. The region is a coastal plain with a relatively flat topography, much of which is located within a few meters of sea level.

Communities in Hampton Roads (home to a total of about 1.7 million people) experience nuisance flooding during high tide, heavy precipitation, and storm events. This region is highly

vulnerable to flooding due to land subsidence and accelerated sea level rise (Spanger-Siegfried et al., 2017).

Figure 1. Hampton Roads, Virginia and Nuisance Flooding on Roads



Source: Developed by the authors. Photos by K. Anuar (with permission).

For our study, we used a two-stage method to learn how drivers perceive the risk of nuisance flooding and how they approach driving in the midst of such flooding. First, in May 2015, we conducted two focus groups, with a total of 14 participants, to help us to understand concerns about nuisance flooding and how it impacts driving and travel in the region. Focus group participants were asked about (1) their level of concern with nuisance flooding and (2) their likely response to nuisance flooding in the context of their regular commute and/or discretionary trips. Second, based on the responses from the focus groups, we developed 14 scenarios for use in verbal “think aloud” protocols (Ericsson & Simon, 1980). In these think

aloud protocols, we asked participants to respond to specific flooding scenarios while they verbalized their thoughts as they made their decisions about each scenario.

We analyzed the focus groups and the verbal protocols results, using an open coding method, to determine the actions that participants report taking when driving on flooded roads, the factors that influence their decisions, and the information sources that drivers use to make their travel decisions. We then grouped similar themes into categories and determined the contextual factors that influenced the respondents' behaviors.

Research participants came from faculty, staff, and students at Old Dominion University and from residents of the area, which is known for frequent nuisance flooding. Participants were recruited using several different internet strategies, including email announcements to all university staff and students and direct email solicitations. The key criteria used in the selection of participants were: (1) the type of primary vehicle driven, (2) sufficient driving experience with nuisance flooding, and (3) the need for travel across municipal boundaries for work, school, or discretionary travel. All of the potential participants were pre-screened using the following criteria: licensed drivers, daily commute greater than five miles, driving to neighboring cities at least twice a week, and vehicle type. Driving behavior and the characteristics of participants are summarized in Figure 2.

Figure 2. Driving behavior and characteristics of the study sample

- 80% commuted more than 5 miles to work or school 
- Average commute time: 30 minutes 
- 70% drive to neighboring municipalities for discretionary purposes (shopping, leisure, recreation) 
- Average driving time: 6 hours per week
- 80% drove cars, 20% drove SUVs or trucks 
- Average age: 39 years
- Gender: 60% female 
- Race/ethnicity: 50% white, 20% Black or African-American, 30% other race/ethnicity

Source: Developed by the authors.

In the next section, we discuss our findings regarding the sources used by drivers to learn about roadway flooding and the drivers' responses to nuisance road flooding. For the latter, we illustrate the way in which the risk management strategies of these drivers conform to the four categories of the RPA framework, and we discuss the contextual factors that affect both responses and risk management strategies.

Communication and Information Needs of Drivers

In a 2015 survey, residents of Hampton Roads indicated that they rely on multiple sources for information about flooded roads; local news programs are their primary source, cited

by 61% of survey respondents (Parker et al., 2015). Other sources of information about flooded roads include mobile phone applications (50%) such as text message alerts, GPS navigation tools, the 511 Road Information System, and road cameras; word of mouth (28%); social media (24%); and weather information sources (20%). Slightly less than one-fifth of respondents (15%) indicated that they do not seek out information about flooded roads.

The participants in our current study mentioned their reliance on information sources similar to those used by respondents in the 2015 residents survey. Our respondents indicated that they use a combination of local knowledge and easy-to-use online sources to help make their decisions. Many use the internet and social media to access information, and they are also likely to rely on information communicated by friends and family. Many participants indicated that they rely on observations and experiences, which is consistent with behavior found in the research literature. The length of time that participants have lived in the area plays an important role in the extent to which they rely on their observations and experiences. Long-term residents reported greater experience with flooding events, exhibited a better understanding of the types of flooding and flood impacts, and knew where to find and how to use reliable information sources. In contrast, residents new to the area had informational deficits, such as not understanding the tidal influences on nuisance flooding or the damage that can happen to their vehicles from exposure to flooding.

Furthermore, their ability to find timely, credible, and granular information to help gauge the risks of flooding and to make constructive adaptive decisions about their travel routes was often challenging, study participants reported. Several sources used by participants were found to be insufficient or lacking. For example, weather radar information was not street specific, public service announcements about flooding only cautioned about general flooding in low-lying areas,

and news reports on weather and traffic generally covered major streets but not minor intersections. Information provided via local news applications and social media did not specify whether a particular road of interest was dangerous to traverse, nor were reports regularly updated. Drivers indicated they want reliable mobile phone applications with crowdsourced data that would show flooded roadways – both real-time and projected flooding – along with information about possible detours, accidents, and ongoing construction.

Drivers' Responses to Nuisance Road Flooding and Links to Perceptions of Risks and Perceived Ability to Respond

In this section, we discuss the results from our focus groups and verbal protocols; these illustrate how drivers in Hampton Roads exhibit risk management attitudes. Consistent with the expected RPA categorization, drivers respond to nuisance flooding in four different ways depending on their perception of the risk and their perceived ability to respond or adapt. They are (1) responsive, (2) avoidant, (3) proactive, or (4) indifferent.

Responsive

Responsive drivers are the most capable and prepared, when faced with nuisance flooding. They are knowledgeable about the risks of flooding and they trust their ability to act. Responsive drivers participate in risk mitigation behaviors designed to limit the potential impacts of nuisance flooding. Because nuisance flooding is often associated with high tides, specifically chosen behaviors, such as modifying travel plans by taking alternate routes and altering departure times, help responsive drivers avoid flooded areas and limit damage and loss to their property. One focus group participant stated that he bases his departure times on the projected tide levels. Specifically, he would “do the math” to learn the effects of an upcoming high tide

and then would determine the best time for his departure. Responsive behavior may result in delayed arrival, but responsive drivers are able to make decisions in real time based on their knowledge about flooding. Participants reported that they were also willing to wait, if necessary, for rain or flooding to dissipate if no alternate route was available. One participant stated, “there’s always a nice restaurant or bar to stop in and wait for the flooding to go away.” Other participants stated that they modified work arrangements, including location and work hours, to avoid flooding impacts.

In addition to altering routes and departure times, responsive drivers’ behavior also includes changing the mode of transportation used to reach their destinations. Seeking transport from a family member or a friend with a truck or SUV (high clearance vehicles) was a common option for participants. As an example, one participant stated, “My wife has an SUV, and when they were talking about the tropical storm coming through, I said ‘You may have to get the girls... my car may not be able to get through, depending on how bad the flooding is.’” Rescheduling or cancelling plans is another option that responsive drivers consider. One focus group participant stated, “If I’m supposed to pick [a family member] up at, say, 4:30 or 5 p.m. [and] we are expecting heavy storms and the roads may flood ... I might call them a few hours before and say, ‘let’s have a game plan to pick you up at 6:30 or 6 p.m.’” Other drivers reported that they respond by leaving their vehicles in safe places (higher ground) and walking or relying on a rideshare service. Respondents reported that mobile applications are useful in helping drivers determine both where to park their cars and how to reach their destinations.

Avoidance

Avoidant drivers are less likely to be motivated to act than responsive drivers. They are knowledgeable about the risks of nuisance flooding, but they do not believe they possess the

ability to actively address them. Due to this, they undertake behaviors such as avoiding situations that may present flooding, or the inverse, driving on flooded roadways. Among the respondents in our verbal protocol, there were fewer instances of avoidant drivers than responsive. Some avoidant drivers cancel their travel plans to remove themselves from situations involving flooding. One participant acknowledged that other drivers are likely not knowledgeable about flooded roadways, so she did not rely on the cues of other drivers when making decisions regarding driving in flooded areas. The participant stated that those drivers “have no better clue about where the higher ground is, more so than I” and that she would choose “not follow the rest of the lemmings” through flooded streets.

Participants who displayed avoidant behaviors stated that the key factors that they consider when deciding to avoid a flooded area were potential vehicle damage or loss of life. Cost also proved to be a critical factor. One participant noted, “too many people have driven through water, and it has really messed up their cars... I don't want to spend money on a new car.” Another participant stated that he previously drove through flooded roadways – until water infiltrated his car’s intake and resulted in damage. He now uses a “stop and retreat” method – a defensive tactic – to protect his car. Another participant stated that she observes other drivers to see whether she can safely navigate flooded areas, but that she often chooses to redirect her path, because “that’s the way people get swept away – and even die.” However, avoidant drivers often risk being stuck in flooded areas because of their reluctance to act and their lack of adaptive skills. According to Morss et al. (2016), drivers use a complex set of contextual factors to weigh their options, as they weigh the potential loss of their vehicle and the accessibility of their destination. Due to this, drivers may attempt to navigate through flooded areas if they have only limited options, even when they are aware of the risks and know few adaptive strategies.

Proactive

We found that many participants believe themselves to have high adaptive skills, even as they don't necessarily believe that the risks associated with nuisance flooding are significant. These drivers are considered proactive, because they are knowledgeable about the risks and likely to act, but their failure to perceive imminent threats limits their responsiveness. Some of the study participants alluded to this dynamic. One participant, a resident of the Hampton Roads area for over 40 years, questioned why there is so much discussion about sea level rise and flooding when "we haven't noticed any discernible change ... the human eye doesn't notice this." In fact, he said, residents are so familiar with road flooding that they "want to come out and commune" after a nuisance flooding event. Another participant noted that, after three years in the area and multiple attempts to navigate through flood waters both by car and by bike, she felt "like part of the tribe now." That participant also noted that individuals who lived in Hampton Roads for decades say that they do not put much consideration into flooding risks.

Consistent with the tenets of optimism bias, proactive drivers may consider that others are more vulnerable to risk than they are, themselves. Some participants in the study were confident that they could determine the depth of the water by simply observing the flooded street. And, even though these participants indicated a desire for more real-time road condition information, they did not indicate that they saw the need to develop personal plans to avoid the threat of flooding. One participant stated that he would attempt to get to his appointments 90 percent of the time, even in the midst of such flooding. Another participant, a 25-year resident of Hampton Roads, said that she had gotten used to flooded streets and would simply try to find ways around impassable streets. She would do this, she reported, "because I'm an urgent kind of person." Behaviors such as these are potentially problematic, because drivers minimize both the

impact of nuisance flooding and the risks associated with it, potentially putting themselves and others in danger. Furthermore, proactive drivers' sense of being acclimated to the ever-increasing risk of nuisance flooding presents a large challenge risk for communicators; specialized messaging is needed to communicate with drivers who are knowledgeable of the area, but who disregard risks.

Indifference

Indifferent drivers are the ones most likely to participate in risky behaviors. Individuals in this category do not believe that nuisance flooding presents risks, and they do not possess the skills to address such risks. Of the four categories of drivers, indifferent drivers are the least motivated to act to mitigate the impacts of nuisance flooding. For example, people with experience driving through flooded streets without suffering consequences are more willing to indulge in the risky behavior again (Pearson & Hamilton, 2014); in fact, frequent experience with flooding may exacerbate this behavior. Study participants who appeared to be indifferent drivers stated that they are often not left with a safer driving option, since the other routes are just as flooded, and this encourages them to repeatedly drive through flooded roadways. Due to factors like these, some of the verbal protocol participants admitted to displaying indifferent behaviors and regularly driving through nuisance flooding. However, indifference was the least observed category in the verbal protocols study, perhaps because flooding is such a significant and widespread problem in the Hampton Roads region.

Focus group participants in this category stated that they use various approaches when deciding to continue through a flooded area. Indifferent drivers use factors such as the perceived level of water in comparison to the curb, the level of water in comparison to vehicles that are parked or that are driving through the water, and the size of the vehicles that are able to

successfully navigate the roadway. One indifferent verbal protocol participant reported that she looks for areas that offer easier navigation by watching vehicles that were close in size to, or smaller than, her own as they drive through flooded streets. She stated, “when I come across a flooded road, I'm looking to see if there is an opportunity where the road is a little higher and I can get across... I have an SUV, so if there's cars in front of me, I will try to watch them to see – okay, it's a little car or an SUV about the same size – are they making it through?” Another participant stated that driving through flooded areas quickly is key: “I just put the hammer to the floor and went as fast as I could.” Another participant stated, “[The road] was covered with [water]. I basically called [my husband] because I didn't know what to do. He said, ‘go through, put your windows down, and whatever you do, don't stop,’ and I did.” This indifferent behavior is extremely dangerous and can result in loss of life or property.

Summary of Findings

Our findings show the way in which risk and perceived adaptive ability combine to determine how drivers approach nuisance flooding on roads. Our study highlights drivers’ communication and information preferences, and it offers insights into how they process risk information. These findings are important to know because, as Kjellgren (2013) has pointed out, scholars and practitioners of risk communication too often assume that individuals will want to actively engage, both with discussions about risk in their environment and with considering the steps that may be taken to mitigate those risks.

However, the recurrent and pervasive nature of nuisance flooding has contributed, in the Hampton Roads area, to the rise of a proactive mindset among members of the community. As Kjellgren (2013) points out, this makes engagement with this audience challenging because a

large number of community members tend to see themselves as well-equipped to deal with flooding risks, even when the result is maladaptive behavior driven by an underestimation of those risks. Beyond the need for real-time, granular information, risk communicators will likely find that they can help promote increased resilience to nuisance flooding through a comprehensive communication strategy that includes (1) consistent signage and messaging, (2) reliable information sources, and (3) an education component for new residents. The needed comprehensive risk communication approach calls for the encouragement of both a broader awareness of the risk of flooding and an inclination, on the part of drivers, to take on a range of adaptive approaches that reflect a deeper awareness of the risks specific to nuisance flooding.

Implications for Practice

The increasing frequency of nuisance flooding in many coastal cities means that more and more drivers are likely to encounter this new and under-examined risk. While the threat of being swept away by nuisance flooding is not the same as it is in flash flooding, there is significant risk to property, as well as the continuing disruption of drivers' commerce, school, and work lives. Still, we found that drivers in Hampton Roads, for the most part, have a tendency to want to persist through flooded roads. There are myriad factors that contribute to this behavior, but for the purposes of this chapter's scope of study, their disposition to persist aligns with the three categories of individuals most likely to drive through nuisance flooding. Responsive drivers are knowledgeable of the risks and use a wide range of options to avoid or to mitigate the threat of floodwaters (e.g., they change their travel patterns, they seek out assistance from others, etc.). Proactive drivers see themselves as having the skills to avoid the threats of

nuisance flooding, but they see the risk as overblown. Indifferent drivers are exactly that – they have the skills to negotiate the floodwaters, but they don't see nuisance flooding as risk.

Climate change and risk communicators may, at first, see these groupings as part of a complicated, three-part challenge. However, since all three groupings share the inclination to persist, the overarching implication for communicators is the need to provide drivers with timely information regarding their options for driving in the midst of nuisance flooding. So, rather than attempting to convince drivers to change their disposition, communicators can help drivers develop personal strategies to minimize risks. This can be as simple as communicators' pushing out flooding information through traditional and social media news sources or investigating ways to use technology to push out real-time information to drivers (e.g., through mobile phone apps that tie-in to street sensors that relay the extent of road flooding). Furthermore, it is important that such messaging not simply provide data and information on alternative routes, but that it also briefly signal the risk of driving on flooded roads (e.g., "driving through flooded waters can lead to the deposit of abrasive chemicals on your vehicle that will damage its look and performance"). Since all three groups (responsive, proactive, and indifferent) have different views of the salience of the risks presented by nuisance flooding, providing drivers with real-time flooding information, accompanied by a brief narrative about risk, can provide each group with a common orientation point from which to make decisions. This approach recognizes that its primary aim is not to change the divergent worldviews of individuals about risk. Rather, it is to encourage these varied drivers to use more resilient and adaptive behaviors. This is a legitimate objective that can be accomplished through the provision of a combination of pertinent, real-time data coupled with a brief, relevant narrative of risk.

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