NATURAL DISASTERS AND RISK COMMUNICATION

IMPLICATIONS OF THE CASCADIA SUBDUCTION ZONE MEGAQUAKE

Edited by **C. VAIL FLETCHER** and **JENNETTE LOVEJOY**

Natural Disasters and Risk Communication

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Foreword

Kathryn Schulz

A year before writing about the Cascadia Subduction Zone for *The New Yorker*, I wrote an article about Norman Maclean's *Young Men and Fire*, a remarkable book about a wildfire in a remote part of Montana and the thirteen smokejumpers who were killed trying to put it out. I wrote that article because I'd been arguing with the book in my head for so long that I figured I might as well do so on paper. On the one hand, *Young Men and Fire* is one of the best pieces of nonfiction I've ever read: it's gripping, heartbreaking, full of dazzling facts, and so gorgeously written that whole chapters of it make me clutch my head in envy and pleasure. On the other hand, it gets the story of wildfire in America absolutely wrong, valorizing the tactics, strategies, and fallen heroes of a War on Fire that we should never have fought. As such, it contributed to the cultural beliefs and forestry practices that gravely exacerbated the wildfires we now see raging across the West—and to the deaths of still more young men and women who have been sent to battle them.

I say all this by way of explaining the trepidation I felt when I sat down to write about the earthquake risk in the Pacific Northwest. Disaster writing always takes place on that thin strip between the devil and the deep blue sea—the devil, in this case, being the risk of sensationalism, and the deep blue sea being the risk of screwing up the facts. But Norman Maclean taught me that there's another obstacle lurking out there, too: you can get every single fact right and still tell the wrong story. There are sins of omission, personal blind spots, cultural biases—all kinds of angles, overt and hidden, that can cut off the correct line of sight.

What I set out to do when I wrote the Cascadia piece was, first and foremost, avoid all of that. I wanted to tell the story right, and I wanted to tell the right story. I also wanted it to *matter*—not in the diffuse way that I like

to think all good writing matters, but in the direct way that would improve seismic preparedness in the Pacific Northwest. I wanted to get the attention of my friends out there, who knew about the problem but hadn't yet gotten around to strapping down their water heater or making a plan for their family; I wanted to get the attention of community members whose kids went to school in the tsunami zone; I wanted to trouble the consciences of CEOs and senators. Archimedes famously said that if you gave him a lever, he could move the world. The job of the writer is to find the lever.

Well, I didn't find the lever. But the piece did matter, at least somewhat, to some people—enough, maybe, to make a few places a little safer when the world (or the Northwest, anyway) *actually* moves. Still, beyond the initial ballyhoo, it's incredibly hard to know how much of a difference a given piece of writing makes, or why, or how to go about doing it again. And yet we urgently need to do it again; nature is full of dramatic events, and full of humans here to turn them into disasters. (The distinction is important; even a magnitude nine earthquake isn't a catastrophe unless there's a civilization sitting on top of it.) We humans are also around to make nature itself more dangerous. We live in a time of fires that rage with the artificial accelerant of human mismanagement, and of hurricanes—and countless other things—made worse by a climate that we've radically destabilized.

My job as a writer is to make people care about all of this, but no one does that alone. Finding our way toward a more responsive, more effective, and more ethical approach to the relationship between human beings and the rest of the natural world requires a vast collaboration, and an ongoing conversation. The one about Cascadia began long before I got to it—among seismologists and emergency planners, among policy wonks and politicians, among my colleagues in the Pacific Northwest news media and their readers. I'm honored to have joined it, happy to know so many others are continuing it, and certain that this collection will advance it.

Acknowledgments

A book is always the result of tremendous professional and personal collaboration and effort. It takes months and months of energy and creative thinking to bring together an innovative story that is worth telling, contributes to our field of communication, and connects to interdisciplinary literature across academia. And so we are grateful to *all* the people, friend or stranger, who have engaged us in dialogue over the past year and/or listened to us dissect or unpack various parts of our ideas and thoughts about the intersection between communication and the Cascadia Subduction Zone (CSZ), specifically, and natural disasters, generally. Thanks for your support and encouragement; it had an indelible and intangible impact. We are, of course, eternally grateful to our Department of Communication colleagues who have supported us along the journey as junior—and now senior faculty—en route to academic identity. Your nurture and patience is unmatched. To our University of Portland and transdisciplinary colleagues: thanks for your cheer and kindness and support. Without time provided by our sabbaticals, we would never have had the space to gather our thoughts on this project. To Elayne Shapiro, our first mentor post graduate school, 'thank you' does not begin to convey our sincere joy in having had your sage perspective on our family and professional lives. You are dearly missed on campus. Thank you to National Public Radio (NPR) and Oregon Public Broadcasting (OPB) for covering this topic and being willing to continually highlight such a unique social and cultural phenomenon. We recognize your influence as invaluable. We most certainly would not be as excited to publish this book without the willingness of Kathryn Schulz to be involved. Your voice on the CSZ earthquake has instigated countless conversations, changed lives, and will be remembered. Your love of the Pacific Northwest is true and resonates with us. A load of

high fives and hugs to Robert Butler, who has been the most wonderful contributor and supporter of the project. We are indebted to you for coming out of retirement to share your research and wisdom from studying the CSZ for 30 years. Thanks for your insights; this book is yours in many ways. Chris Goldfinger, preeminent scholar on the CSZ quake, also answered our email begging him to share his perspective with immediate ease. Thank you, Chris, for saying 'yes' so quickly. You have single-handedly changed what we know about seismology in the PNW forever. In particular, we also want to acknowledge Nicolette Amstutz, acquisitions editor at Lexington Press, for being so enthusiastic and supportive. And to Lexington Press, for being such a stellar publisher of academic work. To Julie Mann Lind, our assistant copy editor and the most professional person to work with, thank you for helping us catch all the teensy mistakes; and to our amazing Portland artist, Camille Shu, for helping us change the look and feel of an academic book by painting the most beautiful cover art ever.

Vail: I would like to start by acknowledging my coeditor, Jen. You have been the most authentic coeditor and dear friend. Your continued level of rigor, intellect, and spunk made working with you a treat. Thank you for sharing this adventure with me; I am always relieved when friends can write together and still have fun. Also, thank you to my partner, Gregory, for simply being here. I am so glad I found you; my life would never have been the same without you. You are my truest North and I love you. And to Huckleberry and Poppy: everything I do is for you and you are my joy. Finally, thanks to my nonhuman animal friends, domestic and wild, who loyally sat at my feet and/or passed by my window for hours on end while I worked on this project. I wish nothing less than a planet of wild and glorious spaces for you forever.

Jen: To the PNW that raised me—the tall pines, the sharp basalt rocks, yarrow and lupine and sagebrush, the smooth river edges, the high Cascade peaks, the rugged Columbia River Gorge, the farmlands and orchards, the smell of fields and pastures after a rain, the way the light reflects off changing leaves in the late summer heat, the sound of Sandhill cranes flying overhead. I am ever grateful for this natural world, where I continue to find my complete center and joy. I will grow old exploring and working in the outdoors. To my steadfast coeditor and dear colleague, Vail. Your propensity to question and find sheer delight in doing meaningful work will always impress me. Thank you for your listening and collaborating skills; it has been an honor to jointly tackle this book project. To my Travis: Your ability to find the seam of support and vision is unparalleled. I will forever be inspired by your immense capacity for making anything in our lives possible and for the forward tilt of your stride. Thank you for walking the rope of chaos with me in the fullness of careers, dreams, and raising three kids. I'm yours, always.

To Georgia, Sawyer, and Roan: Your curiosity for life inspires me daily as I grow with you. May your hearts always expand during a big hike in the mountains. Finally, to my mom: Your hiking boots are wonderfully impossible to follow. I miss you.

Chapter 1

Conceptualizing Risk

Media and Natural Disasters

Jennette Lovejoy

The string of hurricanes that pummeled through the Caribbean from August to October 2017 confirmed the difficulty of preparing for natural disasters. Even in a region accustomed to an annual hurricane season, Harvey, Irene and Maria wreaked havoc. Although scientists were able to somewhat predict each storm's course and timeline, we were unable to foresee the damage they would cause. All we could do from afar was wait and watch their paths of destruction unfold in the media. This is a sign of our modern experience, which Terry Tempest Williams, an author and naturalist, reminds us: "For so many years, talking about the weather was talking about nothing. Now it really is our survival" (September 8, 2017, *The New York Times*).

Meanwhile, on the opposite coast of the nation, we watched, similarly stunned, as the Eagle Creek wildfire ravaged in the Pacific Northwest (PNW). The fire was reportedly started by a teenager setting off firecrackers in the Columbia River Gorge at the height of summer. By the end of September, it had burned roughly 49,000 acres and was only 46% contained.

Both incidents remind us how difficult it is to communicate the threats posed by natural disasters and prepare for them before they occur. The unifying experience of hurricanes, wildfires, floods, blizzards, and earthquakes is the sensation that they lie outside of human control. We can't physically stop a hurricane from making landfall; neither can we put out a wildfire feeding viciously on dry landscape. In the moments of natural disaster, we are often faced with decisions or outcomes that depend on what we've done or thought about ahead of time. Sometimes structures are saved due to foresight in building code, barns and houses are spared due to large swaths of fire line created by bulldozers, or a herd of cattle can be moved to safety due to escape route planning.. Still, often our response and decisions are purely primal, motivated to save life. However, thinking about how to save life during a

natural disaster that might not even happen during one's lifetime is particularly challenging. This book began as a fascination with how people react and respond to predictions of natural disasters, specifically one close to our PNW home: the Cascadia Subduction Zone (CSZ) megaquake, a 1,000 kilometer fault line that stretches from Vancouver BC to northern California. The CSZ has been anticipated by scientists and experts across the globe, and yet, like most natural disasters, it remains ineffable until it happens.

In spite of the difficulty inherent to communicating future natural disasters, Kathryn Schulz's Pulitzer Prize–winning *New Yorker* article, "The Really Big One," succeeded in alerting the nation to the precarious tectonic plates of the CSZ and the inevitable earthquake and tsunami that their movement would cause in the next 50 years. As she stressed, the PNW region was not prepared for what would be the worst natural disaster in North American history. Although Schulz didn't share any new information—the CSZ earthquake timeline, while greatly unknown to the public, had already been reported by many scientists and the media—the widespread impact of her article was immediately palpable. She had thrust the CSZ into the public sphere in a new way. By weaving well-researched stats and scientific citations into a narrative relayed through vivid detail, analogies and anecdotes, she woke us up to the inevitable natural disaster in our future. The fear and panic that we encountered in many different PNW communities and circles revealed the efficacy of her message and affirmed the lack of preparation of the region.

In the hopes of continuing the conversations she started and transforming that initial fear and panic into a well-informed, well-prepared public, we formulated the question that would guide the research of this edited book: How do we communicate about natural disasters and what effect does our communication have on natural disaster education, understanding, assessment of risk, preparation, and recovery? The expertise, analyses and perspectives in this book are designed to help us better comprehend and deal with the risk at hand. With more information and knowledge of the CSZ, we hope, we can assuage our primal, fear-induced physiological and emotional responses to crises. If we accept that the disaster will occur and learn how we can prepare, we can calm the panicked beats of our hearts as we wait for its first tremors.

In this introductory chapter, I use Schulz's article as a springboard to detail the role of the media and social media in communicating natural disaster risks. Then, I give an overview of each chapter, emphasizing the gamut of perspectives offered by contributing authors. Rather than writing in the direct face of natural disasters like so much of our media coverage, our authors are fortunate to have had the time to reflect, consult prior ways of understanding, consider multiple angles, gather data, explore possibilities, and make suggestions for how our theoretical models and practical world could

better communicate the risks of natural disasters. More information and reflection on the CSZ, we hope, will lead to more action, effective preparation, and tighter communities united with common strategic efforts.

MEDIA, COMMUNICATING RISK, AND DISASTER PREPAREDNESS

The success of Schulz's article lies in its skillful combination of scientific research, summaries of the destruction of past earthquakes and quotes that lend themselves to becoming easy, sharable sound bytes on the scope of the disaster at hand. As FEMA's regional director told her: "everything west of Interstate 5 will be toast" (para. 12). The news spread quickly. The risk felt real. Around dinner tables and across related academic fields, everyday citizens and experts discussed the threat.

Eight days after Schulz's original article was published, she wrote a follow-up article: "How to Stay Safe When the Big One Comes," which reinforced the scale of the disaster, offering a further analogy: "the Cascadia earthquake is going to hit the Pacific Northwest [PNW] like a rock hitting safety glass, shattering the region into thousands of tiny areas, each isolated from one another and all extremely difficult to reach" (para. 14). As the article's title implies, Schulz offers clear steps that can be taken in order to prepare for the earthquake. Her initial article had caused such a strong reaction that she needed to follow up with what to do when the Big One came. In a region where earthquakes had not before composed part of the social, economic, or cultural fabric, earthquake emergency preparedness kits were selling out. Families devised emergency plans. Partners agreed on meeting places if they were separated at the time of disaster. Homeowners arranged for seismologists to examine their homes and strapped down hot water heaters for the first time. Everyone tried to calculate the odds of the disaster occurring in his or her lifetime. Schulz's articles had not only effectively communicated the risk, but also began to mobilize the public to prepare.

Paramount to the way natural disasters are understood and reacted to are the ways the media communicate before, during, and after the disaster, which potentially make the difference between keeping an individual or community safe and alive. Communication regarding natural disasters follows the same trajectory of all journalism: the when, why, where, who, and how are central to the story and make sense of what is going on. Not only are these facts important to anticipating and dealing with natural disasters; they are also imperative to educating the public and predicting how we can best approach natural disaster management.

When discussing a future natural disaster, aggregate media coverage leads to heightened anticipation, as is true of the reportage on any potential threat. For example, if there are numerous stories on crime in a neighborhood, residents tend to feel particularly vulnerable and fearful for their safety (see Agenda Setting Theory; e.g., McCombs & Reynolds, 2002). Similarly, when the media begin to focus on how to prepare for a specific disaster or emergency, the public begin to sense that it is bound to happen. Nonetheless, Parmer and colleagues (2016) have argued that in the context of natural disasters, the media does not tend to help the public transform that fear into understanding and action. The findings suggest that natural disaster articles are more apt to be empathic in tone than other risk topics and tend to lack information on "accountability" instead reflecting "news organizations' assumptions about natural processes of the earth or a lack of awareness or understanding of how human decisions contribute to natural disasters" (p. 1220). While some natural disasters may be caused by human actions (e.g., hurricanes have been linked to global warming) others, such as earthquakes, seem to be in a class of their own in determining "predictability" and "accountability." Therefore, the influence of news coverage of earthquake disasters on public understanding may best be investigated by looking at the communication of disaster preparation.

Often, the goal of the media in providing public information about potential disasters is to help prepare society for said disaster and thereby mitigate devastating consequences. However, despite media outreach and education, research shows that public participation in preparing for potential risks is low (Paton, 2003) and may in fact be a waste of resources if the disaster does not actually occur. This may be one reason that news coverage of natural disasters is often seen as reactive instead of proactive. Social media channels have been particularly effective and useful in disseminating and sharing valuable "in-time" or reactive types of natural disaster information (Imran, Elbassuoni, Castillo, Diaz, & Meier, 2013). During natural disasters, research suggests that social media messages should not simply relay information and provide awareness about the event; they should also support the coordination of individuals during emergency response (Imran, Castillo, Diaz, & Vieweg, 2015). Facilitating public coordination during the preparation process and providing a sense of the risk at hand makes social media messages that much more impactful during any natural disaster.

If coverage is to be more proactive and give people the tools they need to take action before an event occurs, it may need to cause an initial reaction of panic, as we saw with Schulz's article. Effective risk communication tends to arouse fear (Paek, Oh, & Hove, 2016), bring awareness of the risk, and inspire the type of information gathering that ultimately decreases fear (Lee & Hawkins, 2016) and may reduce the overall sense of uncertainty and risk.[1]

The role of the media in risk communication has also been explored through Vested Interest (VI) theory, which suggests that there are five attitudes that predict behavior: stake, salience, certainty, immediacy, and self-efficacy (Crano, 1997). Specific research shows that to improve the effectiveness of mass-mediated disaster messages, readers need to have the perception both of their personal susceptibility to the disaster and of the efficacy of taking preparatory action (Adame & Miller, 2015). Behavioral intentions to mitigate risk can be best predicated by messages that increase vested interest. More information and awareness of risk, however, does not necessarily produce better-prepared individuals. A meta-analysis of the literature on the link between risk perception and individual preparation for natural disasters illustrates that there is not a direct relationship between high risk perception and individual preparation; individuals with a heightened sense of risk do not necessarily engage in preparedness measures (Wachinger, Renn, Begg, & Kuhlicke, 2013). The authors of the study give three reasons for this "risk perception paradox": (1) Individuals understand the risk but have little motivation to change their circumstances and the potential benefits of not being prepared (e.g., moving, paying for insurance, etc.) outweigh the associated costs (literal and figurative) of preparation; (2) Individuals understand the risks but determine that they are not directly responsible for their actions and instead count on the preparation of other people/organizations; and (3) Individuals understand the risks but do not feel capable of affecting the situation (p. 1054).

In addition, the relationship between media content and risk perception has become more complex with the increasing number of digital media platforms. Some scholars have argued that the media's influence on risk perception may be minimal and is effective only if the risk is covered often (e.g., information is easily available for consumption; Wahlberg & Sjoberg, 2000). Contrary to more recent research (Paek, Oh, & Hove, 2016), Wahlberg and Sjoberg found that the media more easily influence general rather than personal risk perception due to the impersonal nature of general media content. Because social media is also used to facilitate interpersonal relationships, it may affect individual response levels to natural disaster risk. Further research is needed to parse out the ways different media channels interact with risk behaviors.

Our nonstop media and social media environment has created endless possibilities to encounter multiple messages of overlapping media content, creating potential synergy or, on the opposite end of the spectrum, apathy and desensitization. A recent study looking at social media channels indeed indicates that an interest in natural disasters varies widely based on geography (Yang, Mei, Zhao, & Chen, 2017), illustrating the likely importance of prior knowledge and familiarity of the natural disaster as well as the cultural and social framework in which messages are sent and received.

Examining the influence of the media and social media is only one way we can analyze and advance the communicative lens of preparing for natural disasters and understanding risk. There may be tensions between information in the media and how that information lives in the knowledge, attitudes, beliefs, perceptions, and actions of individuals and communities. In order to further build on our understanding of the intersection between humanity and natural disasters, we selected and compiled the following chapters that circle on the communicative qualities intrinsic and extrinsic to a modern society increasingly faced with natural disasters.

Book Overview

Each chapter in this book details a different aspect of communication in the context of natural disasters: how we educate the public, how we perceive and communicate risk, how we interpret media coverage, how their experience affects risk perception and assessment, and how both individuals and communities can draw on resilience to better prepare themselves. Instead of perpetuating the anxiety and fear that tends to characterize our initial response to the topic of natural disasters, which I have experienced first hand in the process of editing this book, we hope to compel readers to pause, consider what we have learned from past responses and current theoretical models on natural disasters, and utilize that information to move forward in their own (and thereby their community's) process of risk preparedness. We strive to foment movement along the continuum—whether from ignorance to acknowledgment, denial to acceptance or acceptance to action—extend conversations and elucidate systemic considerations that may abate the CSZ disaster.

Our book is organized into four parts, which will be further elucidated below. In Part I, "Cascadia Subduction Zone: Geological Background and Predicting Preparedness in the Pacific Northwest," we situate ourselves in the geological background of the CSZ, analyzing how the region relates to past earthquakes and detailing how residents have assessed their specific risk toward the potential CSZ earthquake and tsunami. In Part II, "Confronting Risk Information: Rhetorical Framing in the Media and Stages of Crisis," we investigate why and how Schulz's "The Really Big One" was so effective, comparing it to other media coverage of the CSZ. We then consider an extended theoretical model that takes into account how people confront and act in the face of risk information. In Part III, "Local and Global Case Studies: Analyzing Demographic, Attitude and Economic Factors in Natural Disasters," we add context and lessons from two case studies greatly affected by natural disasters in Louisiana and Japan. Although the two disasters are very different, they both offer a nuanced understanding that allows us to see the variables that affect perceived risk and subsequent preparedness. Last, Part

IV, "Community, Organizing, and Resilience: Pragmatic Considerations," focuses on how communities can develop resiliency toward natural disasters, the CSZ in particular. We narrow in on our built environment in the PNW and offer practical considerations to better prepare all living beings, human and non-human alike.

PART I: CASCADIA SUBDUCTION ZONE: GEOLOGICAL BACKGROUND AND PREDICTING PREPAREDNESS IN THE PACIFIC NORTHWEST

In Chapter 2, Butler gives us an invaluable overview of the geological science behind the CSZ and its potential impact on our built environment and livelihood. Concentrating on the vital role education plays in preparation, he asks his students (and us all) to prepare on both the individual and community levels. To stress the sobering scale of a CSZ earthquake in the near future, he outlines the anticipated damage: first, 10,000 fatalities and 30,000 injuries; second, in terms of the economy, $50,000 for Washington and $30,000 for Oregon. If that weren't convincing enough, he describes the disaster as "[a] triple threat of three kinds of tectonic earthquakes in the Pacific Northwest and a damaging earthquake somewhere in the region during the next 50 years." While it is clear that we have much to do if we are to be better prepared, Butler also highlights the progress that has been made in developing resilience plans, infrastructure and mapping improvements, policies, legislation, and organizations that have vastly improved the potential of earthquake resilience. By emphasizing education, he inspires us to leverage themes of individual action, community, and resilience to make the CSZ earthquake have the least horrific outcome possible.

Understanding the way that residents in the PNW perceive the risk of the CSZ earthquake and tsunami helps us to get a better grasp on how much education needs to be done. In Chapter 3, Adame and Miller highlight that residents indeed may be very unaware of the severity of the risk they face and thus are underprepared. To survey risk perception, they utilize Vested Interest (VI) theory as a framework to survey risk perception. They demonstrate that six psychological factors of VI (stake, salience, certainty, immediacy, self-efficacy, and response-efficacy) may be key in influencing risk perception susceptibility as well as motivating individuals to prepare. Building a higher level of individual vestedness, they suggest, may rely on making public understanding of risks on par with the understanding that experts have of the future disaster. They offer strategic ways to craft messages to increase vested interest and, in turn, improve risk preparedness.

Both chapters provide many reasons why the CSZ phenomenon matters to the public while documenting the variability of public risk perception and awareness. Together, they suggest how we can better educate the public so that we can take more steps toward preparation. To understand the role of the news media in fomenting public awareness and influencing decision-making, we turn to Part II.

PART II: CONFRONTING RISK INFORMATION: RHETORICAL FRAMING IN THE MEDIA AND STAGES OF CRISIS

In Chapter 4, Homchick Crowe does a thematic analysis of CSZ newspaper and magazine coverage before and after Schulz's article. She finds that the tone of CSZ news coverage changed substantially leading up to it: from the 2001 Nisqually quake to the 2004 Indian Ocean quake to the 2011 Japanese quake and tsunami, articles were increasingly alarmist when describing how unprepared the PNW was for the potential earthquake. She illustrates how and why Schulz's article was more effective than any coverage prior and became a pivotal turning point in public knowledge. Categorizing it as "factual entertainment," she asserts that it was ultimately responsible for turning the CSZ into a national conversation. She then proposes that Schulz's style of journalism is essential to increasing public understanding and response to imminent and nonimminent environmental and health risks.

In Chapter 5, Kuang affirms that communication of risks in the media may vastly affect action taken by the public to mitigate risks. She reviews relevant literature, integrating the popular Extended Parallel Process Model (EPPM) into risk communication to develop a new theoretical model through which to interpret risk communication and judgment and decision-making. This model sustains that action to reduce risk could be the result of mental shortcuts, or heuristics, rather than a propensity to utilize and consider all information. Kuang calls this sequential decision-making and explains that this theoretical approach could mean that less information is more effective in mitigating risk in certain environments. Her model helps close the gap between knowledge and action related to risk for risk and health communication practitioners.

Through the framework of media, these two chapters imply that each of us is implicated in the media's coverage of natural disaster information. Every time we actively read and share an article, whether via social media, email or around the dinner table, we make a small vote for the type of media coverage we prefer to use to inform our assessment of risk and decision-making before, during, and after natural disasters.

PART III: LOCAL AND GLOBAL CASE STUDIES: ANALYZING DEMOGRAPHIC, ATTITUDE, AND ECONOMIC FACTORS IN NATURAL DISASTERS

In Part III, we shift focus to consider public risk assessment through two prominent case studies: the Louisiana floods of 2016 and the 2011 earthquake in Japan, which was the biggest earthquake in recorded history. In Chapter 6, Kim and Madison use a survey distributed via social media after the worst flood in Louisiana history to collect data on the variables that affect public risk perception attitudes (RPA's) regarding flooding. Positing the types of factors that would increase RPA, it illuminates strategic tactics that may enhance crisis preparation related to natural disasters. The survey focuses on ten factors—flood zone, flood insurance, flood experience, business ownership, homeownership, dependents, gender, age, perceived economic status, and education level—and their relationship to risk perception attitudes. The authors find that while knowledge of variables predicts high RPA, having a high RPA does not necessarily indicate behavior change to mitigate risk. In the end, they are able to provide insights into which variables communication interventions should focus on in order to improve communication efficacy and efficiency.

In Chapter 7, Matsuura and Sato consider the use of hazard maps in Japan, where earthquakes are common, to illustrate how risk communication may influence perceived land value. They employ a hedonic pricing approach to evaluate multiple natural disaster risks in Japan in order to ascertain whether the effort to produce and release the maps has an effect on risk assessment of multiple natural disasters (earthquake, river flood, sediment disasters, tsunamis, and volcanic eruption). They find that land price, or perceived amenity value of land, does not respond to the risk information of earthquakes, even when there is high earthquake awareness in the region. However, the perceived risk of other natural disasters is associated with a decrease in land value. Matsuura and Sato suggest increasing disclosure of information regarding natural disasters in Japanese real estate transactions, along with using multirisk assessment in risk communication, to promote shifts in public awareness.

By looking at these two case studies, we have the opportunity to compare them to our responses to natural disaster risk. How do we actually facilitate a change in attitude or action with a known risk? Although Part III may seem to insinuate that increasing the perception of risk leads to better preparation, we see that this is not always the case. High perception of risk can leave the public feeling overwhelmed and frozen as to what to do next. In that context,

the next section gives us practical considerations to help motivate preparation in the PNW.

PART IV: COMMUNITY, ORGANIZING, AND RESILIENCE: PRAGMATIC CONSIDERATIONS

Part IV of our book links the broader issues of resilience and natural disaster preparation back to our home front in the PNW. These last two chapters reflect on human-companion animal relationships, community and built environments. They lead us to consider our roles in building resilience in communities in preparation for the CSZ disaster.

In Chapter 6, Novak and Day analyze the pragmatic issues surrounding the care and survival of companion animals during natural disasters. While companion animals are part of our everyday lives, Novak and Day point out that there are not systems in place or plans of action that include how to evacuate, transport, relocate, and house them during crisis, which highlights the current secondary nature of their value in current risk communication and disaster. Novak and Day posit that public health, safety, and risk issues have too often been defined narrowly to serve human needs and concerns. They use past examples of the effects of natural disasters on companion animals to make pragmatic recommendations for how crisis communication activities and plans can include humans and companion animals alike.

In Chapter 7, Doulis closes our study with a reflective narrative of what natural disaster preparation currently looks like at the government, community and individual levels. He then details what it might look like if we focused preparation on the notion of resilience. By recalling past responses to natural disasters, he shows how the PNW can move more toward resilience within communities instead of relying solely on the governmental or social systems in place to mitigate damage. He urges readers to get to know their neighbors in ways that build community, fostering connections that will prove vital during the CSZ disaster and what Doulis asserts to be the bigger other risk: climate change. The sense of connectivity Doulis calls for is an extension of the interdependence humans have on each other and nature. He urges everyone to do something to rebuild it, stressing that even the seemingly smallest individual actions—like bringing your neighbor eggs or extra water—yield community benefit.

ONWARD TOGETHER

In the conclusion, Fletcher links the chapters into three distinct themes. From the lens of nature and our complex, ever-evolving relationship with it, she points to areas where questions remain unanswered and where we find ourselves particularly vulnerable. Her framework isn't meant to corral the book, but rather to further open it beyond its original intention, inspiring tangential or related questions and allowing us consider how we experience natural disasters in general and the Cascadia risk in particular.

By offering a social science perspective to our understanding of the intersection between risk communication and natural disasters, specifically regarding the CSZ, we hope to inspire greater organization in how we prepare for this disaster, which may or may not occur in our lifetimes. Although the science behind the CSZ is united, the methods of responding, organizing and preparing to it remain uncertain and unclear. We believe that the communicative lenses offered by each author in this book bring new perspectives and considerations for how to comprehend the risk and what actions to take next.

Any CSZ earthquake preparation done in our lifetime will, at the very least, hopefully augment the resiliency efforts of future generations and bond individuals together in a common purpose. There will always be unbelievable crises and ill-preparedness when a natural disaster strikes, but attention to the communicative issues and focus on leveraging strategic communication to prepare will undoubtedly make a difference in its outcome.

NOTE

1. Lee and Hawkins (2016) explored the effect of worry on the process of seeking additional information in the context of the communication of negative health and medical news. They indeed found that increased anxiety predicts greater information gathering, and that worry decreases when more information is obtained. While the uncertainty surrounding natural disasters is clearly different than the uncertainty surrounding health (e.g., cancer), it may be met with the same action of seeking additional information.

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Part I

CASCADIA SUBDUCTION ZONE

Geological Background and Predicting Preparedness in the Pacific Northwest

Chapter 2

Cascadia Earthquake Science and Hazards

Robert F. Butler

The science behind the Cascadia Subduction Zone (CSZ) has truly provided ground-breaking insights into our human understanding of the planet, as Kathryn Schulz eloquently reminds us:

> Geology, as even geologists will tell you, is not normally the sexiest of disciplines; it hunkers down with earthly stuff while the glory accrues to the human and the cosmic—to genetics, neuroscience, physics. But, sooner or later, every field has its field day, and the discovery of the Cascadia subduction zone stands as one of the greatest scientific detective stories of our time. (Schulz, 2015, para. 15)

Twenty-five years ago, conventional wisdom was that the Pacific Northwest is a region of low to moderate earthquake hazard. Few people had even heard the term "Cascadia" let alone begun to worry about "The Really Big One." Now we know the Pacific Northwest is most assuredly earthquake country where massive earthquakes much larger than those in California occur every few centuries and smaller but still major earthquakes occur every few decades. How did this revolution in geoscience happen? What were the key discoveries? What new methods and new instruments of geophysical research were used to make these discoveries? The author has invested much of the last 15 years translating recent discoveries in Cascadia plate tectonics, seismology, and geodesy for novice learners. He has instructed professional development workshops on Cascadia earthquake science and hazards education for hundreds of K–12 science teachers across the Pacific Northwest. He also taught a course on Natural Hazards of the Pacific Northwest to more than one thousand students at the University of Portland. In addition, he collaborates with geoscience educators at the Incorporated Research Institutions for Seismology to develop animations about earthquake science and hazards.

This chapter will provide the reader an introduction to Cascadia earthquake science. That background is followed by an analysis of the built environment and how buildings and infrastructure have been affected by past earthquakes and will likely respond to future earthquakes. Finally, this chapter will conclude with examples of how citizens, communities, and governmental organizations are mapping the path and starting the journey from our current condition of unpreparedness toward the goal of an earthquake resilient Pacific Northwest.

PAST GREAT CASCADIA SUBDUCTION ZONE EARTHQUAKES

The last great Cascadia Subduction Zone (CSZ) earthquake occurred January 26, 1700 at about 9 p.m. local time. This event occurred over a century before the Lewis and Clark expedition arrived on the northern Oregon coast, so there are no written records of eyewitness accounts. Although Native American oral histories provide evidence for a natural disaster including the destruction of coastal villages by "a great wave that arrived in the night and put the canoes in the trees," these accounts provide only rough estimates of the date of occurrence (Ludwin et al., 2005). So how can we know the time of the 1700 earthquake to a precision of one hour? This scientific discovery story is one of the most fascinating and important in the history of geology. One of the principle researchers who literally unearthed evidence of past Cascadia great earthquakes is Brian Atwater, a U.S. Geological Survey scientist based in Seattle. Atwater has referred to the discovery of past great CSZ earthquakes as "a Trans-Pacific Detective Story."

Many people fear earthquakes as random "acts of God." To replace fear with a rational understanding of earthquakes and the methods for mitigating their effects, we must understand some principles of plate tectonics, a relatively new scientific discovery. The theory of plate tectonics arose after World War II, in part due to marine geological studies that employed ships and technologies developed for the war effort. Concerns about nuclear weapons development during the Cold War led to installation of the Worldwide Seismic Network that enabled detection of nuclear test explosions. A byproduct was vastly improved measurements of the size and location of earthquakes. During the 1960s, what were originally thought to be isolated discoveries in geomagnetism, marine geology, seismology, and other geophysical disciplines were united in plate tectonic theory, a true scientific revolution in our understanding of planet Earth (Menard, 1986; Oreskes, 2003).

Figure 2.1 illustrates the Pacific Northwest portion of the North American Plate and the adjacent oceanic Juan de Fuca Plate. The CSZ encompasses

the entire region from the offshore line of contact between the Juan de Fuca and North American plates on the west to the line of Cascade volcanoes on the east. The subduction zone stretches from Cape Mendocino in northern California to the middle of Vancouver Island. In the subsurface, the Cascadia megathrust fault is the sloping interface between the top of the subducting Juan de Fuca Plate and the bottom of the overriding North American Plate. Because the Juan de Fuca Ridge, where seafloor spreading generates new Juan de Fuca Plate, is not far offshore, even the oldest part of the Juan de Fuca Plate is only 10 million years old (geologically young) when it subducts. On a global scale, the Juan de Fuca Plate and CSZ are small. Other aspects of the CSZ are unimpressive when compared to larger and more active zones like the Aleutian, Japan, and Western South America subduction zones. Rate of subduction of the Juan de Fuca Plate beneath the North American Plate increases from 3 cm/yr in the south to 5 cm/yr in the north, slower than in the more active zones.

The Cascade Mountains are a chain of young volcanoes but much less active than Andean or Aleutian or Japanese volcanoes. Compared to the

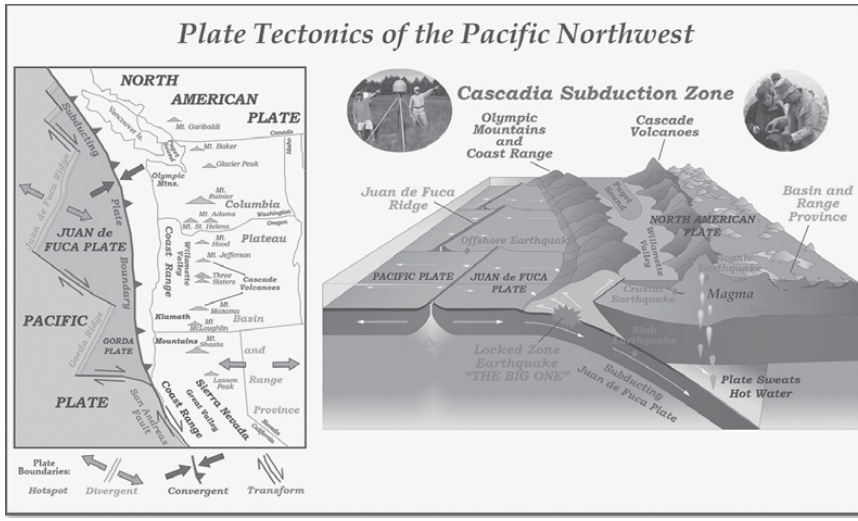


Figure 2.1. Plate Tectonics of the Pacific Northwest Plate tectonics of the Pacific Northwest region. Map view on left and cross section on right show plate boundaries. The Cascadia subduction zone is the North America—Juan de Fuca (and Gorda) plate boundary stretching from northern California to Vancouver Island in British Columbia. Locations of different types of earthquakes are shown on the cross section. *This illustration was developed by the Cascadia EarthScope Earthquake and Tsunami Education Program (http://ceetep.oregonstate.edu/) of which the author was a Principal Investigator.*

Aleutian, Japan, and Western South America subduction zones that have scores of magnitude-6 (M6) and M7 earthquakes every decade and a great M8 or M9 earthquake every few decades, the CSZ is seismically quiet with only a handful of M6 earthquakes recorded during the era of modern seismology. This quiescence led many seismologists to conclude that the CSZ was a special, largely aseismic, subduction zone that never has great M8 or M9 megathrust earthquakes. Even Chris Goldfinger, a marine geologist at Oregon State University who would later do seminal research on the history of great Cascadia earthquakes, coauthored an article in 1995 arguing that Cascadia does not have M9 great earthquakes (McCaffrey & Goldfinger, 1995). So, the prevailing view into the early 1990s was that the CSZ is small and harmless so far as great earthquakes are concerned, although the 1980 eruption of Mount St. Helens clearly illustrated the hazards of Cascade volcanoes.

The two largest earthquakes of the twentieth century, the 1960 M9.5 Chile earthquake and the 1964 M9.2 Alaska earthquake, were subduction zone megathrust earthquakes that produced massive tsunamis and major changes in land level above the rupture zones. During the great Alaska earthquake, the broad continental shelf at the leading edge of the North American Plate uplifted as much as 9 meters while the landward region subsided by as much as 2 meters, thus dropping the inland shoreline below sea level (Plafker, 1969). This shoreline subsidence dropped coastal forests into the intertidal zone where previously healthy trees were poisoned by submersion in seawater during high tide. (Use the link in Appendix A to view *The 1964 Great Alaska Earthquake* animation for a tutorial about that subduction zone earthquake and tsunami.) The resulting coastal marshes with standing dead stalks of Sitka spruce became "ghost forests" for several decades before the trunks rotted and fell leaving only the stumps entombed in intertidal mud.

Armed with this understanding of land level changes that accompany great subduction zone earthquakes, Atwater began his study of ghost forests along the Washington and Oregon coast. Figure 2.2 is a photograph of the ghost forest along the Copalis River on the central Washington coast west of Olympia, one of the primary sites of Atwater's research. The standing dead stalks of rot-resistant western red cedar are over 100 feet tall and 4 feet in diameter at their base. They are victims of the 1700 great CSZ earthquake.

Figure 2.3 is a photograph of geological layers beneath a tidal flat along the Niawiakum River on the east side of Willapa Bay on the southern Washington coast. Atwater and other researchers have found this "three-layer cake" of Cascadia tsunami geology in ghost forests along coastal rivers and estuaries from northern California to the Olympic Peninsula of Washington. From bottom to top, the three layers are: (1) an organic-rich forest soil often containing well-preserved pine needles and Sitka spruce cones; (2) a layer

Figure 2.2. Photograph of ghost forest on the Copalis River on Washington coast west of Olympia, WA. Standing dead stocks are western red cedar trees killed by seawater when land surface subsided during the January 26, 1700 great Cascadia subduction zone earthquake. *Photograph taken by author.*

of sand up to one foot thick sometimes containing sublayers of alternating fine and coarse sand; and (3) an upper layer of mud and clay. After rejecting an alternative interpretation that these layers might record slowly rising sea level, Atwater and Hemphill-Haley (1997) concluded that this characteristic layering was the geological record of past great CSZ earthquakes. In the centuries between great earthquakes, land near the coast slowly rises allowing formation of rich soils and growth of dense forests just above the high-tide level. When a great earthquake occurs, coastal land suddenly drops by up to 2 meters plunging the forest into the intertidal zone. Within minutes a massive tsunami washes beach sand over the forest floor sometimes depositing multiple sand layers that record the multiple surges of the tsunami wave sequence. Over the succeeding decades and centuries, intertidal mud and clay is deposited on the tsunami sand and tidal marsh plants begin to grow at the high-tide level.

Recognizing the critical importance of dating these ghost forests, Atwater recruited David Yamaguchi, a dendrochronologist, to do tree-ring dating of the ghost forests. Yamaguchi compared the growth rings of "victim" trees

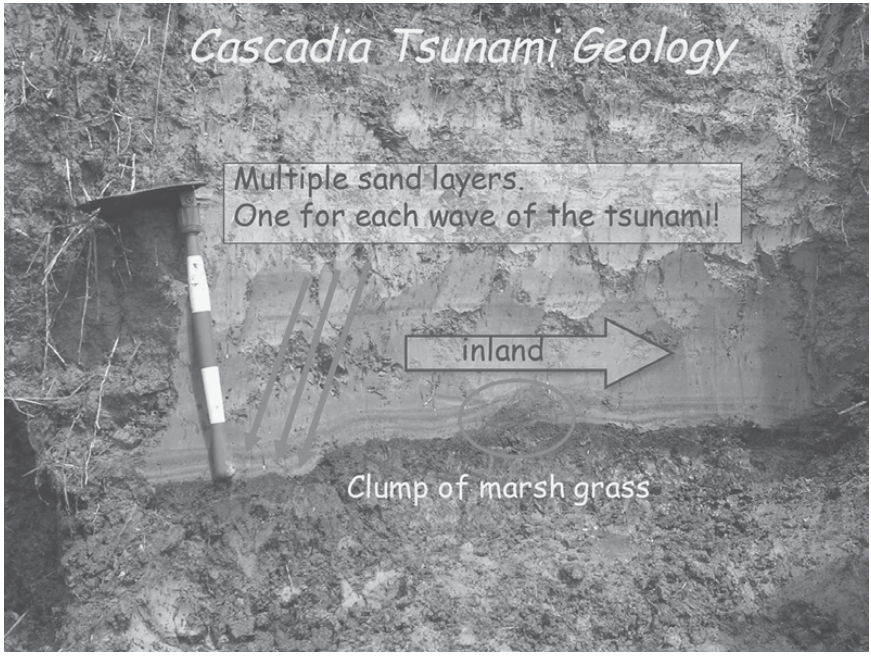


Figure 2.3. Cascadia tsunami geology along Niawiakum River east of Willapa Bay in southwestern Washington. Red and white bars on the shovel handle are 10 cm (~ 4 inches) in length. "Three-layer cake" of organic-rich forest soil at bottom is overlain by tsunami sand containing multiple layers produced by successive waves of tsunami wave sequence following the 1700 earthquake with intertidal mud and clay on top. Marsh grass was bent to the right (upstream) as tsunami waves carrying beach sand rushed ashore. *Photograph taken by author.*

killed by submergence in seawater with tree rings of "witness" trees on nearby higher ground that experienced but survived the earthquake. Combining C-14 and dendrochronology dating methods, Atwater and Yamaguchi (1991) narrowed the time of formation of ghost forests, and thereby the date of the last great Cascadia megathrust earthquake, to somewhere in the late 1600s to early 1700s. Ultimately by dating the outer ring of bark-covered roots in buried stumps of victim trees, they determined that the last ring formed during the growing season of 1699 so the trees died between the fall of 1699 and the spring of 1700 (Atwater et al., 2005).

Kenji Satake, a Japanese seismologist, is a world expert on subduction zone earthquakes and tsunamis. When Atwater and Yamaguchi (1991) narrowed the time of the last great Cascadia megathrust earthquake to a window of about 20 years, Satake et al., began searching Japanese historic documents for records of the arrival of the tsunami generated by the Cascadia earthquake

in harbors and on shorelines of Japan (1996). "Tsunami" is a Japanese word meaning "harbor wave." In Japan, the connection had been made centuries ago between severe and prolonged ground shaking caused by a local great earthquake and the arrival of a tsunami soon thereafter. Historic records of tsunamis have been kept in numerous coastal cities in Japan back to 1400. While most tsunamis were preceded by violent ground shaking, sometimes tsunamis arrived with no earlier perceived ground shaking. These were referred to as "orphan tsunamis" because they arrived without a "parent" earthquake. Enlisting the assistance of experts on historic documents, Satake and coworkers found consistent written accounts of an "orphan tsunami of 1700" (Satake, Shimazaki, Tsuji, & Ueda, 1996). The properties of this tsunami were consistent with an origin in the Pacific Northwest. Knowing the nine-hour travel time for a tsunami to transit the North Pacific Ocean from coastal Cascadia to Japan and the details of historic clocks and calendars, Satake et al. (1996) determined that the last great Cascadia megathrust earthquake occurred January 26, 1700 at about 9 p.m. local time. (Use the link in Appendix A to view *Orphan Tsunami: Megathrust Earthquakes in the Pacific Northwest* animation for a tutorial about Cascadia tsunami geology and the orphan tsunami of 1700.)

Continuing research on Cascadia tsunami geology documented the history of great Cascadia megathrust earthquakes over the past 3,500 years (Atwater & Hemphill-Haley, 1997). To extend the great earthquake record further back in time, Goldfinger et al., analyzed turbidites in sediment cores from the deep ocean floor adjacent to the Pacific Northwest continental shelf (2012). A turbidite is a deposit grading from sand at the base to finer-grained silt or clay at the top resulting from a turbidity current, a turbulent mixture of seawater and sediment that roars down a submarine canyon from a landslide on the continental slope. Goldfinger reasoned that great Cascadia megathrust earthquakes would shake the continental shelf generating turbidity currents in submarine canyons along the length of the subduction zone that ruptured in those earthquakes. By dating turbidites in ocean sediment cores collected from the deep ocean floor outboard of the Cascadia continental margin, Goldfinger and coworkers have documented the last 10,000 years of Cascadia megathrust earthquakes (Goldfinger et al., 2012). The resulting history is shown in Figure 2.4.

The advance in our understanding of great CSZ earthquakes over the past 25 years is both astonishing and sobering. Although formerly viewed as a seismically harmless subduction zone, we now know the "inconvenient truth" that the CSZ has ruptured in great megathrust earthquakes many times in the past and will do so in the future. The average time between great M9 megathrust earthquakes that have ruptured all or most of the length of the subduction zone is about 500 years. In addition, the southern half of the

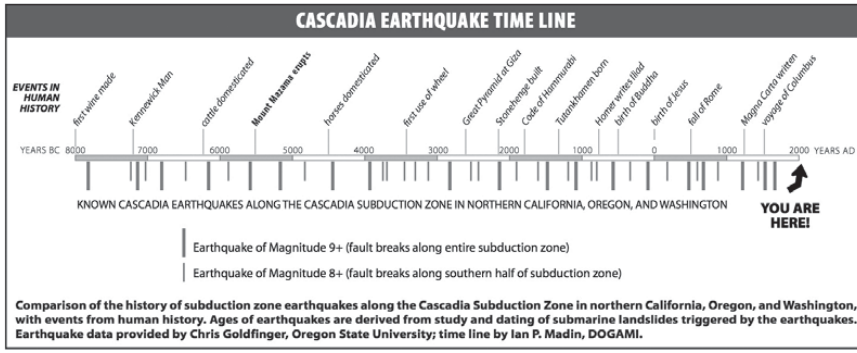


Figure 2.4. Historical timeline of Cascadia great earthquakes and human events over past 10,000 years. Bold gray vertical bars indicate ages of M9 Cascadia subduction zone earthquakes that ruptured full length of the subduction zone. Thinner and shorter gray vertical bars indicate ages of M8 Cascadia subduction zone earthquakes that ruptured only the southern part of the subduction zone. *Illustration courtesy of Oregon Department of Geology and Mineral Industries (DOGAMI, 2010).*

subduction zone has ruptured in great M8 or larger megathrust earthquakes about as often as has the entire subduction zone. So, the southern half from the central Oregon coast to Cape Mendocino in northern California ruptures in a great megathrust earthquake on average every 250 years. However, as evident in the history of Figure 2.3 and characteristic of earthquake zones worldwide, the time between great earthquakes is highly variable. Sometimes there are 1,000 years between full-length M9 megathrust earthquakes and sometimes that interval is only about 200 years. At present, we are 317 years into the great CSZ earthquake cycle and we do not know when the next one will occur. But we do know there are great CSZ earthquakes in our future.

The preceding is a short version of the discovery of great CSZ earthquakes. Readers desiring a more thorough introduction to Pacific Northwest plate tectonics and Cascadia earthquakes can chose from the books listed in Appendix A. In *The Orphan Tsunami of 1700*, Atwater et al. (2005) take readers through their personal histories of exploring ghost forests in Cascadia and scouring Japanese historic documents leading to the conclusion that the last great Cascadia megathrust earthquake occurred January 26, 1700, at about 9 p.m. local time. In *At Risk*, Clague, Yorath, Franklin and Turner (2006) introduce readers to a broad view of Cascadia earthquake science and hazards in a superbly illustrated book. In *Living with Earthquakes in the Pacific Northwest*, Yeats (2004) presents fundamentals of seismology, geology of earthquakes in the region, hazards presented by these earthquakes, and emergency preparedness measures that can mitigate those hazards. *Cascadia's Fault* (Thompson, 2012), *Full-Rip 9.0* (Doughton, 2013), and *The Next Tsunami* (Henderson,

2014) are well-written and less technical accounts of the discovery of Cascadia earthquake and tsunami science and hazards.

GPS: CASCADIA LOCKED AND LOADING

Most of us have some familiarity with the Global Positioning System (GPS). Map apps on our phones or the navigation system in our cars use GPS to locate our position on Earth's surface, determine where we are on the street grid, and our direction and speed of travel. These simple GPS receivers can locate us to a precision of about 10 feet or 3 meters. The Plate Boundary Observatory (PBO) is a collection of more than 1100 high-precision GPS receivers installed across the U.S.United States as part of the EarthScope Program funded by the National Science Foundation. GPS data are used to determine the location of every PBO station to within an error ellipse the size of a grain of rice. PBO stations are concentrated near plate boundaries such as the San Andreas Fault in California and across the Pacific Northwest, above the subsurface megathrust boundary between the subducting Juan de Fuca and overriding North American plates. Millimeter-scale GPS locations determined for PBO stations across the Pacific Northwest document the ongoing compression of the Cascadia continental margin as it stores elastic energy that will be released in the next Cascadia megathrust earthquake.

Figure 2.5 illustrates GPS observations from the PBO station at Astoria, Oregon. With respect to interior parts of North America, like eastern Montana, the Astoria GPS station is moving toward the north at 0.29 inches/yr (0.74 cm/yr) and toward the east at 0.33 inches/yr (0.84 cm/yr). Total rate of motion for Astoria is 0.44 inches/yr (1.12 cm/yr) toward the northeast (N49°E to be precise). PBO stations in the Willamette Valley and the Puget Lowland are also moving toward the northeast but more slowly than are stations on the coast. PBO stations east of the Cascade Mountains are basically not moving. One way to think of this, in map view, is that Astoria is being pushed toward Spokane as the distance between these cities is decreasing at a rate of nearly one half inch per year.

Figure 2.6 is a simplified cross section of the Juan de Fuca—North America plate boundary in Cascadia. The cartoon GPS station on the left represents a coastal location that is moving more rapidly to the northeast than is the GPS station in the middle that represents a location in the Willamette Valley or the Puget Lowland. The GPS station on the right represents a location east of the Cascade Mountains that is not moving. The geological interpretation is that the shallow part of the Juan de Fuca—North America plate boundary (the Cascadia megathrust fault) is locked by friction so the northeast motion of the Juan de Fuca Plate is pushing the western "leading" edge of the North

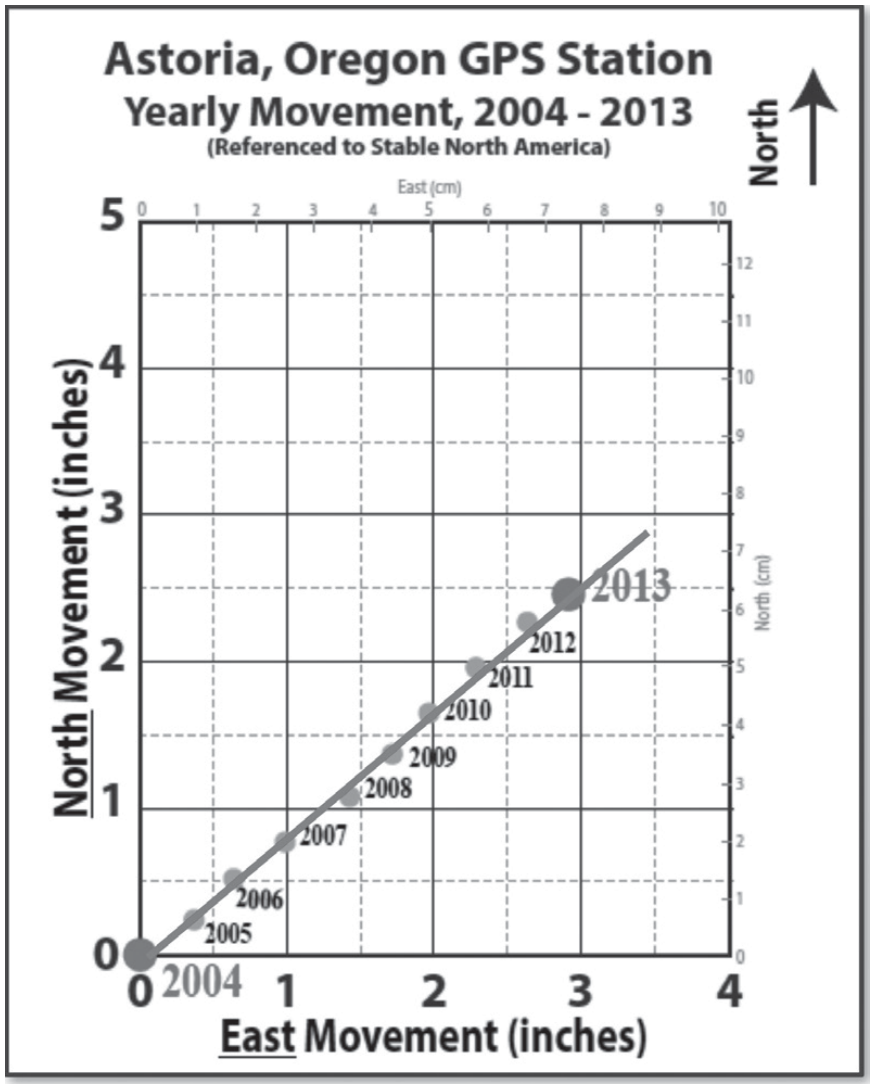


Figure 2.5. GPS observations showing northeastward motion of the Plate Boundary Observatory GPS station at Astoria, Oregon during the 2004 to 2013 interval. *This illustration was developed by the Cascadia EarthScope Earthquake and Tsunami Education Program (http://ceetep.oregonstate.edu/) of which the author was a Principal Investigator.*

American Plate to the northeast. This means the Cascadia continental margin is being compressed as it stores elastic energy that will be released in the next Cascadia great subduction zone earthquake.

The earthquake cycle involves an interplay between forces, faults, and friction, the "three Fs of earthquakes." As rocks surrounding a fault locked by friction are deformed, elastic energy builds. When the stored elastic energy ultimately overcomes friction, the fault is suddenly displaced and the stored elastic energy is released causing an earthquake. The Cascadia Subduction Zone has been in the "elastic energy building" phase of the earthquake cycle since January 26, 1700. Since that last great CSZ earthquake, Astoria has moved 11.6 feet (3.54 meters) toward the northeast during compression of the Cascadia continental margin. If the next great Cascadia megathrust earthquake happens tomorrow, Astoria will jump back to the southwest by almost 12 feet during the earthquake ground shaking. Although we cannot predict when force will overcome friction to produce the next great Cascadia megathrust earthquake, the GPS observations prove that the CSZ is "locked and loading" as elastic energy builds within the continental margin. (Use the link in Appendix A to view *What Can GPS Tell Us About Future Earthquakes?* animation for a description of Cascadia GPS observations.)

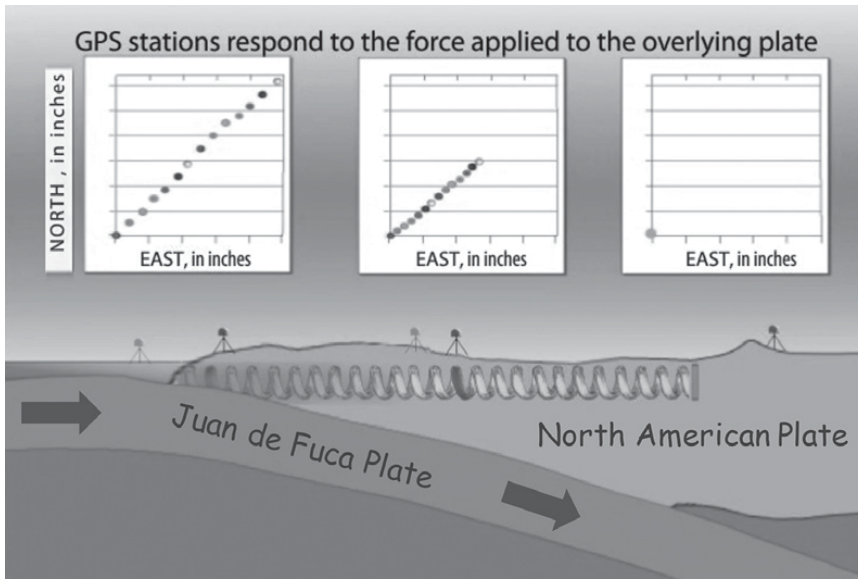


Figure 2.6. Plate tectonic cross section of the Cascadia subduction zone. Compression of the continental margin due to convergence of Juan de Fuca Plate with North American Plate is analogous to a spring being compressed. *Illustration courtesy of UNAVCO.*

TRIPLE TROUBLE: THREE TYPES OF TECTONIC EARTHQUAKES IN CASCADIA

The Really Big One, a M9 Cascadia megathrust earthquake, gathers so much attention that many people think it is the only type of earthquake hazard in the Pacific Northwest. However, the rest of the story is that there are two other types of tectonic earthquakes that pose important hazards: (1) Magnitude 6.5 to 7.0 deep earthquakes; and (2) Shallow crustal-fault earthquakes with magnitudes up to 7.5. The Nisqually earthquake of February 28, 2001 is an example of a "deep" earthquake. This M6.8 earthquake occurred 52 km (32 miles) beneath the epicenter located 18 km (11 miles) northeast of Olympia. As shown in Figure 2.7, the Nisqually earthquake occurred at least 7 km (4.3 miles) below the subduction zone plate boundary and thus within the upper part of the subducting Juan de Fuca Plate beneath the southern Puget Sound. As the Juan de Fuca Plate dives beneath the Pacific Northwest, it bends downward at an increasing angle causing the upper part of the plate to stretch. The resulting tension causes faults that occasionally rupture to produce deep earthquakes. In fact, these deep earthquakes are the most common type of damaging earthquakes in Cascadia. The M6.8 Olympia deep earthquake in 1949 caused eight deaths and $200 million in damage. That earthquake occurred during school spring vacation, a fortunate coincidence because 10 schools were so severely damaged that they were subsequently torn down and replaced. In 1965, a M6.7 deep earthquake occurred 60 km (37 miles) beneath Seattle killing seven people and causing an estimated $100 million in damage. So during the past 70 years, three strong deep earthquakes have occurred beneath the southern Puget Sound suggesting a recurrence time of less than 25 years for M6.5 to M7.0 deep earthquakes beneath this part of the Pacific Northwest. Although no strong deep earthquakes have occurred beneath the Portland metro area or the Willamette Valley during the short span of modern seismic recordings, it would be prudent to include deep earthquakes along the length of Cascadia among the earthquake hazards to the region.

The continental crust in the Pacific Northwest is broken by numerous crustal faults that can generate shallow earthquakes with magnitudes up to perhaps 7.5. While less than 20 crustal earthquakes with magnitudes between 5.0 and 6.0 have occurred in Washington and Oregon since 1980, recent research has discovered evidence for infrequent but major crustal fault earthquakes in the M7.0 to M7.5 range. These crustal fault earthquakes are analogous to strong and major earthquakes in California such as the M6.6 1971 San Fernando, M6.9 1989 Loma Prieta (World Series), and M6.7 1994 Northridge earthquakes. Dense vegetation, high precipitation rates with resulting rapid erosion, and a short-written earthquake history make

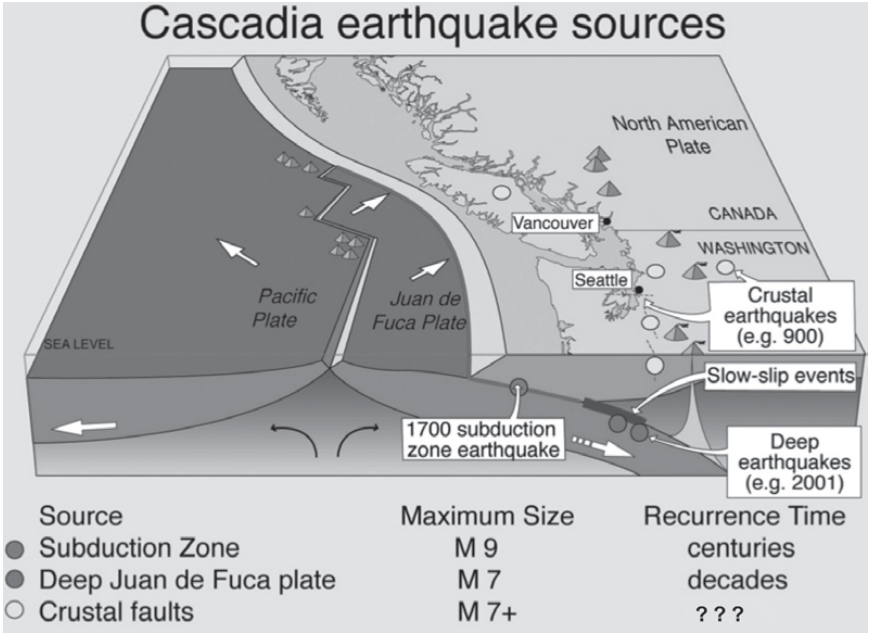


Figure 2.7. Three types of Pacific Northwest earthquake sources: Juan de Fuca—North America plate boundary earthquakes like the 1700 subduction zone earthquake; deep earthquakes within the top of the subducting Juan de Fuca Plate like the 2001 Nisqually earthquake; and crustal fault earthquakes on faults within continental crust including the ~900 AD earthquake on the Seattle Fault. *Image courtesy of the U.S. Geological Survey.*

locating Cascadia crustal faults and evaluating their earthquake hazards difficult. Nevertheless, recent application of Lidar (light detection and ranging) mapping, magnetic anomaly mapping, and seismic-reflection profiling have greatly improved identification and mapping of crustal faults, especially in the Puget Sound area (Blakely et al., 2004; Haugerud, et al., 2003). Detailed geologic mapping in trenches cut across potentially active faults and radiocarbon dating of materials from those trenches have determined earthquake histories of some of these crustal faults (Johnson et al., 2003). The Seattle Fault Zone is an example of a Cascadia crustal fault that poses a major earthquake hazard to a densely populated area. The most recent major earthquake on the Seattle Fault Zone occurred in AD 900–930, uplifting marine terraces and triggering a tsunami in Puget Sound (Nelson et al., 2003). Other crustal faults in the Puget Lowland include the Olympia Fault, Tacoma Fault, South Whidbey Island Fault, Devil's Mountain Fault, and the Utsalady Point Fault. Research is ongoing to determine the earthquake history and hazards

of these faults and other crustal faults across Cascadia. While there is much yet to learn about Cascadia crustal faults, earthquakes on these faults are an important part of Pacific Northwest regional earthquake hazards. (Use the link in Appendix A to view *Pacific Northwest: Three Types of Tectonic Earthquakes* animation about tectonic earthquakes in Cascadia.)

THE BUILT ENVIRONMENT

A saying often applied to earthquake hazards is: "Earthquakes don't kill people. Buildings that fall down in earthquakes kill people." While incomplete, there is much truth in this statement. Before considering the hazards posed by the three kinds of Cascadia earthquakes, we must consider the built environment, the building stock and infrastructure within which we live and work in the Pacific Northwest. In 1900, there were less than 1 million people in Oregon and Washington combined. Most of these people arrived in the late 1800s migrations when farming in the Willamette Valley and Puget Lowlands, fishing along the Pacific coast or Columbia River or Puget Sound and lumbering in the Coast Range were the primary livelihoods. Waterways were the primary routes of commerce and major ports developed in Seattle, Tacoma, and Portland. Geologically, what became the I-5 corridor is a set of valleys and structural basins filled with young sediments that are often unconsolidated and water-saturated. This is relevant to earthquake hazards because seismic waves are amplified in soft sediments and water-saturated sediment can liquefy during ground shaking.

By 1950, the population of Oregon plus Washington reached 3.9 million and early 1900s industrialization concentrated populations in cities. Modifications of the natural environment to promote industry included dredging of rivers and ports and artificial filling of adjacent wetlands and estuaries to make land suitable for factories and warehouses. The Duwamish River Valley near the Port of Seattle and the Willamette River near Portland are examples. Artificial fill is particularly hazardous ground in earthquake country because it becomes "geologic jelly" during earthquake ground shaking. In retrospect, one of the poorest decisions on siting is the "Critical Energy Infrastructure Hub," a six mile stretch of the western bank of the Willamette River in northwest Portland containing: Oregon's major liquid fuel port terminals; liquid fuel transmission pipelines and transfer stations; natural gas transmission pipelines; a liquefied natural gas storage facility, and high voltage electric substations and transmission lines (Wang, Bartlett, & Miles, 2013). This area is largely underlain by sediment deposited naturally by the river and artificial fill pumped onto the shore during dredging operations to straighten the Willamette River shipping channel in the early 1900s.

Buildings and infrastructure built prior to 1950 were constructed with little or no consideration of earthquake hazards. From 1950 to today, increasingly stringent building codes have been adopted in a step-wise fashion in California, Oregon, and Washington. While recently constructed houses, apartment and office buildings, and bridges and highways can withstand the ground shaking caused by Cascadia earthquakes, the combined 11 million citizens of Oregon and Washington now live in a built environment with many older structures that are vulnerable to earthquakes. If they are bolted to their foundation, a building-code requirement enacted in the 1970s, wood-framed houses are resistant to ground shaking. Unreinforced brick chimneys of older houses often topple, sometimes into the house, during earthquakes. Unreinforced masonry buildings (URMs) are particularly vulnerable to ground shaking because they were constructed with brick walls and wood or concrete floors that are poorly attached to walls. There are about 1,800 URMs in the city of Portland alone. In 2007, an earthquake engineering analysis estimated that 47% of Oregon public school buildings had "high" to "very high" probability of sustaining life-threatening damage during a major earthquake (Lewis, 2007). With the many rivers, lakes, and inlets in the Pacific Northwest, bridges are critical components of our transportation infrastructure. Two thirds of Oregon bridges were constructed before the 1970s. While few of those older bridges are expected to collapse, most would sustain extensive to moderate damage (CH2MHill, 2012). Portland drawbridges over the Willamette River are particularly vulnerable to the minutes-long duration of ground shaking that will occur during the next great CSZ earthquake (Oregon Department of Transportation [ODOT] 2009; Roberts & Dusicka 2011).

IMPACT OF THE 2001 NISQUALLY EARTHQUAKE

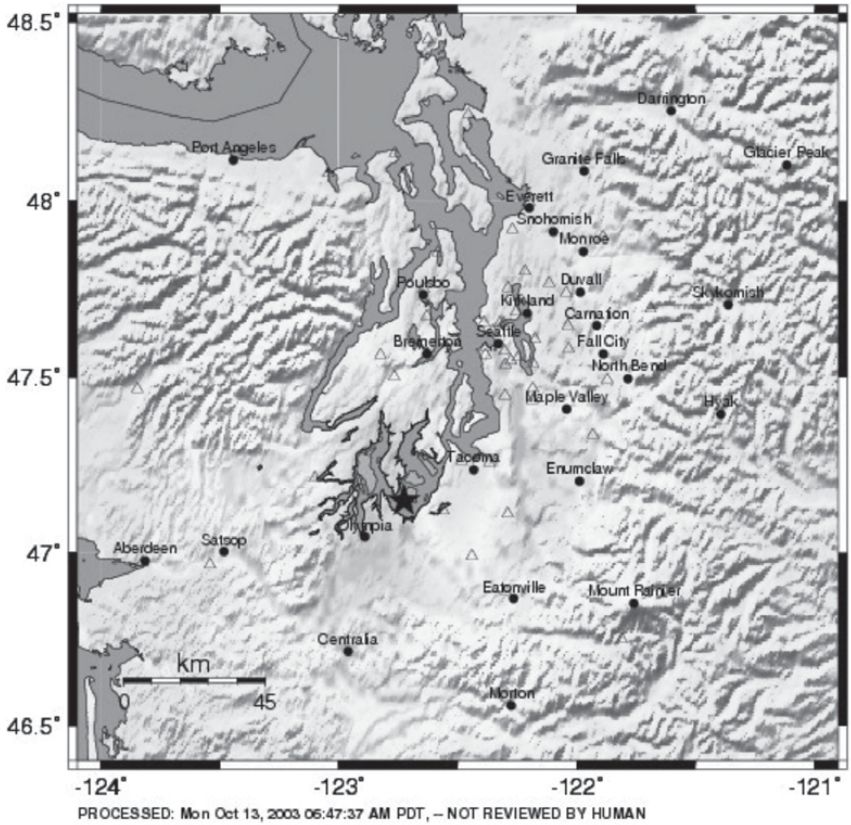
In terms of the area affected and the likely impacts, the three types of Cascadia earthquakes present distinct hazards. The February 28, 2001 M6.8 Nisqually earthquake provides an example of the impact of a Cascadia deep earthquake. The location of this earthquake at 52 km (32 miles) depth was within the top portion of the Juan de Fuca Plate beneath the southern Puget Sound. Seismic wave energy from a deep earthquake spreads over a larger area than would energy from a shallower earthquake of similar magnitude. So a larger area experiences significant shaking although the maximum intensity of shaking is less than from a shallower earthquake of similar magnitude. The intensity of ground shaking during the Nisqually earthquake is shown on the ShakeMap of Figure 2.8. (If you are unclear on the difference between earthquake magnitude and earthquake intensity, please view the *Earthquake Intensity: What Controls the Shaking You Feel During an Earthquake?*

animation listed in Appendix A.) Strong ground shaking near the epicenter lasted about 30 seconds and caused one death, 400 injuries (27 head injuries from falling bricks), and damaged 40 bridges and 300,000 buildings, many beyond repair (Nisqually Earthquake Clearinghouse Group, 2001). The strongest ground shaking occurred in low-lying alluvial valleys, river deltas, and poorly compacted artificial fill where soft soils amplified ground shaking and, in some areas, experienced liquefaction. Boeing Field was damaged by liquefaction necessitating transfer of Boeing and air cargo operations to other facilities. Landslides and lateral spreading (a landslide on a gentle slope) caused major damage to some roads. Economic losses reached $4 billion with only 12% insured losses.

Damage to single family homes and apartments include 4 destroyed, 46 with major damage, and 120 with minor damage, mostly to chimneys. URMs constructed before 1950 experienced the most extensive structural damage, with sections of brick walls and parapets falling but no buildings collapsed. Modern buildings and older buildings, including URMs that had been recently seismically upgraded, performed well structurally. An extensive program of retrofitting bridges was initiated in the 1990s and proved very successful with only a few before-1980 bridges closed for extended time. There was no damage to the water supply system and electric power outages were minimal. Unlike the 1989 Loma Prieta and 1994 Northridge earthquakes where fires produced major damage, only one fire in downtown Seattle was reported and there were no hazardous materials spills.

"Nonstructural" damage like falling light fixtures, toppling bookshelves and computers, furniture moving across floors, and broken water pipes was the dominant type of damage in all buildings and resulted in downtime and economic losses for businesses. This emphasizes the importance of the "Drop, Cover, and Hold On" response to earthquake ground shaking. People who took shelter beneath a desk or table were rarely injured whereas many injuries resulted from falling objects inside buildings and bricks falling from building exteriors. Securing nonstructural elements of buildings is an effective and inexpensive measure to mitigate earthquake damage. Effects of the Nisqually earthquake confirmed that three things make a building dangerous: its type of construction, the soil it's built on, and how secure the nonstructural elements are.

Damaging deep earthquakes in 1949 and 1965 destroyed many of the oldest and weakest buildings in the southern Puget Sound area. And these earthquakes motivated changes to building codes and retrofitting of older structures in this area. So the southern Puget Sound area has progressed further along the path to earthquake resilience than have other areas of the Pacific Northwest. This is fortunate because the probability of another deep earthquake of magnitude 6.5 or greater occurring in the Puget Sound



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 2.8. Observed intensity of ground shaking in southern Puget Sound area during the 2001 Nisqually earthquake. Intensity is coded in grayscale from weak (clear topographical gray) to strong (blurry light gray) to severe (blurriest medium gray – south of Olympia and line from Seattle to Eatonville). Note the concentration of the strongest ground shaking in river valleys containing unconsolidated sediment and artificial fill. *Image courtesy of the U.S. Geological Survey.*

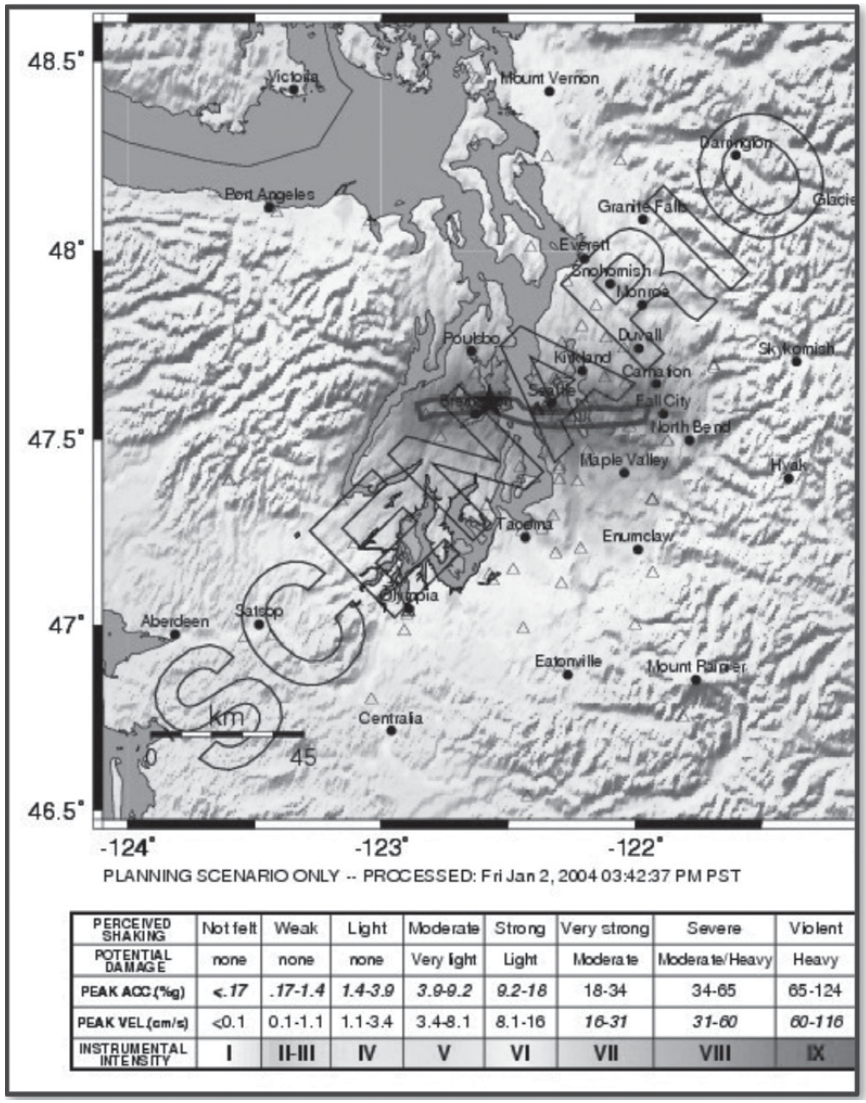
area within the next 50 years is 84%, a virtual certainty (Cascadia Region Earthquake Workgroup [CREW], 2008). A Nisqually-type earthquake beneath Portland, that has not experienced a comparable earthquake, would likely result in a higher concentration of damage to buildings and infrastructure. The probability of such an earthquake occurring beneath Portland or

other areas of the Willamette Valley is not well known but is less than for the Puget Sound area.

SEATTLE FAULT EARTHQUAKE SCENARIO

As an example of impact from a major crustal fault earthquake in Cascadia, let's consider the Seattle Fault that runs through the Central Puget Sound region, from Hood Canal in the west, through south Seattle, and east through Bellevue and Issaquah. A scenario ShakeMap for a M7.2 earthquake on the Seattle Fault is shown in Figure 2.9 at the same scale as the Nisqually ShakeMap in Figure 2.8 for ease of comparison. A quick inspection reveals that the impacted area for a Seattle Fault earthquake is smaller but the ground shaking is much more intense than for the Nisqually earthquake. This is because the depth of a Seattle Fault earthquake is only 10 km (6.2 miles) whereas the Nisqually earthquake occurred at a depth of 52 km (32 miles). The most intense ground shaking during the Nisqually earthquake reached a peak ground acceleration (PGA) of 0.2 g (20% of gravity) while ground shaking within a few miles of the Seattle Fault could reach PGA of 1.0 g (100% of gravity). Such intense ground shaking in the vertical direction would literally throw boulders and cars into the air and lift unattached buildings off their foundations.

The 1994 Northridge and 1995 Kobe, Japan earthquakes provide examples of impacts of a major crustal fault earthquake on an urban area. Two professional groups of earthquake experts have evaluated the impact of a major earthquake on the Seattle Fault (CREW, 2009; Earthquake Engineering Research Institute and the Washington Military Department Emergency Management Division [EERI-WMDEMD], 2005). They analyzed the earthquake effects and likely damage by overlaying the known built environment and population onto the Seattle Fault ShakeMap. The results are sobering. Earthquake damage is often summarized by three Ds of disaster—deaths, dollars, and downtime. For a major earthquake on the Seattle Fault, the projections are: more than 1,600 fatalities; $33 billion damage and economic loss; and months to years for recovery of the area within a few miles of the rupture zone. Further expectations are: about 130 major fires; more than 24,000 injured; almost 10,000 buildings destroyed; more than 150,000 moderately damaged buildings. URMs that survived the Nisqually earthquake are likely to be destroyed by the much more intense ground shaking of a major Seattle Fault earthquake. These buildings must be retrofitted or replaced. Much of the projected impact is a consequence of damage to infrastructure, including transportation routes, pipelines for water supply, wastewater, and



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX

Figure 2.9. Expected ground shaking intensity produced by a M7.2 earthquake at 10 km depth on the Seattle Fault. Scale is same as used in Figure 2.8 to ease comparisons of intensities. *These ShakeMaps are a product of the U.S. Geological Survey National Earthquake Information Center (Wald, Wald, Worden, & Goltz 2003).*

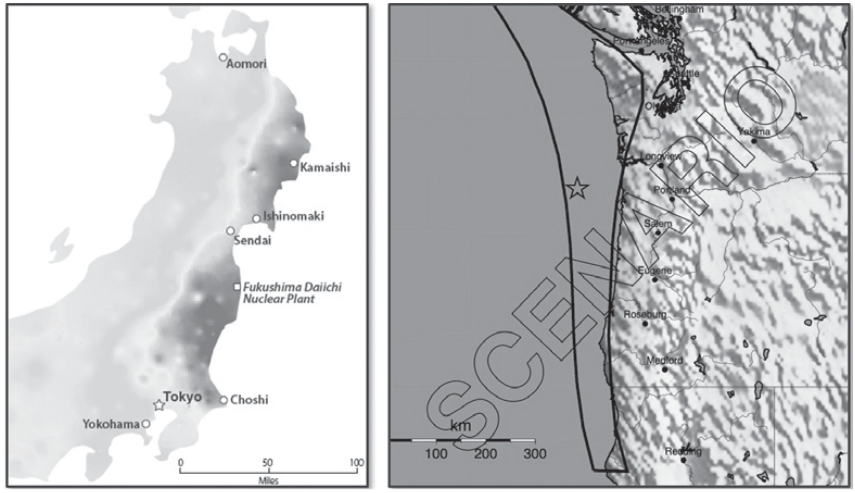
natural gas, and electric power lines that run north-south along I-5 corridor. To achieve earthquake resilience, this infrastructure must be retrofit or replaced.

Because the last major earthquake on the Seattle Fault occurred more than 1,000 years ago, it is easy to discount the probability of a future major crustal fault earthquake as remote. However, when the network of crustal faults in the Puget Sound area are considered collectively, the probability of a major crustal fault earthquake within the next 50 years is about 15%, comparable to the probability of a CSZ earthquake within the same time interval (CREW, 2009). Because research on crustal faults across Cascadia is ongoing, we cannot fully evaluate the probability of crustal fault earthquakes in other areas of the Pacific Northwest. What we do know is that crustal fault earthquakes are a wildcard because they are not limited to west of the Cascade Mountains. Indeed the largest earthquake in historic times struck near Lake Chelan east of the Cascade crest in 1872. The bad news for crustal fault earthquakes is that a major earthquake can cause extensive damage in the area near the epicenter. The good news is that the area affected by a crustal fault earthquake is relatively small so relief efforts can reach the affected area quickly.

THE REALLY BIG ONE: M9 GREAT CASCADIA SUBDUCTION ZONE EARTHQUAKE SCENARIO

In Figure 2.10, a scenario ShakeMap for a M9 CSZ earthquake is compared with the observed shaking produced by the 2011 M9 Tohoku-oki subduction zone earthquake in Japan. The energy released by a M9 earthquake is more than 1,000 times the energy released during a M7 earthquake like the Northridge or Kobe earthquakes. The fault length that ruptures in a M9 earthquake is immense. A full-length rupture of the CSZ would reach over 1,000 km (over 600 miles) from northern California to the middle of Vancouver Island. Fault displacement during the Tohoku-oki earthquake reached over 50 meters (over 160 feet). Fault rupture during a M9 earthquake occurs over four to six minutes, not a few seconds as for a M7 earthquake. One way to describe a M9 subduction zone earthquake is that it releases the equivalent energy of four M7 earthquakes every second over a rupture interval of four minutes!

The intensity of ground shaking during the Tohoku-Oki earthquake was severe on the east coast and decreased from east to west across northern Honshu. Ground shaking in Cascadia during the next M9 earthquake will be very strong to severe on the coast, strong to very strong along the I-5 corridor, and moderate to light east of the Cascade Mountains. It is worth noting that the absolute values of projected ground shaking in the Puget Sound area are comparable or even slightly less than the observed ground shaking during the Nisqually earthquake. However, ground shaking will last for four to six



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Figure 2.10. Observed intensity of ground shaking in northern Honshu, Japan during the 2011 M9.0 Tohoku-oki earthquake is shown on the left. Expected ground shaking intensity across Pacific Northwest produced by a M9.0 Cascadia subduction zone earthquake that ruptures the full length of the subduction zone is shown on the right. Starting location for the Cascadia rupture is the epicenter shown by the star. *Image courtesy of the U.S. Geological Survey.*

minutes with much of the shaking at low frequencies with the ground moving back and forth over an interval of 10 to 20 seconds. Such low frequency and long duration of ground shaking is particularly challenging for long and tall structures like bridges, highway overpasses, tall buildings, and high-voltage electrical transmission towers. Within 15 to 20 minutes after ground shaking stops, the first waves of the resulting tsunami will reach the coast inundating areas up to 15 meters (50 feet) above normal sea level.

Both Oregon and Washington have prepared resilience plans that address likely impacts of a M9 Cascadia Subduction Zone earthquake and tsunami (Oregon Seismic Safety Policy Advisory Commission, 2013; Seismic Safety Committee, Washington State Emergency Management Council, 2012). The CREW reported on impacts across Cascadia (Roddey & Clark, 2013). Obviously, the area affected is very large and accordingly the impacts are great. Not so obviously, the size of the area affected and damage to transportation systems results in a very long recovery and rebuilding time. Listing just a few of the projected damage estimates and expected recovery times

provides a sobering glimpse at the impact of a M9 CSZ earthquake and tsunami, were it to occur in the near future:

- 10,000 fatalities and 30,000 significant injuries. Eastern cities and airports, such as Redmond, Oregon, and Spokane and Moses Lake, Washington, may become staging areas for emergency resources and personnel. Hospitals in western zones are likely to be damaged or overwhelmed by the number of injured, so patients would be evacuated to other hospitals as soon as transportation is available.
- Scores of I-5 bridges heavily damaged and a few collapsed; over 50 bridges on coastal highways collapsed or closed by landslides; some Seattle area island communities isolated by bridge and ferry terminal damage; port facilities damaged by amplified ground shaking, liquefaction, and lateral spreading of soft soils; major damage to coastal airports and slight to moderate damage to international SEATAC and PDX airports. Patching the transportation system will required weeks to months and rebuilding will take years.
- Widespread electric power and natural gas outages within 100 miles of the coast lasting for weeks to months. Restoring electric power will require one to three months for the I-5 corridor and three to six months for the coast. Most liquid fuel facilities damaged and facilities in Oregon's Critical Energy Infrastructure Hub heavily damaged. Lack of fuel greatly delays recovery efforts.
- Drinking water and sewer systems damaged with restoration of service taking three weeks to many months for inland areas and one to three years for the coast.
- Thousands of URMs will suffer major damage while most wood-frame houses will have minor damage unless they are unattached to their foundation.
- Two weeks is the longest disruption the business community can withstand before companies and corporations face closure, bankruptcy, or leaving the region. With essential services out for many months, the economy of the Pacific Northwest would suffer a crippling impact.
- Economic impacts in Washington State total $50 billion while impacts in Oregon are over $30 billion.

Impacts of this magnitude would result in a "lost generation"; decades of economic and population decline that affect the regional and national economy. The silver lining in this scenario is that the probability of a M9 CSZ earthquake and tsunami during the next 50 years is only about 15%, although the probability of a M8+ earthquake on the southern portion of the subduction zone is about 30%. It is critical to remember that the regional seismic hazard

is the combination of the hazards from the three types of Cascadia tectonic earthquakes.

DISPELLING MYTHS AND OVERCOMING HURDLES ON THE PATH TO EARTHQUAKE RESILIENCE

Three great subduction zone earthquake and tsunami disasters during the last 13 years (Sumatra 2004, Chile 2010, and Japan 2011) have produced a dramatic increase in public awareness of Cascadia earthquake and tsunami hazards. If that awareness leads to broad understanding of earthquake hazards and sustained efforts to increase preparedness and mitigate damage, the region could achieve earthquake resilience in the next 40 to 50 years. When I taught the Natural Hazards of the Pacific Northwest course at the University of Portland, I concluded that class with a challenge to my young students. That challenge was to turn their newfound knowledge of Cascadia earthquake hazards into personal actions to achieve family preparedness and public actions to achieve regional earthquake resilience within their lifetime. Accomplishing that goal would allow those students to hand over an earthquake-resilient Pacific Northwest to their grandchildren. I believe this optimistic but possible goal can motivate our fellow citizens to embark on the decades-long path to earthquake resilience.

There are few deniers of Cascadia earthquake science but misconceptions and feelings of fatalism and pessimism are widespread. One misconception that has been addressed above is that CSZ earthquakes are the only earthquake hazard. That misconception can lead to a dismissive response like: "Why should I worry about something that only happens every 500 years?" The reality is that we face a triple threat of three kinds of tectonic earthquakes in the Pacific Northwest and a damaging earthquake somewhere in the region during the next 50 years is a virtual certainty. The fatalist response is: "We're all going to die when the 'Really Big One' hits." In fact, your probability of dying in that event is about 0.1% so you're almost certain to live through it and be faced with the results of our preparedness or lack thereof. The pessimist reaction to Cascadia earthquake hazards is: "There's nothing we can do about it, so why think about it?" This attitude must be countered with the example of nations that have worse earthquake and tsunami hazards than Cascadia yet have achieved a high degree of resilience.

In the Oregon Resilience Plan, the Oregon Seismic Safety Policy Advisory Committee defined the seismic resilience goal: "Oregon citizens will not only be protected from life-threatening physical harm, but because of risk reduction measures and pre-disaster planning, communities will recover more quickly and with less continuing vulnerability following a CSZ earthquake

and tsunami" (OSSPAC, 2013). The Seismic Safety Committee of the Washington State Emergency Management Council has also developed an earthquake resilience plan (SSCWSEMC, 2012). A recent example of earthquake resilience was provided by Chile where 90% of communication services and 95% of power supply was restored within two weeks after the 2010 M8.8 Maule earthquake and tsunami. Even the 2011 M9.0 Tohoku-oki earthquake and tsunami in Japan, the most-costly natural disaster in Japan's history, is an example of earthquake resilience. While nearly 20,000 fatalities resulted from that tsunami, 95% of people who live or work within the tsunami inundation zone evacuated to survive that event. Very little damage to buildings or infrastructure occurred during Tohoku-oki earthquake ground shaking despite the nearly six minutes of shaking at some locations. (To understand how Japan, the country best prepared for earthquakes and tsunamis, underestimated the tsunami hazard in northeast Honshu, view the *Japan's Earthquakes & Tectonic Setting* animation listed in Appendix A.)

The fundamental science of Cascadia earthquake and tsunami hazards is understood and those hazards are profound. The good news is that much progress has been made in earthquake engineering so we do know how to construct and retrofit buildings and infrastructure to make our built environment resilient. We can apply in the Pacific Northwest all that has been learned over the past century about constructing earthquake-resilient buildings and infrastructure and about earthquake preparedness in Japan and Chile and California and elsewhere. In fact, initial steps of defining the problem, identifying the most critical needs, and outlining procedures, costs, and timetables for achieving earthquake resilience have largely been completed (OSSPAC, 2013; SSCWSEMC, 2012). Some notable examples of progress on the path to earthquake resilience include:

- Detailed mapping of tsunami inundation zones has been completed for the entire Cascadia coast using the state-of-the-art computer modeling of worse-case scenarios for CSZ earthquakes and detailed offshore bathymetry and onshore topography. This mapping was then used to develop tsunami evacuation maps and locate tsunami evacuation shelters. New regulations restrict construction of essential facilities like hospitals, schools, fire and police stations within the tsunami inundation zone.
- The City of Portland has a stock of about 1800 URM buildings including about 45 schools, 35 churches, and 270 multifamily structures with over 7,000 residential units (Portland Bureau of Emergency Management, 2012). Most of these structures were built between 1870 and 1960 and the average Portland URM is 88 years old. Starting in 2014, the Portland Bureau of Emergency Management, the Portland Development Commission, and the Bureau of Development Services have coordinated

with a citizen committee to develop a policy and timetable for mandatory seismic retrofitting of URM buildings within the city. Tax incentives for building owners, partial or complete state funding for school upgrades, and placarding of retrofit buildings are among the policy recommendations. If adopted as law, these recommendations would result in retrofitting or replacement of all URMs within 30 years.

- Seismic retrofitting of many public schools has been completed, either through state grants or local school district bond measures. An inspirational example is from Westport, Washington, a coastal community almost entirely within the tsunami inundation zone. In April 2013, the Ocosta School Board submitted a $13.8 million bond issue to voters for construction of a new elementary school in Westport incorporating a gym roof with a concrete platform on top to provide a tsunami safe haven for 1,000 students, staff, and local community members. The new school with tsunami safe haven was dedicated June 11, 2016. If such a project can be completed in a community within the most economically challenged county in Washington State, every community in the Pacific Northwest can address and mitigate their earthquake and tsunami vulnerabilities.
- Earthquake early warning (EEW) systems have been developed in several countries including Japan. We cannot predict earthquakes, but EEW detects earthquakes fast enough that warnings can be given before the strongest shaking arrives providing seconds to minutes to prepare. During the 2011 Tohoku-oki earthquake, the Japanese EEW allowed precautionary measures like stopping the high-speed trains, stopping surgeries, getting workers away from dangerous machines and chemicals, and alerting emergency responders. A prototype EEW system named ShakeAlert has been developed in California by the U.S. Geological Survey, Cal Tech, and UC Berkeley with support from the federal government and the Moore Foundation. These groups are collaborating with the Pacific Northwest Seismic Network at the University of Washington and the University of Oregon to expand ShakeAlert to include the Pacific Northwest. (To understand the principles and benefits of EEW for Cascadia earthquakes, view the *Earthquake Early Warning: Pacific Northwest Subduction Zone* animation listed in Appendix A.)

Do we have the political will and collective commitment to achieve earthquake resilience before the next great CSZ earthquake or major deep earthquake or major crustal fault earthquake strikes the Pacific Northwest? It is important to realize that politicians often play kick-the-can with issues of geological hazards of all kinds. To address these problems of public safety squarely and effectively, a politician must argue to impose new regulations

and increase revenue for investments in public safety to mitigate damage from an event that will probably not happen during their term in office. That is a big ask. Yet there are political leaders like Oregon State Senate Chairman Peter Courtney who are champions of earthquake safety. To achieve the goal of earthquake resilience, Pacific Northwest citizens must decade-upon-decade steadfastly support public investment in earthquake mitigation and hold politicians accountable for supporting legislation that advances earthquake safety. It's doable and we know how to do it but the goal of earthquake resilience will require half a century of effort and investment.

While city, county, state, and federal government must legislate toward and invest in earthquake resilience, individuals, families, and neighborhoods must engage in their own earthquake preparedness. In fact, the present time when public investment in earthquake preparedness has only just started is the time when we are most vulnerable. If you want to know who is going to help you when a major earthquake occurs in the near future, look to the coworker in the next cubicle or your neighbor in the next house. They are your most likely emergency responders because police, fire, and medical emergency workers will be overwhelmed or otherwise unable to reach you.

Many people don't want to think about the prospect of natural disasters, so preparing for emergencies is easily put off. The challenge of learning how to prepare yourself, your family, and your neighborhood then gathering and storing emergency supplies can be intimidating. Fortunately, city, county, state, and federal emergency management agencies and organizations like the Red Cross and Mercy Corps have decades of experience teaching citizens how to prepare. Those agencies in the Pacific Northwest have developed and coordinated emergency management plans for Cascadia earthquakes and they provide a wealth of information resources to help citizens and neighborhoods prepare. In fact, if you start searching the Internet for earthquake preparedness information, the volume of information available may overwhelm you.

Susan Romanski, U.S. Director for Disaster Preparedness and Community Resilience at Mercy Corps, has 20 years of experience in international relief and development. Working from Mercy Corps headquarters in Portland, she helps school-based groups understand and prepare for earthquake and other emergencies. For a presentation at Mercy Corps in May 2017, Susan prepared a resource list to help citizens along their path to earthquake preparedness. An edited version of that list is provided in Appendix B. This resource list is organized into categories of home, neighborhood, and school preparedness and that order is a sensible way to prioritize your preparations. A manageable way to develop your preparedness is to do so over a year or two, investing the first third of that interval preparing your family then turning attention to your neighborhood and finally to your school or business. Putting goals and deadlines on a calendar is essential and sharing your progress with extended

family and neighbors can foster peer pressure and support. A particularly easy and effective way to start family preparedness is to secure nonstructural elements in your house or apartment (book cases; cabinets; etc.) that can fall on you during earthquake ground shaking. And making a "family plan" for contacting family members is critical. A powerful motivation to address earthquake preparedness is to realize that, if you are not prepared, you become part of the problem by putting yourself, your family, and your community at risk.

James Roddey, former Earth Sciences Information Officer for the Department of Oregon Geology and Mineral Resources (J. Roddey, personal communication, July 29, 2008) challenged citizen groups with the following statement: "We are the first generation to understand the geologic hazards facing the Pacific Northwest. Just as Katrina has defined New Orleans for this century, how we respond to Pacific Northwest geologic hazards will define our regional culture for the next few centuries." The impact of *The Really Big One* on the Pacific Northwest in our current state of unpreparedness would be horrific. That grim fate is avoidable, if we individually and collectively commit to achieving earthquake resilience. To paraphrase the Nike motto: "Let's Just Do It."

Discussion Questions

1. What are the probabilities of occurrence and the likely effects of: (1) a Cascadia subduction zone earthquake; (2) a magnitude 6 or 7 deep earthquake within the subducting Juan de Fuca Plate; and (3) a magnitude 6 or 7 crustal fault earthquake?
2. What aspects of regional history, geography, geology, and culture are responsible for the current lack of earthquake preparedness and resilience in the Pacific Northwest?
3. Compare and contrast the best approaches to improving Pacific Northwest regional earthquake resilience over the short-term (3 to 5 years) and long-term (30 to 50 years) future. What are the economic and cultural barriers to implementing those best approaches?

APPENDIX A: RESOURCES FOR LEARNING ABOUT CASCADIA EARTHQUAKE SCIENCE AND HAZARDS

Animations about Earthquake Science and Hazards

Earthquake Early Warning: Pacific Northwest Subduction Zone
https://www.iris.edu/hq/inclass/animation/earthquake_early_warning_pacific_northwest_subduction_zone

Earthquake Intensity: What Controls the Shaking You Feel During an Earthquake?
https://www.iris.edu/hq/inclass/animation/earthquake_intensity
Japan's Earthquakes & Tectonic Setting
http://www.iris.edu/hq/inclass/animation/japans_earthquakes__tectonic_setting
The 1964 Great Alaska Earthquake
https://www.iris.edu/hq/inclass/animation/alaska_the_great_alaska_earthquake_of_1964
Orphan Tsunami: Megathrust Earthquakes in the Pacific NW
https://www.iris.edu/hq/inclass/animation/orphan_tsunami_megathrust_earthquakes_in_the_pacific_nw
Pacific Northwest vs Japan: Similar Tectonic Settings
https://www.iris.edu/hq/inclass/animation/pacific_northwest_vs_japan_similar_tectonic_settings
Pacific Northwest: Three Types of Tectonic Earthquakes
https://www.iris.edu/hq/inclass/animation/pacific_northwest_three_types_of_tectonic_earthquakes
Subduction Zone Tsunamis Generated by Megathrust Earthquakes
https://www.iris.edu/hq/inclass/animation/subduction_zone_tsunamis_generated_by_megathrust_earthquakes

Books by Geoscientists about Cascadia Earthquakes

At risk: Earthquakes and tsunamis on the West Coast, J. Clague, C. Yorath, R. Franklin, and B. Turner, Tricouni Press, 200 pp., 2006, ISBN 0-9697601-7-5.

Living with earthquakes in the Pacific Northwest: A survivor's guide, 2nd edition, revised and expanded, R. S. Yeats, Oregon State University Press, 400 pp., 2004, ISBN 978-0-87071-024-7. Internet version: http://oregonstate.edu/instruct/oer/earthquake/

The orphan tsunami of 1700: Japanese clues to a parent earthquake in North America, 2nd edition, B. F. Atwater, M. Satoko, K. Satake. T. Yoshinobu, U. Kazue, and D. K. Tamaguchi, University of Washington Press, 144 pp., 2016, ISBN-13: 978-0295998084.
Internet version: https://pubs.er.usgs.gov/publication/pp1707

Books by Writers and Reporters about Cascadia Earthquakes

Cascadia's Fault: The coming earthquake and tsunami that could devastate North America, J. Thompson, Counterpoint Press, 2012, 337 pp., ISBN 978-1-58243-643-2.

Full-rip 9.0: The next big earthquake in the Pacific Northwest, S. Doughton, Sasquatch Books, 2013, 273 pp., ISBN 978-1-57061-789-8.
The next tsunami: Living on a restless coast, B. Henderson, OSU Press, 2014, 322 pp., ISBN 978-0-87071-732-1.

APPENDIX B: CASCADIA EARTHQUAKE PREPAREDNESS RESOURCES

What Can You Do at Home?

Make a Family Plan
https://www.ready.gov/make-a-plan
Talk to Your Children
https://earthquake.usgs.gov/learn/kids/
Build a Kit—American Red Cross Resource Guide
http://www.redcross.org/images/MEDIA_CustomProductCatalog/m35240363_prepare_a_resource_guide3.pdf
Remember Water Is a Critical Item
http://www.regionalh2o.org/emergency-preparedness
Know Your BEECN Site
https://www.portlandoregon.gov/pbem/article/483656
Sign Up for Public Alerts
https://www.publicalerts.org/signup
https://itunes.apple.com/us/developer/american-red-cross/id529160694
https://www.fema.gov/mobile-app
Learn How to Shut Off Your Utilities
https://www.youtube.com/watch?v=DEGJRV9FXlY
Check for Hazards at Home
https://www.youtube.com/watch?v=MGqfvhtbmOQ
https://www.fema.gov/media-library/assets/documents/3261
http://www.totallyunprepared.com/wp-content/uploads/2011/08/TUChecklist-en-tu.pdf

What Can You Do in Your Community?

Map Your Neighborhood
http://www.preporegon.org/get_prepared_with_your_neighbors
http://mil.wa.gov/emergency-management-division/preparedness/map-your-neighborhood
Become a NET Member
https://www.portlandoregon.gov/pbem/58587

Become an Amateur Radio Operator
https://www.portlandoregon.gov/pbem/article/563401
Take a First Aid/CPR Course
http://www.redcross.org/m/phssmrd/take-a-class

What Can You Do in Your School?

School Earthquake Plans
https://www.fema.gov/media-library-data/20130726-1922-25045-3850/rems_k_12_guide.pdf
School Supply Lists
http://www.k12.wa.us/safetycenter/Emergency/pubdocs/EmergencySuppliesGoKitSuggestions.pdf
Understand Your School Earthquake Plan
http://www.shakeout.org/downloads/ShakeOutDrillManualSchools_v2.pdf
http://www.pps.net/Page/201
https://www.eeri.org/projects/schools/
Look for Hazards in Your School
https://www.fema.gov/media-library/assets/documents/21405
Earthquake Preparedness Committees and Advocacy for Schools
https://portlandprepares.org/get-ready/parents-and-schools/
http://www.pps.net/Page/2657

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Chapter 3

Risk Perception and Earthquake Preparedness Motivation

Predicting Responses to a Cascadia Subduction Zone Catastrophic Event

Bradley Adame and Claude Miller

The Cascadia Subduction Zone (CSZ) represents a substantial dual threat faced by millions of people living along the Pacific Northwest coasts of the United States and Canada.

> It [tsunami] will look like the whole ocean, elevated, overtaking land. Nor will it be made only of water—not once it reaches the shore. It will be a five-story deluge of pickup trucks and doorframes and cinder blocks and fishing boats and utility poles and everything else that once constituted the coastal towns of the Pacific Northwest. (Schulz, 2015, para. 35)

Emergency response experts agree the region is woefully unprepared for the catastrophic consequences of a great earthquake and resulting tsunami (Schelling et al., 2013). Despite the continuing efforts of federal, state, and local agencies, recent studies indicate U.S. citizens are largely unprepared for, and underinformed about the potentially devastating consequences of a major catastrophic event (Federal Emergency Management Agency [FEMA], 2014).

On the other hand, research has also demonstrated how community and citizen-level preparedness can be effective at mitigating the potentially shattering devastation and suffering caused by natural disasters such as earthquakes and tsunamis (Chandra et al., 2011; Eisenman et al., 2006; Solomon, 2008). Moreover, recent risk and crisis communication research has shown how strategic, theoretically framed campaign messages can instill more accurate risk perceptions to help persuade and motivate individuals to actively prepare for natural disasters (Adame & Miller, 2015; Turner & Underhill, 2012).

CHAPTER OVERVIEW

This chapter presents the findings from a focused investigation assessing the risk perceptions and perceived vestedness of Washington and Oregon states' residents living in the region of the CSZ, with the goal of predicting their likelihood to prepare for a largescale (M8 to M9+) earthquake and following tsunami. The aim is to apply a cutting-edge communication theory specifically designed to measure and target key attitudes and beliefs relevant to the psychological profile of CSZ residents. The ultimate objective is to provide a framework for understanding the critical factors involved in motivating people to take active measures to prepare for the highly probable and imminent occurrence of a major catastrophic event.

Using vested interest (VI) theory (Crano, 1983; Crano & Prislin, 1995; Sivacek & Crano, 1982) as an explanatory and predictive framework, we report how key dimensions of VI—especially perceptions of certainty, immediacy, and salience—relate to levels of perceived self-efficacy and the probability of people actively responding to the very real threat of a great earthquake and tsunami. Our overarching goal is to inform and influence stakeholders at the federal, state, local, and individual levels to actively engage in protective disaster mitigation behaviors.

We begin with a characterization of the monumental threat facing the coastal regions of the Pacific Northwest, followed by an overview of VI and its application in the contexts of risk perception, disaster preparedness, and crisis management. We then present the results and implications of a targeted investigation examining key attitudes and risk perceptions of individuals living near the CSZ as they pertain to their vested interest in preparing for the very real and forthcoming catastrophic effects of a megathrust rupture.

The potential cataclysmic consequences of a major seismic event for CSZ residents cannot be understated. When, not if, it occurs, millions of residents in four U.S. states and the Canadian province of British Columbia will be affected. Experts anticipate the earthquake will destroy critical infrastructure including roads, water and sewage systems, communication facilities, as well as housing and businesses. Further, the ensuing tsunami is anticipated to essentially obliterate all human activity within the immediate vicinity of the coast. Those who do not perish in the initial events will face apocalyptic conditions, with no essential services available. Evacuation, when possible, is expected to be extremely slow and tremendously difficult. Areas geographically near, but outside the proximate disaster region can expect to absorb the horrendous impact of aiding, housing, sustaining, and caring for a massive influx of disaster refugees for an indefinite period of time (Schelling et al., 2013).

Despite this calamitous outlook, short- and long-term hazard preparedness at the citizen, community, state, and national levels can work to significantly mitigate these devastating consequences, saving lives and facilitating the creation of a new normal for CSZ residents. We believe governmental, community, and individual stakeholders can use the findings reported here to create theoretically grounded, targeted campaign strategies designed to maximize CSZ residents' perceived vestedness, optimizing critical preparedness outcomes associated with a large-scale seismic event.

THE CASCADIA SUBDUCTION ZONE

The CSZ is a 700-mile long convergent plate boundary where the eastward moving Juan de Fuca and Pacific oceanic plates are being forced down into the Earth's mantle beneath the westward moving edge of the North American continental plain. In a process known as "subduction," the confluence of these tectonic plates has generated the volcanic activity that raised the Cascadia Mountain range, and created the rugged and beautiful landscape that has since attracted so many of the area's current residents (Schelling et al., 2013). The southernmost end of the subduction zone begins along the northernmost coast of California, and continues along the Oregon and Washington coasts ending near Vancouver Island in Canada. The region affected by CSZ has a combined population of approximately 11.2 million people, and includes several major cities: Salem and Portland, Oregon; Olympia, Tacoma, and Seattle, Washington; and Victoria and Vancouver, British Columbia.

The Juan de Fuca and Pacific plates are forcing themselves beneath the North American plate at a rate of about four meters per 100 years (Atwater et al., 2005; Sullivan, 1991), and as one might expect, this subduction process is not always smooth. As the plates move toward each other, their rough edges seize up against one another, building pressure that can only be released in the form of seismic activity (Oreskes & Le Grand, 2003). Experts have determined that tectonic pressure has been steadily building along the CSZ for over 300 years. At 9:00 p.m. on January 26, 1700, an earthquake of approximately Magnitude 9 (M9) (Satake, Shimazaki, Tsuji, & Ueda, 1996) devastated the coast of what is now modern-day Oregon and Washington and sent a tsunami racing across the Pacific Ocean (Satake et al., 1996; Schulz, 2015). Since that time, the plates have been locked against each other as they have attempted to advance a combined 42 feet in opposing directions. Something has got to give; and the 42-foot coseismic slip deficit of the locked zone can only be recovered in a future earthquake.

Until the 1980s, geologists did not believe the CSZ had the capacity to produce large-scale earthquakes (Schelling et al., 2013). However, pioneering

geologic research along the coasts of Washington and Oregon, combined with the creative use of archival data sources, has revealed the region's history in greater detail, and given geologists keener insights into the next potential event. During the last major earthquake along the CSZ, the only residents of the region were first nation peoples who kept no written history, and although their oral histories tell of a great flood from the sea, there were few explicit details of the event (Atwater et al., 2005). However, researchers have combined discoveries from costal sediments, tree rings, and archeological sites with historical records of early eighteenth century Japan that tell of a giant "Orphan Tsunami." So titled, Japan's Orphan Tsunami was notable not only for its size, but also because survivors and historians could not identify the origin of the tsunami's parent earthquake. Residents neither felt an earthquake, nor experienced any of the requisite signs that typically accompany a tsunami. Written accounts indicate the orphan wave simply appeared out of nowhere. Given that the originating event was roughly 5,000 miles away, their puzzled characterization is entirely understandable. Piecing together a number of corroborating clues, seismologists have been able to pinpoint the exact date and time of this last major CSZ event (Atwater et al., 2005; Schelling et al., 2013). Recent discoveries of past disaster cycles, combined with the modern-day silence and quiescence of the fault, along with the enormous volume of human development and migration to the area, have resulted in the CSZ becoming one of the most scrutinized fault zones in the world (Schulz, 2015).

The stakes are high, not only for those in the disaster zone, but also for those living nearby who will be affected by the cataclysmic event. Seismologists examining the CSZ have documented the occurrence of no less than 19 magnitude 9+ Cascadia earthquakes over the last 10,000 years. Another 22 magnitude 8+ quakes have also occurred during that span of time, for a total of 41 major seismic events (M8.2 or higher; Floyd, 2010) dating back to 8,000 BC. The math reveals a mean megathrust rupture cycle of roughly 244 years; we are now in year 318. The utter predictability of the CSZ's geologic cycle should create an insistent sense of urgency for those facing the looming threat of such a titanic seismic event. But has it done so?

Determining the nature of the M9 earthquake of 1700, coupled with the examination of a pair of more recent similarly massive megathrust ruptures that have occurred in the Indian Ocean (the 2005, M9.2 off Sumatra), and South America (the 1960, M9.5 Valdivia event off the coast of Central Chili), have permitted researchers to more precisely predict how the next CSZ megathrust event will likely unfold. Seismic experts at FEMA, the University of Washington, and the University of Oregon estimate the probability of an M9.0 or greater earthquake occurring in the CSZ in the next 50 years to be

roughly 14%; and for an M8.0–8.5 megathrust quake occurring, the 50-year probability is a sobering 25% to 40% (FEMA, 2016a).

Seismologists predict the next great earthquake will likely begin with four to six minutes of violent shaking (the M9.5 Valdivia event lasted 10 minutes), accompanied by intense rumbling and the sounds of crumbling concrete, crashing glass, and splintering wood. Some minutes after the initial shaking has ceased, the region will almost certainly experience a catastrophic tsunami expected to inundate and destroy a wide stretch of the Washington, Oregon, and British Columbian coastal regions (Schelling et al., 2013). Damage to the ports of Seattle and Vancouver could be catastrophic.

Given that many of the region's structures were built without seismic considerations, they are not anticipated to withstand an M7.5, much less an M9 event. Moreover, even the newer structures built to modern earthquake-resistant standards are not assured of surviving a megathrust event in the M8.5 to M9.5 range. Consider that an M9.2 earthquake is 50 times bigger than an M7.5, however, more ominous is the fact that it releases 355 times more energy (USGS, 2017). Even if many buildings were to survive a great earthquake in the M8.2 to M9.2 range, many structures built near the Pacific Northwest coast, including schools and hospitals, are located in the tsunami inundation zone (Schelling et al., 2013). The region's railways, freeways, bridges, and other transportation infrastructure have largely been built on alluvial and potentially unstable land, leading experts to expect a near total collapse of all major transportation systems. Communication infrastructure is also anticipated to be destroyed and incapacitated for weeks, or even months, leaving emergency managers, first responders, and survivors regionally isolated, and largely responsible for their own survival (Atwater et al., 2005; Schelling et al., 2013).

TSUNAMI THREAT

Despite its tremendous magnitude, the damage caused by an M9 earthquake may not even represent the greatest peril. With significant portions of Seattle and Vancouver, and dozens of smaller coastal communities in the tsunami inundation zone, the combination of earthquake and tsunami events has been estimated to result in as many as 38,000 casualties, of which 14,000 fatalities may be expected. Beyond the loss of life, we can also anticipate an estimated $81 billion in damages to Washington and Oregon alone (Schelling et al., 2013), with most of the devastation attributable to tsunami destruction. As Vasily Titov, director of the NOAA Center for Tsunami Research in Seattle puts it, when a Cascadia megathrust rupture occurs, "the tsunami is going to be the big destructive factor" (Rafferty & Pletcher, 2016).

For residents located close to the Pacific Northwest coast, the prospect of a tsunami is a daunting one, especially for those living in the "near-field" of an M9 rupture occurring along the Northern California and Southern Oregon coasts. In areas close to where the Pacific and Gorda Plates meet, the subduction zone is less than 50 miles off shore. Water depths and the configuration of the shore line could produce tsunami heights exceeding 26 feet, and evacuation time in these areas could be as short as 15–20 minutes (Schelling et al., 2013). Such a combination of factors could result in a sequence of exceptionally devastating outcomes.

Judging from the tsunamis generated by the Maule M8.8 earthquake off the coast of central Chile in 2010, and the Tohoku M9.0 event off Northeast Honshu, Japan in 2011, beyond the first initial strike, we can expect a great Cascadia earthquake to spawn multiple waves over a period of hours. The Tohoku tsunami was comprised of five large waves, the last of which arrived more than two hours after the initial earthquake. Nearly 20,000 deaths were caused by the tsunami, although the earthquake and post-disaster health conditions contributed to that number, and another 2,000 people went missing. As of 2016, five years after the catastrophe, the Japanese government had estimated the material damage at roughly 25 trillion yen ($300 billion), with a substantial portion of that attributable to the devastation reeked upon the six reactors at the Tokyo Electric Power Company's Fukushima Daiichi nuclear power plant. It is estimated the tsunami swept roughly five million metric tons of debris offshore, 70% of which sank to the ocean floor, leaving as much as 1.5 million tons floating in the Pacific (Ripley, Ogura, Griffiths, & Wakatsuki, 2016).

The tsunami devastation that struck Chile after the M8.8 Maule earthquake in 2010 consisted of four waves, the last of which, being the largest, reached shore four hours after the earthquake (Orcutt et al., 2011). In contrast to the loss of life suffered in Japan, the Chilean government reported only 521 fatalities, with an additional 56 missing. Officials attribute the relatively low mortality level to Chile's strong building codes and laws requiring compensation by construction companies to those who suffer losses if applicable building codes are not adhered to. Although economic losses amounted to approximately $30 billion, the Chilean government estimated that, across the affected regions, over 370,000 housing units were damaged or destroyed, and nearly 13 million people were impacted by the M8.8 earthquake and resulting tsunamis (Hinrichs, Jones, Stanley, & Kleiner, 2011).

For emergency managers, a near-field tsunami presents an overwhelming challenge. Even if local managers receive immediate warnings of an impending tsunami from forecasting systems within one or two minutes after an earthquake, and even if the near-field population has already been well-informed about the potential for a tsunami after feeling the ground shake,

there will likely be only a few short minutes before inundation begins. As Orcutt and colleagues (2011) note in their assessment of U.S. tsunami preparedness efforts, there will barely be enough time for individuals to flee even a relatively short distance of three to four miles. Moreover, if the initial earthquake is severe enough, it is almost a certainty that local communications will have been disrupted, bridge structures damaged or destroyed, and evacuation routes cut off in many if not most areas across the region. Even where major roadways remain open, gridlock is likely to ensue, making realistic hopes for a rapid exit from the inundation zone untenable, except on foot. Even in communities farther away from the tsunami source, the disrupted communication system could mean local managers and forecasters may not receive timely data from the coast, and the people in these outlying areas may be too distant to have felt the ground shaking enough to be warned and thereby mobilized to flee.

To detect a tsunami earthquake in time for effective individual and community responses, near-real-time direct measurements of water currents and water surface variations are needed. As Orcutt and colleagues (2011) have noted, communities beyond the near-field of a major seismic event must depend on the national tsunami detection system to immediately assess the threat and swiftly deliver warnings and evacuation orders. Since the source of a major Cascadia tsunami will be in an undersea fault zone relatively near the coast, the near-field region will be affected within minutes after the earthquake. However, there will also be a number of outlying regions at various distances affected as late as several hours following the initial shock. For these reasons, swift warnings, with as much information as possible going out in all directions are critical.

For those close to the source who do feel the powerful ground movement, there is still great value in government leaders, emergency managers and response/recovery personnel providing rapid warnings to the local populace, as long as citizens are not taught to wait for a warning if they have felt an earthquake (Orcutt et al., 2011). People living in the tsunami inundation zone should be prepared with knowledge to respond immediately after feeling the ground shake. Formal warnings urging evacuation should emanate from all possible sources, TV, radio, internet, cell phone calls, text messages, and loudspeakers, even though people will likely be under strained physical and psychological conditions instilled by the strong ground shaking (Orcutt et al., 2011).

Added to this grim picture, a great Cascadia megathrust rupture is likely to be followed by a number of aftershocks—perhaps as many as 15 to 20, with several attaining magnitudes up to 7.5 or higher. Based on experience from similar events worldwide, following a main shock of magnitude 9, aftershocks in the M6.5 to M7.5 range could easily bring down already

weakened buildings. Considering that some aftershocks may be triggered at some distance from the main shock, the spreading activity could be psychologically overwhelming as well as physically devastating (Schelling et al., 2013). Beyond initial rescue and evacuation efforts, FEMA's planning scenario assumptions anticipate residents will be without electricity and fuel for weeks, if not months, and without running water or sewer systems for months, if not years. FEMA also anticipates that the combination of earthquake and tsunami events will severely limit most forms of commercial activity for several weeks, or possibly months (FEMA, 2016b).

GOVERNMENTAL AND COMMUNITY-LEVEL PREPAREDNESS

The results of a recent FEMA multiregion planning exercise provide strong evidence for the catastrophic potential of a large CSZ earthquake. On June 7, 2016, federal, state, and local agencies across the states of Washington, Oregon, and Idaho, which is expected to suffer secondary impacts from a CSZ megathrust event, began a four-day exercise that included 20,000 participants at multiple venues throughout the three states. In after-action reports, it was concluded that most of the participating agencies and jurisdictions were generally ill-equipped and unable to respond to a disaster of the expected magnitude.

> Notwithstanding several successes, the emergency management community lacked the capabilities and resources to respond to the CSZ scenario. At the most basic level, the exercise uncovered region-wide staffing and resource shortages … and several federal and state partners were unfamiliar with the priorities, needs, and expectations outlined in their catastrophic plans. (FEMA, 2016b, p. 6)

Beyond the significant planning gaps observed, the analysis uncovered serious critical response latencies. This report was not meant to condemn the participating agencies for their lack of preparation or urgency, but rather to point to how the severity of such an unprecedented event can overwhelm the limited capacities of governmental agencies (FEMA, 2016b; Schelling et al., 2013).

CITIZEN-LEVEL PREPAREDNESS

Among the first steps necessary for providing governmental and community level preparedness, is the need to shape and enhance individual-level preparedness, by building citizens' capacities to facilitate their own responses and speed their neighbors' responses as well. Forming the beliefs and attitudes that will stimulate and motivate a healthy level of pre-event resilience can work to effectively buffer the impact of a great CSZ earthquake and tsunami (Adame & Miller, 2015; Burkle, Williams, & Kissoon, 2011). Individual-level disaster preparedness not only enhances survivability for those who are prepared ahead of time, but it also acts to extend protection to others in the community who are less able to help themselves in the event of a catastrophe. By reducing pressure on first-responders, and allowing them to focus their efforts on those who need it most, citizens who are individually prepared can contribute to the overall resilience of their community (Landau, 2007; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

Since 2007, over $16 billion dollars in federal money has been earmarked to fund various preparedness efforts (FEMA, 2013a). Although much of the funding has been used to enhance governmental capacities at state and local levels, significant resources have been devoted to building hazard resilience though citizen-level preparedness. Despite these efforts, nationwide survey data reveal that only a minority of U.S. households are prepared; and among those who report themselves as feeling prepared, most are nonetheless underprepared, as indicated by their level of knowledge and self-described behaviors (FEMA, 2014).

Past disaster experience indicates that, independent of hazard context, those who are genuinely prepared for a disaster are better able to cope with the stress and demands of a crisis situation; they are less likely to interfere with governmental response, and more likely to provide aid and comfort to neighbors during a disaster (Chandra et al., 2011; Eisenman et al., 2006; Solomon, 2008). As FEMA and other crisis management experts have noted, effective communication strategies are vital for informing citizens of both the response efficacy of various disaster preparedness activities, as well as the motivational advantages of perceived self-efficacy in sustaining readiness and stimulating actual preparedness behaviors (Adame & Miller, 2015; Miller, Adame, & Moore, 2013). For emergency managers, the challenge of motivating a population to take action involves knowing which key psychological buttons to push, targeting the primary attitudes and beliefs useful in marshaling people's willingness to prepare themselves for a disaster. The issue then becomes, how best to identify, focus upon, and modify those key

attitudes and beliefs that function to insure people will be motivated enough to act.

VESTED INTEREST AND DISASTER PREPAREDNESS

Public surveys typically show most U.S. Americans recognize the importance of preparedness. Nevertheless, there is a great disconnect between thoughts and actions; unfortunately, very few people take effective steps to prepare for potential disasters. Some 66% of Americans feel they are personally unprepared for a disaster; and when asked why they're not prepared, 26% report they have not had enough preparation time, and 22% claim they have no idea what to do or how to proceed (Redlener, Grant, Berman, Johnson, & Arbramson, 2006). Even though most Americans report positive attitudes about the need for disaster preparedness, those attitudes do not reliably predict their actual preparedness behaviors. To address this problem of attitude/behavior inconsistency, we propose the use of VI, which was specifically designed to identify and target attitudes that reliably predict behavior.

Social psychologists agree that attitudes are linked to behavior in direct and measurable ways (Glasman & Albarracín, 2006). However, they have not always agreed on the nature of the attitude construct; and after more than 70 years of research examining the link between attitudes and behaviors, the results are decidedly mixed, with a recent meta-analysis indicating an overall .52 correlation between attitudes and behaviors across a range of conditions (Glasman & Albarracín, 2006). In other words, an individual's expressed attitude is predictive of his or her behavior only about half of the time.

Typically, persuasion researchers attempting to influence behaviors by shaping attitudes have sought to maximize the influence of those attitudes on targeted behaviors by emphasizing their importance (Boninger, Krosnick, & Berent, 1995), how accessible they are (Laroche, Cleveland, & Maravelakis, 2002), with how much confidence (Berger, 1992) or conviction (Abelson, 1988) they are held, their affective vs. cognitive basis (Breckler, 1993), and their hedonic relevance (Miller & Averbeck, 2013). Given these findings, the attitude-behavior link is multidimensional in nature, and thus multiple factors should be involved in influencing the degree to which a targeted attitude will reliably predict a relevant behavior.

Vested interest theory specifies six distinct dimensions of vestedness—stake, salience, certainty, immediacy, self-efficacy, and response-efficacy—that taken together specify the hedonic relevance of a targeted attitude object, and in turn, determine the attitude's ability to reliably predict behavior (Crano & Prislin, 1995; Miller et al., 2013). Each of these six dimensions functions within an additive relationship to define overall vestedness, such that, when

each is perceived as high, vestedness will be maximized, and targeted attitudes should closely correspond with relevant behaviors. Alternatively, when one or more of these dimensions is minimized, vestedness will be reduced, and the attitude-behavior relationship will be significantly diminished. In risk and disaster contexts, research has demonstrated that highly vested attitudes are reliable predictors of heightened risk perceptions, and overall intentions to engage is self-protective behaviors (Adame & Miller, 2015, 2016; Miller et al., 2013).

Vested interest theory is a particularly useful framework for measuring risk perception and preparedness attitudes with the purposes of motivating information-seeking and citizen-level preparedness activities (Adame & Miller, 2015; Crano & Prislin, 2006; Miller et al., 2013). A focus on CSZ residents' perceived vestedness in preparing for an earthquake and tsunami disaster can better inform disaster preparedness campaign design and help focus more effective messaging strategies. Governmental agencies and organizations can use VI as an explanatory framework for enhancing threat, risk, and vulnerability perceptions to encourage and facilitate proactive preparedness behaviors at the individual citizen and household levels.

COMPONENTS OF VESTED INTEREST

Stake

In natural hazard research, the VI dimension of stake has been conceived of as a demographic variable, where residents of a particular region are thought to be invested in the material health and welfare-relevant consequences of living in that part of the world. In a very real sense, the stakes are directly related to the predominant threats involved. For example, along the U.S. Gulf Coast the stakes are high due to the threats of hurricanes and flooding, along the Central Plains the threats are violent storms and tornados, and along the West Coast, the threat is earthquakes and tsunamis. Because all residents close to the CSZ are subject to the cataclysmic consequences of a megathrust rupture, the stakes near the CSZ are high indeed, with the direct consequences including damage to property, significant social disruption, personal injury, and widespread death and destruction. Indirectly, residents may experience delayed disruptions, and economic and social consequences that last far beyond the initial event (Brookshire et al., 1997; Okuyama, 2004). As all threats that are present whether one realizes them or not, residents near the CSZ have a tremendous stake in earthquake and tsunami related issues (Schelling et al., 2013).

Salience

The relative prominence or conscious accessibility of an attitude object is referred to as it salience (Crano & Prislin, 1995). In the case of residents of the Pacific Northwest living in the general vicinity of the CSZ, the salience of a potential megathrust rupture will be a defining aspect of their hazard awareness and disaster preparedness knowledge (Miller et al., 2013). Attitudes focused on issues and topics in the news, at the center of attention, and that are on everyone's lips are going to be salient. Moreover, attitudes about critical events that are easy to recall, and that everyone seems to be aware of, are going to be highly salient, and thus more likely to be highly vested. Near the CSZ, high issue salience will be evidenced by residents being able to easily recall information about the nature of the subduction zone, or the conjuring of visions of a catastrophic earthquake, and/or thoughts pertinent to the threat of widespread devastation due to tsunami inundation. Residents for whom the consequences of a great seismic event are not salient will be less able to recall important disaster preparedness information. They will likely to be unaware of the potential risk of annihilation faced by their families, their community, and themselves.

Certainty

The perceived certainty of the personal consequences associated with attitude relevant behavior has a powerful regulating effect on one's level of vested interest. Moreover, context can play an important role in the perception of certainty associated with attitudes that are created, maintained, and influenced by one's larger environment (Visser & Mirabile, 2004). For example, the relatively greater certainty of earthquakes occurring along the West Coast of the United States will induce residents to be more highly vested in their attitudes regarding earthquakes compared to their attitudes regarding tornadoes and hurricanes—and vice versa for those living in the Midwest and South East.

According to VI, when the consequences of an event are deemed highly probable, the attitudes relevant to those consequences will be more reliably associated with pertinent behaviors (Crano & Prislin, 1995; Miller et al., 2013). Residents close to the CSZ who perceive the consequences of an earthquake and tsunami with greater certainty are more likely to prepare themselves for such an eventuality. Alternatively, residents who perceive such an outcome as less certain are more likely to delay or forgo disaster preparation altogether. Greater levels of certainty should also be related to greater information seeking, which should in turn contribute to the threat of an earthquake and tsunami taking on greater salience as well.

Immediacy

The temporal immediacy of hedonically relevant, personal consequences associated with an event also translates into higher levels of perceived vestedness. The more immediate the anticipated outcomes associated with a set of attitudes, the greater likelihood individuals will act in ways consistent with those attitudes (Crano & Prislin, 1995; Thornton & Knox, 2002). When outcomes are perceived to be closer in time, VI specifies relevant attitudes are more likely to closely correspond with pertinent behaviors. For CSZ residents who recognize a catastrophic earthquake as a near future potentiality, disaster-relevant attitudes are more likely to be manifested as preparedness behaviors. Conversely, for individuals who perceive consequences to be further off in the future, disaster-relevant attitudes will be less likely to find expression in the form of immediate concrete actions, as individuals will perceive their import with less urgency (Adame & Miller, 2015; De Dominicis et al., 2014).

Self-Efficacy and Response-Efficacy

Finally, VI specifies two distinct and independent dimensions of efficacy influencing the degree to which attitudes will correspond with relevant behaviors. Self-efficacy concerns the perception of one's ability to successfully affect change, or effectively act in a given context (Bandura, 1994, 2001). Response-efficacy is the perception that a given response will be effective (Adame & Miller, 2015; Miller et al., 2013; Witte, Meyer, & Martell, 2001). In the context of a natural disaster, self-efficacy may be defined as individuals' self-perceived ability to perform FEMA-recommended preparedness actions—regardless of their actually ability to do so. Whereas, response-efficacy is one's perceptions regarding the relative effectiveness of a given preparedness action to mitigate earthquake and tsunami-related consequences.

Results from FEMA-sponsored, nationwide disaster preparedness research point to the powerful influence of perceived efficacy on disaster preparedness decisions. These studies show how individuals' readiness to act in preparation for a disaster is diminished by their self-perceived inability to do so (Bandura, 2001), along with their beliefs that FEMA's recommendations would have only a limited capacity to aid in their survivability (FEMA, 2009, 2013b, 2014). Beyond disaster preparedness, a large body of behavioral research has confirmed the relationship between self-efficacy, motivation, and behavior in a wide range of contexts using various theoretical approaches. The general and robust finding across studies is that self-efficacy consistently functions as a reliable predictor of attitude-relevant behavior (Crano & Prislin, 2006; Gecas, 1989; Sadri & Robertson, 1993).

For any attitude object, the six dimensions of VI can be assessed along high-to-low continua, and overall vestedness is hypothesized to occur as an additive array, such that when all six are perceived as high, attitude-behavior consistency will be maximized. Simply put, highly vested attitudes will reliably predict pertinent behaviors. In the context of the CSZ, this means highly vested attitudes concerning the consequences of a great earthquake will be associated with actions aimed at preparing for and reducing the threat. However, when one or more of the variables is perceived as low, for example, if the perceived immediacy of a megathrust rupture occurring is low, vestedness will be reduced, and the predictive power of individuals' attitudes about the consequences of such an event will fail to reliably predict their preparedness behaviors (Adame & Miller, 2016; De Dominicis et al., 2014; Lehman & Crano, 2002; Miller et al., 2013). Communication research has demonstrated VI's usefulness in explaining attitude behavior consistency in a diverse range of contexts, including: biased perception and student activism (Crano, 1983), counter-attitudinal advocacy (Crano, Gorenflo, & Shackelford, 1988), political judgment (Lehman & Crano, 2002), and organ donation (Siegel, et al., 2008). Recently, researchers have used the VI framework to investigate risk perception in health risk, natural hazard, and disaster contexts (Miller & Adame, 2016).

Miller and colleagues (2013) developed a comprehensive tool to measure perceived vestedness, and tested the scale in two distinct natural hazard contexts: earthquakes, and tornados; and the metric was further tested in the context of flood risk perception (Adame & Miller, 2016). Researchers have also used VI in an international context promoting Italian citizen's willingness to cope with impending flooding disasters (De Dominicis et al., 2014) demonstrating VI to be an effective framework for guiding the assessment of risk-related attitudes, and further designing messages to promote disaster preparedness. Adame and Miller (2015) have also demonstrated VI's utility as a guide for strategic campaign message designs useful in promoting health-risk reducing behavior, and citizen-level disaster preparedness.

In the following sections, we present the details of a survey study conducted to assess the vestedness of earthquake and tsunami-related attitudes held by Washington and Oregon residents. Our goals are to understand CSZ residents' relative levels of vestedness in earthquake and tsunami-related consequences. In the CSZ, the risk of a tsunami is almost inextricably tied to the risk of a major earthquake. Despite this relationship, the two events require different preparedness behaviors, and immediate responses; because of this, we have structured our data collection to allow for direct comparison of the target variables, based on the perceived risk of an earthquake and accompanying tsunami.

We are also interested in understanding how the elements of VI are related to key outcome variables including perceived risk, and behavioral intentions to prepare. By examining levels of vestedness and perceived risk, it is possible to ascertain how susceptible CSZ residents feel, and provide concrete evidence-based recommendations for PSA message designs capable of enhancing perceived risk and motivating self-protective action. This analysis should also allow practitioners to identify which dimensions of VI appear to be low in perceived vestedness within a vulnerable population, and thereby help target those areas for special attention.

We begin by detailing the methods and measures used, and presenting the results of a two-part investigation assessing the earthquake and tsunami relevant vested interest of more than 300 adults living near the CSZ. We finish with a discussion of pertinent results, and recommendations for how governments, communities, aid organizations, and businesses stakeholders can effectively enhance individuals' risk perceptions, thereby raising the entire community's level of vestedness, and motivating residents to actively engage in effective disaster preparedness.

METHOD

Data were collected using Mechanical Turk (mTurk), an online crowdsourcing service provided by Amazon.com. The service allowed us to exclusively target residents of Washington and Oregon, two states with citizens who have a clear stake in the preparedness of its citizens, both with high population concentrations and significant risk for the catastrophic consequences of a megathrust rupture along the CSZ. Using a targeted mTurk sample also allowed us to draw on a more diverse population of adult residents than is typically recruited in most social science studies (Buhrmester, Kwang, & Gosling, 2011). Recent research has also demonstrated how mTurk respondents are equivalent in quality to those obtained in other sampling methods, with respondents generally demonstrating more reliable performance on attention checks relative to other sampling methods (Casler, Bickel, & Hackett, 2013; Hauser & Schwarz, 2014).

Using survey materials approved by a university institutional review board, a work request was submitted to the mTurk interface, and participation was limited to residents of Washington and Oregon, independently verified by location questions and IP addresses. Participants were informed they would be responding to a disaster preparedness study, and that they would be compensated $2.00 USD upon their completion of the survey.

Participants

A total of $N = 313$ participants responded to the call to participate; $n = 8$ participants were excluded either for not meeting the location criteria, or for not completing the survey.[1] The final sample ($N = 305$), included ($n = 146$) Washington residents, and ($n = 151$) Oregon residents, and was 59% female, with a mean age of 38.1 years ($SD = 11.60$). Participants reported their ethnicity as American Indian/Alaskan Native (2%), Black (2%), White (86%), Asian/Pacific Islander (4%), Hispanic (2%), Semitic (0.5%), and Other (3.5%), with 35% having earned a college degree, and 14% having earned a master's degree or higher. Median income for the sample was $50,000-$59,000, with 58% residing in a single-family home or condominium, 34% living in either an apartment or townhome, and 8% living in either a mobile home or other type of structure.

Procedure

Data were collected using Qualtrics survey software. Participants were asked to report their city of permanent residence, ZIP code, telephone area code, the distance in miles they lived from the coast ($M = 109.57$, $SD = 91.21$), and the length of time in years and months they had lived in the area ($M = 23.5$ years, $SD = 15$). Participants then responded to a battery of scales designed to measure their perceived vested interest relative to the threat of a CSZ earthquake (see below), followed by a second identical battery concerning the threat of a tsunami. The presentation order of the six VI subscale was randomized, as was the order of the individual items within each scale, except for response-efficacy.

To avoid biasing participants' answers on items concerning the first five dimensions of VI, the response-efficacy items were presented last. Before assessing response-efficacy, participants were first presented information about FEMA disaster recommendations (e.g., assembling an emergency kit; making an emergency plan concerning evacuation routes, meeting places, and emergency contacts; and staying informed about local hazards, etc.), and then asked how they feel about the ability of these recommendations to effectively reduce the potential consequences of a catastrophic CSZ seismic event. The response-efficacy measures were followed by a set of sliding behavioral intention scales designed to assess participants' perceived likelihood to engage in the various FEMA recommended responses. Upon completing the survey, respondents were thanked for their participation and directed back to the mTurk web interface, where they were compensated.

Measures

The six VI subscales used were developed and adapted from previous natural disasters preparedness research examining earthquakes, tornados, and flooding (Adame & Miller, 2015, 2016; Miller et al., 2013), and modified to address either an earthquake (EQ) or tsunami (TSU) threat. Each VI subscale was comprised of five items measured along a 7-point *strongly disagree—strongly agree* continuum where higher scores indicate higher levels of perceived vestedness. Sample items drawn from each of the subscales included: "I often think about catastrophic earthquakes" (EQ salience); "A catastrophic earthquake is likely to affect me personally" (EQ certainty); "I do not have much time before a catastrophic tsunami affects me" (TSU immediacy); "I have the ability to reduce the personal consequences of a catastrophic tsunami" (TSU self-efficacy); "The FEMA preparedness recommendations can help me respond to the consequences of a catastrophic tsunami (TSU response-efficacy). All six VI subscales demonstrated good to excellent internal consistency: salience (EQ $\alpha = .86$; TSU $\alpha = .87$), certainty (EQ $\alpha = .93$; TSU $\alpha = .96$), immediacy (EQ $\alpha = .92$; TSU $\alpha = .94$), self-efficacy (EQ $\alpha = .87$; TSU $\alpha = .91$), and response-efficacy (EQ $\alpha = .90$; TSU $\alpha = .94$). Other preparedness measures were adapted from FEMA nationwide citizen-level preparedness surveys (FEMA, 2014).

Attitudes toward preparedness were measured using a scale developed by Adame and Miller (2015) in response to Decker's (2009) call for more effective measures of the public's perception of risk and preparedness. The scale is comprised of 10 items, measured along a 7-point *strongly disagree—strongly agree* scale, with higher scores indicating more positive attitudes. Sample items included: "Preparing for natural disasters will increase my odds of survival," and "Awareness of information related to disasters is a worthwhile activity for my well-being," and the overall scale also demonstrated excellent internal consistency ($\alpha: = .92$).

The survey also included two 5-item threat risk scales assessing respondents' perceived susceptibility to earthquakes and tsunamis, measured along a 7-point *strongly disagree—strongly agree* scale, with higher scores indicating increased perceived risk. Sample items included: "I am vulnerable to the effects of a catastrophic tsunami," and "I am at risk of the consequences of a catastrophic earthquake." Both susceptibility scales likewise demonstrated excellent internal consistency (EQ $\alpha = .93$; TSU $\alpha = .95$). Perceived risk was also measured using two 0–100 sliding scales assessing participants' perceived risk, where 0 = "not at risk," and 100 = "very high risk" of experiencing either an earthquake ($M = 54.22$, $SD = 30.04$) or a tsunami ($M = 21.87$, $SD = 26.96$). The two measures for perceived earthquake risk were strongly

Table 3.1. Means, Standard Deviations, and t-values for Vestedness of Earthquake vs. Tsunami Threat

VI Element	*EQ–N*	*EQ Mean (SD)*	*TSU–N*	*TSU Mean (SD)*	*t-value*
Stake	299	59.9 (30.0)	291	27.0 (31.2)	15.8**
Salience	305	4.23 (1.31)	303	3.58 (1.37)	10.5**
Certainty	305	4.49 (1.42)	303	3.17 (1.52)	17.4**
Immediacy	305	4.18 (1.21)	304	3.32 (1.36)	13.1**
Self-efficacy	306	4.58 (1.21)	303	4.89 (1.31)	-4.5**
Response-efficacy	305	5.73 (0.90)	300	5.45 (1.15)	5.9**

Note: All VI subscales range from 1-7 except Stake, which ranges from 0-100. **$p < .001$

correlated $r(309) = .55$, $p < .001$, as were the measures for perceived tsunami risk, $r(301) = .57$, $p < .001$.

Behavioral intentions, and perceived event severity were also measured on 0–100 scales, with participants instructed to think in terms of%ages while responding about their preparedness intention, by rating the likelihood that they would engage in various FEMA-recommended behaviors, such as assemble an emergency kit ($M = 70.27$, $SD = 29.82$), creating an emergency action plan ($M = 65.76$, $SD = 30.18$), and seeking disaster-relevant information ($M = 52.48$, $SD = 31.50$). Intention to assemble a kit was highly correlated with intention to create an emergency plan, $r(297) = .79$, $p < .001$, and information seeking, $r(297) = .50$, $p < .001$; as such, the items were averaged to create a single composite measure ($M = 62.86$, $SD = 26.08$). Risk and severity questions directed participants to rate their perceptions regarding the potential severity of both a CSZ earthquake ($M = 60.03$, $SD = 29.80$), and tsunami ($M = 28.32$, $SD = 31.71$).

Finally, we asked respondents to report the distance in miles that they live from the Pacific Ocean coast line ($M = 109.01$, $SD = 90.77$; Min: 0; Max: 450), and the length of time they have lived in their respective states ($M = 23.25$ years, $SD = 15.22$).

RESULTS

The analysis began by examining the data for systematic differences between residents of Washington and Oregon. We performed several parallel analyses on the dependent variables of interest, controlling for residents' state, residential distance from the coast, and their length of residence in time. None of these variables emerged as significant predictors, therefore subsequent analyses included the full sample of participants from both states. Table 3.1 provides the overall VI subscale means and standard deviations.

As can be seen, paired-sample *t*-tests reveal the VI means for earthquake perceptions to all be significantly higher than those for tsunami perceptions, except for self-efficacy, which is significantly lower. This may be due to the simple nature of perceptions regarding the only real effective means of dealing with a tsunami, namely immediate evacuation.

Note how the mean for perceived stake—which can be thought of as an individual's assessment of how severe a potential disaster might be—is markedly lower for the threat of a tsunami relative to an earthquake. This may be due to people perceiving tsunamis to be far less certain and immediate events relative to earthquakes, as indicated by the significantly lower perceived vestedness for tsunami threat, especially the lower perceived certainty and immediacy of tsunami threat.

Regression Analysis

One of the primary goals of this study was to examine the relationship between each of the VI subscales relative to the respondents' perceived risk of suffering the catastrophic consequences of the dual-threat posed by a CSZ megathrust rupture. For each disaster threat, we regressed the VI subscales onto the perceived risk scale, which essentially measures the individuals' assessments of how susceptible they feel themselves to be to the consequences posed by the threat.

First, in examining the earthquake threat data, a multiple linear regression was calculated to predict perceived threat susceptibility based on perceptions of *stake, salience, certainty, immediacy, self-efficacy,* and *response-efficacy*. The regression model was significant, $F(6, 292) = 55.73$, $p < .001$, $R = .73$, with an adjusted R^2 of .52, which indicates that over half of the variance in perceived earthquake risk was accounted for by the model, with *stake, salience, certainty,* and *self-efficacy* driving the significance of the equation (see Table 3.2). This analysis also revealed self-efficacy to be a negative predictor, showing lower levels of perceived self-efficacy to predict higher levels of perceived risk susceptibility. In other words, respondents who reported lower levels of disaster preparedness-related self-efficacy perceived themselves to be at greater risk for earthquake-related consequences.

As the right side of Table 3.2 shows, for the tsunami data, the relation between the VI subscale predictors and perceived threat susceptibility follows an identical pattern as that of the earthquake data, with the VI model predicting an even higher portion of the variance—67%—in perceived threat of tsunami consequences, $F(6, 284) = 00.94$, $p < .001$, $R = .82$, adjusted $R^2 = .67$. Again, *stake, salience, certainty*, and *self-efficacy* emerged as significant drivers within the model.

Table 3.2. Regression Analysis for VI Subscales Predicting Perceptions of Earthquake Risk Susceptibility

	Earthquake Threat				*Tsunami Threat*			
	B	*SE*	*β*	*t-value*	*B*	*SE*	*β*	*t-value*
Stake	.011	.002	.280	6.02**	.001	.002	.181	4.78**
Salience	.335	.052	.254	4.53**	.202	.061	.170	3.30**
Certainty	.289	.054	.337	5.38**	.623	.068	.577	9.20**
Immediacy	-.013	.062	.013	-0.21	.019	.076	.016	0.25
Self-efficacy	-.244	.045	-.242	-5.39**	-.224	.046	-.178	-4.84**
Response-efficacy	.066	.059	.049	1.12	.057	.053	.040	1.08

Quake model, $N = 299$, $R = .73$, $R^2 = adj.\ R^2 = .52$; Tsunami model, $N = 291$, $R = .82$, $adj.\ R^2 = .67$

One difference in the tsunami results relative to the earthquake findings is that *certainty* appears to be the most powerful predictor of perceived tsunami risk—even more so than stake (i.e., the perceived severity of the threat). This may be due to the fact that tsunamis are rarely reported in the news as affecting the United States, hence few people are likely to rate the probability of their occurrence as high. Thus, despite the capacity for tsunamis to cause almost total devastation within their zone of inundation, citizens are more likely to think of them as less of a threat.

Based on these initial results, we performed several more nuanced analyses to gain deeper insights into how certain VI dimensions may be interacting with each other to provide a clearer view of threat perceptions, and thus a more accurate forecast of disaster preparedness behaviors.

Before reviewing the results of how different VI dimensions may interact to predict attitude-consistent behaviors, it is first useful to consider the nature of the structural framework making up the different dimensions of the VI construct. Crano and Prislin (1995) have noted how stake acts as the key factor embodying the core of vestedness, with the other dimensions impinging upon it to influence attitude-behavior consistency. Moreover, three of the remaining five dimensions—salience, certainty, and immediacy—can be characterized as tending to focus primarily on the attitude object and its associated consequences; whereas the final two dimensions, self-efficacy and response-efficacy, tend to be focused more on the attitude holder, and his or her beliefs about coping with those consequences. With these considerations in mind, and holding stake constant, our analyses are aimed at determining how the three outcome predictors, salience, certainty, and immediacy may interact to achieve the highest levels of threat perception. These variables, in turn should spur the coping behaviors associated with the two efficacy factors, thereby resulting in attitude-consistent behavior.

We begin by examining the earthquake threat data, calculating a multiple linear regression designed to predict the likelihood of individuals preparing for a great earthquake, operationalized as a composite of the behavioral intention measures, and based on the main effects of *salience, certainty,* and *immediacy,* and their interaction terms. All predictors were sequentially entered into the model in three blocks using backward elimination selection to reduce the set of predictors to only those necessary to account for nearly as much of the variance as can be accounted for by the total set (Cohen & Cohen, 1983). Backward elimination is a statistical method that helps determine the importance of each predictor variable while assessing the effects of the remaining variables once the other predictor variables are statistically eliminated.

In our multiple regression model predicting the likelihood of individuals to prepare for a great earthquake, we entered the three predictors, *salience, certainty,* and *immediacy* into the first block, followed by their three 2-way interaction terms *salience x certainty, salience x immediacy,* and *certainty x immediacy* into the second block, and their single 3-way *salience x certainty x immediacy* interaction into the third block. The elimination criteria set the probability of F to remove at .10, and missing cases were excluded listwise. After five iterations, the reduced regression model retaining *immediacy, certainty x immediacy,* and *certainty x salience* was significant, $F(3, 148) = 20.75$, $p < .001$, $R = .54$, with an adjusted R^2 of .28, and this reduced set of three factors accounted for nearly as much of the variance ($R^2 = .30$) as can be accounted for by the total set of seven factors ($R^2 = .31$) (see Table 3.3).

The main effect found for *immediacy* on *likelihood to prepare for an earthquake* is qualified by the *certainty x immediacy* interaction. As can be seen in Figure 3.1, high levels of *immediacy* are correlated with high levels of *certainty* and high levels of predicted *likelihood to prepare* for an earthquake, whereas lower levels of *immediacy* correlate with generally lower levels of *certainty* and generally lower levels of predicted *likelihood to prepare.*

Figure 3.2 presents the *certainty x salience* interaction predicting *likelihood to prepare* for an earthquake, and a similar, although somewhat more

Table 3.3. Regression of Salience, Certainty, and Immediacy on Likelihood to Prepare for an Earthquake

	Earthquake Threat			
	B	*SE*	*β*	*t-value*
Immediacy	13.27	3.68	0.57	3.61**
Certainty x Immediacy	-1.90	0.55	-0.76	-3.44**
Certainty x Salience	1.91	0.33	0.78	5.79**

N = 152, $R^=$ .54, R^2 = .30, *adj.* R^2 = .28, $^{**}p \leq .001$

Table 3.4. Regression of Salience, Certainty, and Immediacy on Likelihood to Prepare for a Tsunami

	Tsunami Threat			
	B	*SE*	*β*	*t-value*
Certainty	-42.94	10.57	-2.48	4.06**
Certainty x Immediacy	8.03	2.26	2.94	3.55**
Certainty x Salience	8.83	2.01	3.69	4.40**
Certainty x Immediacy x Salience	-1.61	0.44	-3.90	-3.67**

N = 152, *R* = .46, *adj.* R^2 = .19, **$p \leq .001$

discriminating pattern of data has emerged, this time revealing high levels of *salience* to be correlated more distinctly with high levels of *certainty,* as well as high levels of predicted *likelihood to prepare* for an earthquake. However, lower levels of *salience* correlate with generally lower levels of *certainty* and more distinctly with lower levels of *likelihood to prepare* for an earthquake. Comparing the two graphs, it appears that when salience is high, there is an increased *likelihood to prepare* for an earthquake, even for many individuals whose perception of *immediacy* is low.

To predict the likelihood of individuals preparing for a tsunami, a similar multiple linear regression using the tsunami data was calculated based on the same three factors and their interaction terms. As with the earthquake analysis, all predictors were sequentially entered into the model in three blocks using backward elimination selection, the probability of *F* to remove was set at .10, and missing cases were excluded listwise. After four iterations, the reduced regression model retaining *certainty, certainty x immediacy, certainty x salience, and certainty x immediacy x salience* was significant, $F(4, 147) = 9.84$, $p < .001$, $R = .461$, adjusted $R^2 = .19$, and this reduced set of four factors accounted for nearly as much of the variance ($R^2 = .21$) as can be accounted for by the total set of seven factors ($R^2 = .22$) (see Table 3.4).

The main effect found for *certainty* is qualified by the three interactions. Figure 3.3 presents the *certainty x immediacy* interaction predicting *likelihood to prepare for a tsunami*. Although there is some similarity this interaction for both the earthquake and tsunami data—for example, high levels of perceived *immediacy* are correlated with high levels of *likelihood to prepare* in both cases—there are a few distinct differences in the two models regarding perceptions of certainty, the overall spread of scores, and the two slopes.

The most noticeable difference is in the overall lower levels of perceived *certainty* regarding tsunamis. Whereas for the earthquake threat, perceptions of *certainty* are spread out across all levels of predicted *likelihood to prepare*,

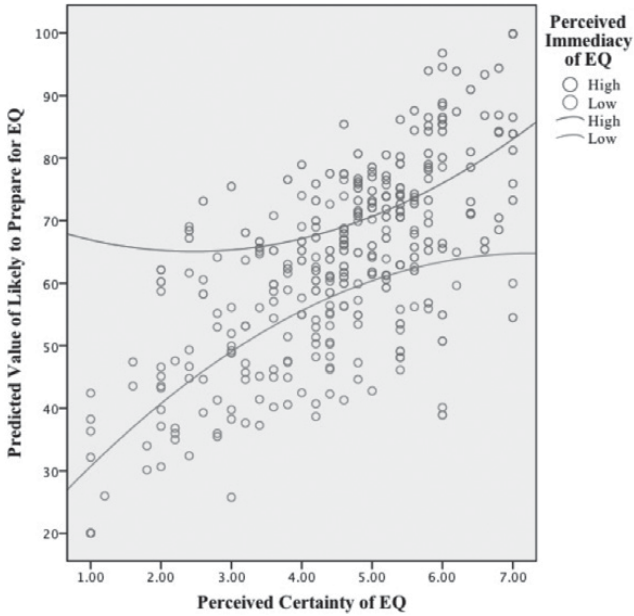

Figure 3.1. Certainty x Immediacy Interaction Predicting Likelihood to Prepare for an Earthquake. *Figure created by author.*

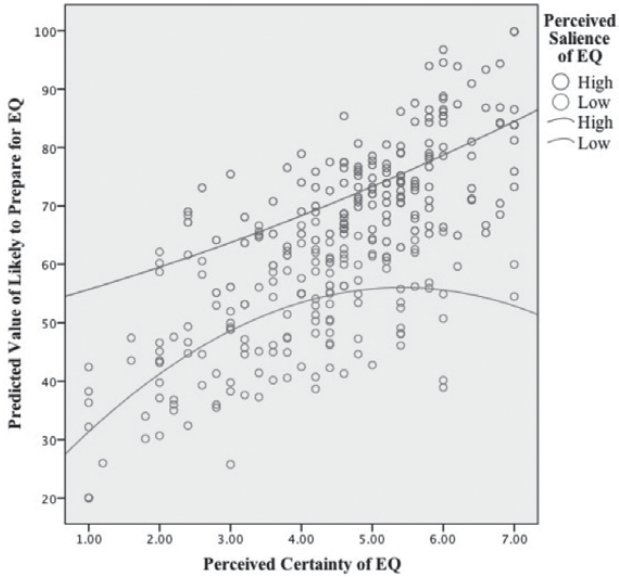

Figure 3.2. Certainty x Salience Interaction Predicting Likelihood to Prepare for an Earthquake. *Figure created by author.*

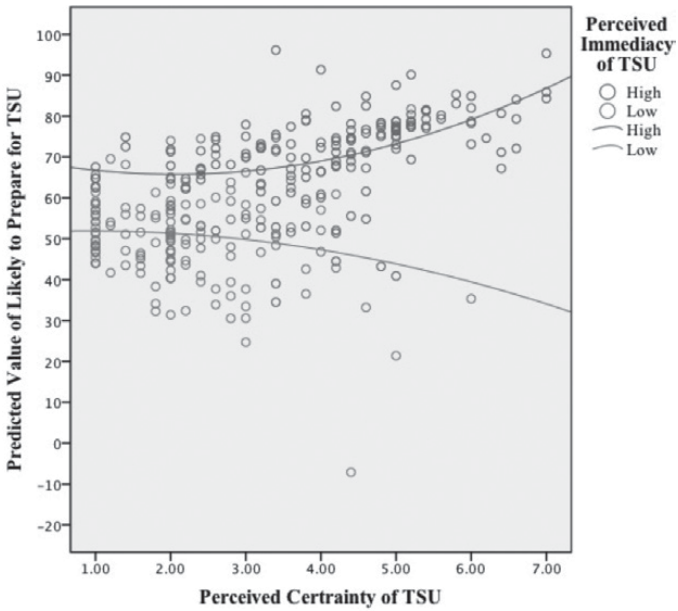

Figure 3.3. Certainty x Immediacy Interaction Predicting Likelihood to Prepare for a Tsunami. *Figure created by author.*

and the high and low *immediacy* slopes are relatively steep; for the tsunami threat, the scores are mostly clustered at the low end of perceived *certainty*, and the *immediacy* slopes are comparatively flat, with only those who perceive high immediacy showing elevated levels of certainty and *likelihood to prepare* for a tsunami (see Figure 3.3). The *certainty x salience* interaction shows a very similar pattern as well, with perceived *certainty* scores mostly clustered at the low end, and the *salience* slopes comparatively flat, with only those who perceive high salience showing elevated levels of certainty and *likelihood to prepare* for a tsunami.

The above 2-way interactions are further qualified by the 3-way *certainty x immediacy x salience* interaction predicting *likelihood to prepare* for a tsunami (see Figure 3.4).

As can be seen from examining the 3-way intersection, the main effect for *immediacy* and the *certainty* x *immediacy* interaction are both being driven by perceived *salience.* Which is to say, when examining the simple effect of *high salience* on predicted *likelihood to prepare* for a tsunami (Figure 3.4), the *certainty* scores are clustered in the center of the spectrum, the levels of *likelihood to prepare* are markedly higher, and they are almost exclusively associated with high levels of *immediacy*. Moreover, when examining the simple effect of *low salience* (Figure 3.5), the *certainty* scores are clustered

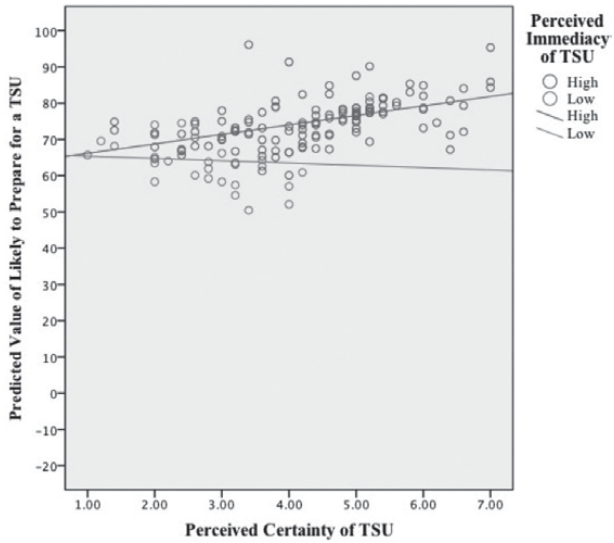

Figure 3.4. Certainty x Immediacy x Salience Interaction Predicting Likelihood to Prepare for a Tsunami at High Salience. *Figure created by author.*

at the low end of the spectrum, the levels of predicted *likelihood to prepare* are significantly lower, and they are almost exclusively associated with low levels of *immediacy*.

DISCUSSION

The goals of this research have been to assess the risk perceptions of residents of the Pacific Northwest living close to the CSZ, and more specifically, to measure their levels of vestedness in preparing for the dual-threat of a megathrust rupture resulting in a great earthquake and tsunami disaster. The aim was to offer evidence that VI can provide a valuable framework for understanding the key psychological factors motivating disaster preparedness, as well as point to the most effective means for crafting and targeting effective disaster preparedness messages. Overall, the results presented here support the use of VI as a framework for identifying those attitudes and perceptions most reliably related to motivating actual preparedness behaviors. Using scales developed in previous disaster research, a diverse sample of adult Washington and Oregon residents was surveyed regarding their disaster-relevant perceptions of six key dimensions of VI known to reliably influence perceptions of risk susceptibility instrumental in not just

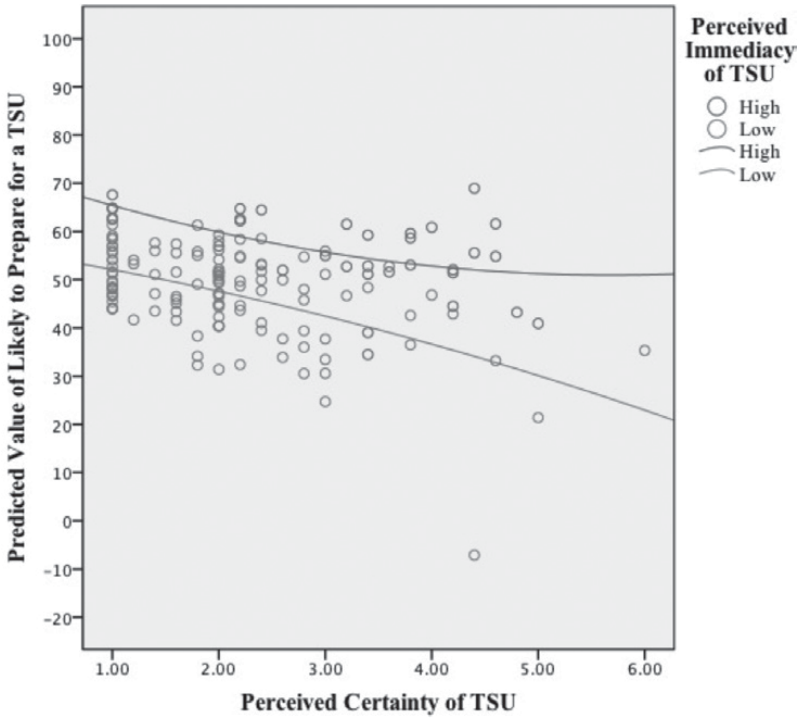

Figure 3.5. Certainty x Immediacy x Salience Interaction Predicting Likelihood to Prepare for a Tsunami at Low Salience. *Figure created by author.*

generating more positive attitudes about preparedness, but motivating actual disaster preparedness behaviors (Adame & Miller, 2015; Miller et al., 2013).

Our results also indicate residents of the CSZ may be generally unaware of the risks of a major earthquake and resulting tsunami, and therefore relatively underprepared to act in the event of a disaster. This conclusion may not come as a great surprise given that, nationwide, citizens generally report being underinformed, underprepared, and apathetic toward natural and man-made hazards (FEMA, 2014). This situation, however, is especially critical for CSZ stakeholders, given the cataclysmic nature of a megathrust rupture that is going to happen sooner or later. Herein lies the challenge: influencing residents living in the proximity of the CSZ that a great earthquake and tsunami *are* coming—of this, geologists and seismologists have no doubt. The question is *when*, and the sooner citizens of the Pacific Northwest begin to feel a sense of immediacy to add to the certainty of what the future holds, the more motivated they will be prepared to act to protect themselves from the catastrophic consequences.

Based on the results presented here, we believe VI offers a clear path to enhance risk perception and motivate preparedness, with the goals of building the regions capacities for recovery and resilience. For governments, planners, and crisis managers, the greatest challenge will be in building higher levels of perceived certainty and instilling a sufficient sense of immediacy in a population that may not want to think about the likelihood of such a potentially devastating and disastrous set of events. However, there is also an "easy part," and it involves using a sustained disaster preparedness campaign to overcome people's desire not to think about the potential consequences of a megathrust rupture. It may not be easy to immediately influence people's risk perceptions, even with the threats and the stakes as high as they are, but with so much at stake, it should be fairly simple and easy to make the threats and risks salient.

Some initial efforts to build a higher sense of vestedness—and thus a higher level of preparedness—might begin by enhancing laypersons' understanding of the risks to a level approximating those of experts who have been exhaustively studying the CSZ over the past couple decades. When individuals understand the risk, and feel the threat, they are more likely to engage in risk mitigating, self-protective behaviors (Pligt, 1996; Sjoberg, 2000). For the dual threat represented by a Magnitude 9 megathrust rupture, the VI model accounts for 52% of the variance in perceived earthquake risk and 67% of variance in perceived tsunami risk. Moreover, past research has shown that perceived vestedness can be influenced by mass mediated, strategically designed messages (Adame & Miller, 2015; De Dominicis et al., 2014). Together, these findings suggest that effective risk communication messages should be focused on enhancing the vested interest of residents living near the CSZ to actively seek heightened levels of disaster preparedness.

This can be done by launching a sustained message campaign using clear and concrete language to highlight the grimly *certain* and *immediate* consequences of a major seismic event, along with the potential immediacy of its occurrence. As mentioned, making the threat *salient* will be the easy part, moreover, it should be no great challenge to include useful and specific *self-efficacy and response efficacy-based* information about how best to respond to the threat. Building higher levels of response-efficacy will also help instill a greater sense self-efficacy as well. A sustained campaign making residents living near the CSZ more aware of the inevitable, threatening consequences of a major seismic event will work to enhance overall risk perceptions, raising the vestedness of individuals and communities, and motivating the self-protective preparedness behaviors necessary for a resilient population.

To influence perceived certainty, such messages might include phrases like: "Scientists tell us that major earthquakes occur in this area every 250 years or so. They also note how it's been over 300 years since the last one

struck this region. Perhaps we should be paying attention, eh?" Messages to enhance perceived immediacy could include information about the expected timeline, for example: "When the shaking begins, you can expect a devastating tsunami within a few short minutes. The plates below your feet are shifting, so the time to prepare is now. When a tsunami is coming, you need to *act* immediately: KNOW YOUR ESCAPE ROUTE."

Efficacy-based messages should include information that helps the population both prepare for a disaster, and understand that preparedness is effective: "Experts tell us that being prepared with a go-kit containing food, water, a flashlight, radio and extra clothes is an effective way to help survive a major disaster. These items are inexpensive and readily available, so you can easily assemble your own go-kit." Messages such as these have been shown in experimental settings to influence perceived vestedness leading to measureable changes in individuals' intentions to prepare (Adame & Miller, 2015; De Dominicis et al., 2014).

Not all solutions or responses are going to be as simple and straightforward as those possible at the individual level. At the community and regional levels, implementing the kinds of preparedness programs and activities necessary is likely to come at a substantial cost. However, given the conclusions from FEMA's recent (2016b) multiregion planning exercise, capacity-building efforts aimed at crisis management and disaster preparedness are well worth the expenditures needed to meet the dual-threat of a looming megathrust rupture for millions of people living in the vicinity of the CSZ.

EARTHQUAKE THREAT

To examine individuals' likelihood to prepare for both an earthquake and tsunami, we created a composite measure of intentions associated with each event, and regressed the respective VI scales to the corresponding hazards. From our analyses, the earthquake data reveal an interesting dynamic within which the main effect for perceived *immediacy* appears to be a significant and strong predictor of individuals' likelihood to prepare for an earthquake, which is a key outcome variable for predicting actual disaster preparedness behaviors. A major threatening event for which the consequences are perceived to be near in time will exert a strong motivating force on individuals to act in self-defense. For planners, policymakers, and campaigners, the results reported her translate into a message design strategy stressing the importance of communicating the immediacy of an impending M9 megathrust rupture. Boosting perceptions of immediacy should become a priority for effectively influencing earthquake disaster preparedness. Recent disaster preparedness research has demonstrated how perceived immediacy

of consequences can directly influence people's decision-making relevant to preparedness behaviors (Adame & Miller, 2015; Siegel, Alvaro, Lac, Crano, & Dominick, 2008; Soman, 2001).

Our analyses have also revealed an interaction between certainty and immediacy, which exerts a negative effect on intentions to prepare. The scatterplot data show this interaction to be driven by those perceiving an earthquake to be an uncertain and temporally distant event, thereby rendering them less likely to prepare themselves. The certainty x salience interaction adds a further consideration, as those who report high degrees of certainty with higher levels of salience are more likely to prepare. This is likely because individuals who can easily recall hazard-relevant information will also be aware of the most useful mitigation strategies (Huang, Lindell, Prater, Wu, & Siebeneck, 2012; Whitehead et al., 2000).

Given this pattern of results, campaigners should create earthquake preparedness messages that not only help to make perceptions of certainty and immediacy stronger and more salient, but do so in a way laypeople and local government agents can more easily comprehend the key threat factors involved. As mentioned, seismologists have predicted a 37% chance of a great earthquake occurring in the Pacific Northwest within the next 50 years. To repeat, the cycle of M8+ megathrust ruptures along the CSZ over the past 10,000 years is roughly one every 244 years, and we are presently in year 318. This simple fact alone should go a long way in dramatically raising perceptions of immediacy across the threatened population.

Increasing overall threat salience means disseminating pertinent risk and preparedness information frequently enough that the relevant knowledge becomes cognitively accessible for everyone. The most effective messages will include information about the high probability of potentially devastating consequences, while advising residents of both the direct consequences (e.g., potential loss of life, injury, and property damage), and the indirect consequences (e.g., significant, long-term disruption in nearly every facet of daily life). Finally, the most effective preparedness messages should include clear, actionable recommendations residents can use to prepare themselves.

According to FEMA, these recommendations include assembling an emergency kit, seeking hazard information, and creating a response plan (FEMA, 2009). Effective emergency kits contain dedicated reserves of food and water, first-aid supplies, a change of clothes and back-ups stores of essential medication. Information seeking recommendations include familiarizing oneself with locally salient hazards, the risks of such hazards manifesting, and potential mitigation strategies. Finally, FEMA recommends that citizens create a hazard plan (FEMA, 2009). Arguably, this is the most effective response for those in the tsunami inundation zone as it involves practicing evacuation routes, planning a safe space to meet family members, and planning for a

place to stay that is outside of the affected area. Other research has shown that when citizens are prepared, they suffer fewer and reduced disaster consequences (Chandra et al., 2011; Eisenman et al., 2006; Solomon, 2008). Despite this, at-risk citizens remain generally underinformed and underprepared. By focusing on the key dimensions of VI, the results presented here show how communicating FEMA's risk and preparedness information can help citizens increase their perceived vestedness, thereby motivating them to actively prepare for a potentially catastrophic disaster.

TSUNAMI THREAT

The threat posed by a tsunami, although obviously related to that of an earthquake, presents several distinct differences increasing the challenges faced by planners and policymakers. One consideration in motivating effective tsunami preparedness should concern how far people live form the coast; however, this factor did not appear to be significantly related to threat perceptions. We do know that large tsunamis can cause devastation many miles inland, especially as their effects are amplified where bays, harbors, rivers, and flood plains tend to funnel the wave as it moves inland. Moreover, because most Americans only read about tsunamis happening in distant lands, even individuals within the inundation zone may not think much about the threat of a tsunami or its likelihood. In a sense, the lack of physical proximity may reinforce the lack of temporal immediacy, although additional research is required to assess this possibility.

Further complicating the challenge for emergency planners is the unfortunate fact that, for most people in the inundation zone of a near field event, the only effective response to an imminent tsunami is a simple one: Drop everything immediately, and run like hell for higher ground. Unlike an earthquake which typically strikes with no warning, tsunamis generally do have warnings, be it the ground shaking, sirens going off, or messages over the radio, so there should be plenty of time to get out of the way, right? This simple belief may lull people into a premature or false sense of self-efficacy: Many people within the inundation zone may fail to consider how getting somewhere safe might not be so easy, especially when roads and bridges have been damaged or destroyed by the initial earthquake, and those left unscathed are likely to be gridlocked. Furthermore, the tendency to overestimate one's self-efficacy due to ignorance (Dunning, Johnson, Ehrlinger, & Kruger, 2003) may combine with low perceptions of certainty and immediacy, leading a large portion of the population to find itself unprepared to act quickly and effectively when a tsunami strikes.

Similar to our analyses of the earthquake data, an interesting dynamic was revealed in the tsunami data, however this time, rather than the main effect of immediacy, it involves the main effect of certainty; or a better way of putting it might be the main effect of *uncertainty*. There appears to be an adverse relationship between certainty and likelihood to prepare, wherein low certainty regarding a tsunami threat appears to predict decreased likelihood to prepare. For planners, policymakers, and campaigners, this translates into a message design strategy for tsunami threat that stresses the importance of building and reinforcing the grim certainty of a devastating tsunami following on the heels of a massive megathrust rupture.

Boosting perceptions of certainty should become a priority for effectively influencing tsunami disaster preparedness. Recall the 3-way interaction discussed earlier, particularly the simple effect of *low salience* shown in Figure 3.5, wherein individuals' certainty scores are clustered at the low end of the spectrum, and their likelihood to prepare for a tsunami is significantly lower than those for whom the threat is highly salient, and where their low likelihood to prepare is almost exclusively associated with low levels of immediacy. Again, it appears these three dimensions of vestedness are critical in motivating tsunami preparedness behaviors. One final recommendation we would offer is for planners and campaigners to create an assortment of messages (such as the ones mentioned to boost perceived immediacy, certainty, and efficacy) to be disseminated across a variety of media to ensure residents are blanketed by exposure to all the threats and risks involved in living in the vicinity of the CSZ, along with the key perceptions of vestedness needed to motivate active preparedness.

The advantages of such a strategy are three-fold: First, CSZ residents are likely to have varying media preferences and each medium provides unique features useful for influencing greater levels of vestedness. Second, as the main effects reported above show, immediacy and certainty are especially important factors for motivating preparedness behaviors. Campaigners can design messages emphasizing these features presented in the context of a larger, more strategically varied campaign, with individual messages working together to enhance the various aspects of vestedness. In this regard, VI can act as both an assessment tool, and a targeting mechanism (Miller & Adame, 2016).

CONCLUSION

For emergency managers, government officials, and those who will be entering the field in the near future, the findings presented here provide a practical and actionable framework for motivating citizen-level preparedness.

The results presented here provide evidence that preparedness and hazard risk messages emphasizing the psychological elements of certainty, immediacy, and salience can be effective in motivating preparedness behaviors and enhance risk perception.

As federal, state, and local agencies continue to analyze the threat and work to mitigate its potential consequences, it has become clear that citizen-level preparedness is a crucial piece of the puzzle. The sheer size of a major seismic event necessarily limits what crisis managers, emergency responders, and aid agencies can accomplish, especially in their short-term preparations for enhancing rescue and recovery efforts. This reality places a significant portion of the responsibility on the shoulders of residents living near the CSZ, both to understand the risks and the potential consequences of a great earthquake, and to take the appropriate actions needed to help themselves and their neighbors, wherever possible. In other words, citizens should be made aware that, in the initial chaos accompanying a megathrust rupture, they may well be on their own, with no one coming to help them, at least not immediately. They must be prepared to act for themselves, which will in turn allow them to act for each other.

That citizens cannot be compelled by law to prepare for a catastrophic event adds an additional challenge. Individual stakeholders must be targeted and informed of the risks and threats they face with accessible, intelligible, coherent, and comprehensible information strategically designed to persuade and motivate them to achieve a maximal state of readiness.

Despite the theoretical and practical implications of the results presented here, this work is not without its limitations. Our sampling procedure allowed us to target a wide range of CSZ residents who obviously have a stake in the potential consequences of a megathrust event. Despite this, Mechanical Turk workers offer a nonprobability sample by self-selecting into not only the mTurk system, but also into the surveys they wish to complete. Ideally a random sample of the population would offer a more unbiased assessment of the relevant attitudes, beliefs, and behaviors.

The goal of this chapter has been to explore a theory-based method for assessing the key dimensions of vested interest within the minds of a vulnerable target population for the purposes of predicting and maximizing their disaster preparedness behaviors. Framed by vested interest theory, this research has provided evidence that three of these dimensions—salience, certainty, and immediacy—are especially critical factors for understanding individuals' risk perceptions, assessing their level of perceived susceptibility, and motivating their active disaster preparedness behaviors. Building on related research confirming the explanatory value of vested interest theory, our hope is that the theory can be used to expand the potential for citizen-level disaster preparedness that will help develop and foster dynamic communities-wide

resilience. Strengthening the psychological profile of the population ahead of time will aid crisis managers and emergency responders in conducting the most effective response and recovery operations possible, and thereby potentially saving the lives of thousands of residents living near the CSZ.

Discussion Questions

1. The results presented in the chapter generally explain about half of the variance in constructs like risk perception and preparedness intentions. Beyond stake, certainty, immediacy, salience, and perceived self-efficacy, what are some other factors that might shed light on the variance that is unexplained by VI? How might you approach other key psychological variables to create a more effective message?
2. Salience is important, but people may not always be willing to pay attention to the threats around them. What additional barriers to achieving citizen-level preparedness do you see? How might you reduce or eliminate these?
3. What are the ethical implications for presenting risk and hazard information? How might experts address these issues while still motivating citizens to prepare? Also, what are the ethical implications embedded in the expectation that citizens prepare themselves? How might experts address these issues while still motivating citizens to act?
4. Statistics and science can be used to emphasize the apparent certainty that a megathrust rupture is eventually going to wreak havoc upon residents near the CSZ. But what are some ways that perceptions of immediacy can be enhanced to more effectively motivate citizens to prepare for the threats they face?
5. Self-efficacy and response-efficacy are two key dimensions of VI necessary for motivating action. What sorts of message strategies might be used to enhance people's perceptions of these two interrelated constructs?

NOTE

1. The sampling procedure does not allow for the calculation of a response rate, as participants self-select into participation.

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Part II

CONFRONTING RISK INFORMATION

Rhetorical Framing in the Media and Stages of Crisis

Chapter 4

The Article That Shook the Public

A Comparative Study of "The Really Big One" and Other Earthquake News Coverage

Julie Homchick Crowe

When Kathryn Schulz published "The Really Big One" in July of 2015, the West Coast of the United States ruptured with panic.

> We excel at imagining future scenarios, including awful ones. But such apocalyptic visions are a form of escapism, not a moral summons, and still less a plan of action. Where we stumble is in conjuring up grim futures in a way that helps to avert them. (Schulz, 2015, para. 40)

Her story gripped me as well, a long-time Washington resident who grew up learning about the Cascadia Subduction Zone (CSZ) in public school. I knew the story—the Northwest Coast of the United States was overdue for an earthquake of epic proportions. I think about that impending disaster every time I drive through downtown Seattle on a particular stretch of Highway 99 that is publically known to be unfit for surviving such an earthquake (Lindblom, 2011), so much so that the highway's inability to survive an earthquake resulted in the city tearing down and rebuilding the corridor as a tunnel starting in 2013 (the project is currently nearing completion). So why did I, and everyone else I knew in the Seattle area, panic upon reading Schulz's article? In spring of 2015, when Schulz would have presumably been writing her article, only a smattering of peer-reviewed research was published on the CSZ, mostly confirming low-frequency tremors in the area. Such research simply augmented previously published scholarly work by using different methodologies and instruments, meaning that Schulz was not reporting on some new groundbreaking research that would change the scope of the public's understanding of the CSZ. What, then, did Schulz do differently than writers who had previously written about the CSZ in public outlets? What in this article created the pandemonium around news that

wasn't really new news at all? Her story is particularly interesting because it, unlike most other news coverage of the CSZ, was not directly precipitated by anything newsworthy in the world of natural disasters or scientific research. Her story came seemingly out of the blue, summarizing information that had for decades been known by scientists and had been reported to the public in the news repeatedly. And yet, she was able to synthesize such information in a way that impacted the public and earned her a Pulitzer Prize. Understanding what Schulz did (and what other news coverage of the CSZ did as well), will better inform scholars about the public's willingness to embrace or ignore messages about risk, particularly less imminent (but no less dire) risks like climate change.

In order to better understand how Schulz was able to grip the public's attention and imagination, I offer an overview of prior news coverage of the CSZ in major print newspapers and news magazines from 1987–2015, identifying different themes in how journalists framed their stories. I then offer a more detailed analysis of how Schulz disrupted generic conventions by blending information from multiple scientific studies into an apocalyptic narrative. Her use of vivid metaphor, anthropomorphic language and expert testimony leant the piece urgency and gave the readers a call to action, telling them that they need to make themselves safer with better infrastructure and policy. Lastly, I analyze how newspapers and magazines covered the CSZ after the publication of Schulz's piece, noting how public action is or is not attributed to her writing. Ultimately, I find that prior news coverage of the CSZ sent mixed messages to the public about the level of danger as well as the level of preparedness in the region, likely contributing to the lack of public urgency about the issue. Schulz's piece infused the story with narrative elements while utilizing a hybridized genre that allowed her to present the threat of the CSZ as "factual entertainment," ultimately making the threat of the CSZ to the public simultaneously more real and more ominous than prior coverage had, which ultimately resulted in more public calls for action from the press after Schulz's piece. For scholars interested in the ways in which environmental and health risks can be communicated through different genres and outlets, this study provides an example of how different forms of messaging about a nonimminent earthquake can shape public understanding and response.

LITERATURE REVIEW

Several scholars have attended to the ways in which the news media covers natural disasters of all varieties across the world. The lack of attention to the CSZ may seem striking at first, but it is not particularly surprising since the

impending disaster hasn't happened yet. As I show below, scholars tend to look at event-driven coverage once an earthquake, hurricane or other disaster has already taken place, not prior to it. This gap in scholarship on the CSZ is interesting on its own because it points to a perhaps important area of research. If there's any hope for creating more disaster preparedness in the public sphere, it seems worthy to attend to the ways in which the media cover impending disasters, rather than ones that are in-progress or have already taken place. While there are challenges with reporting on how to prepare for something with an unknown arrival date (e.g., the public may become overly anxious, resources may get allocated indiscriminately, etc.), analyzing such coverage may still provide guidance for how such impending disasters can be framed as motivators for behavior-change.

While I note above that scholarship largely examines natural disaster coverage during or after an event, there is one exception in the literature that addresses the act of earthquake prediction specifically. Several communication scholars have examined an earthquake prediction in Missouri in 1990—but this case remains rather curious since the earthquake did not end up happening. For this earthquake, climatologist Iben Browning predicted a 50% chance that an earthquake would happen right around December 3, 1990, in Missouri's New Madrid seismic zone. While the New Madrid seismic zone is still considered a likely site of a serious quake in the future, this specific prediction was wrong. Showalter (1995) highlights some of the more salient elements that contributed to the media hype around this nonevent, including the overemphasis on Browning's expert status: "Browning was not a geologist nor a seismologist, he had no formal training in climatology, his doctorate was in zoology not physiology, he had not predicted the Loma Prieta earthquake, and what he called his 'projection' was based on a widely discredited theory" (p. 2). Major and Atwood's study (1997) focuses on the credibility not of Browning, but of the media both before and after the predicted date of the earthquake. These authors found that the public's trust in newspapers, but not radio and television, declined after the earthquake did not happen, reinforcing the idea that media channels impact the messages they disseminate.

While the above scholars focused more on media messages, others analyzed the ways in which citizens living near the New Madrid seismic zone interpreted and talked about the prediction. Krug (1993) illustrates how residents of an area decoded the intense news coverage leading up to the predicted day of the quake and how mediated stories about the quake were processed, received and retold in local contexts among community members where "messages of the media functioned as *rumors* which people struggled to contextualized in their lives as *stories*" (p. 274). Atwood (1994) similarly unpacks the ways in which people coped with the earthquake prediction and later revised their reactions to it. What's different about the Missouri

earthquake prediction from the prediction of the earthquake in the CSZ, though, is that it was predicted for a particular day, which resulted in frenzied and hyped media coverage in the same way one might expect to see coverage of a predicted "last day on earth" apocalyptic message. With the CSZ media messages, there is a lack of the same type of media coverage in part because a climatologist has not identified an apocalyptic doomsday with such specificity. As seismologist Susan Hough points out, "given the state of earthquake science at the present time, earthquakes are unpredictable" (Hough, 2009, p. 222), meaning that most experts would balk at predictions like Browning's.

While the above work does in fact focus on earthquake prediction, more scholarship on natural disasters and media coverage tends to focus on disasters in progress, particularly in the world of crisis communication. In looking at newspaper coverage of a 2014 month-long wildfire in Sweden, Öhman, Giritli Nygren and Olofsson (2016) illustrate the ways in which such crisis communication efforts were intractably embedded in discourses of power that present gendered "hero" language as well as power dynamics related to urban/rural dynamics. Other research in crisis communication point to problems in how information is distributed to the public. Parmer et al. (2016) illustrate this in their analysis of disaster messaging and how news coverage does or does not meet the established seven "best practices" for crisis communication. While the authors find that 87% of articles meet the criteria of "explaining what is known," the other six criteria, including criteria like "expressing empathy," are met much more infrequently. While such scholarship on disasters-in-progress tell us a lot about how crisis communication works in the media, it also illustrates that such communication is categorically different from news coverage that reports on a disaster predicted at an unknown time in the future.

In addition to scholarship on crisis communication and natural disasters, researchers attend to post-disaster coverage as well. In Houston, Pfefferbaum and Rosenholtz's (2012) work on news coverage of U.S. natural disasters between 2000–2010, they find that media coverage of natural disasters tends to decline more quickly than other topics in the news, indicating that once a disaster has passed it begins to fall behind in terms of its newsworthiness. Several scholars uncover the political biases in post-disaster coverage as well. In Cohen, Vijaykumar, Wray and Karamehic-Muratovic's (2008) research on newspaper coverage after Hurricane Katrina, they find that only a small number of articles in the five weeks after the hurricane provide information for the public on health risks related to the disaster. In other work on post-Katrina coverage, Davis and French (2008) illustrate how print media coverage of the aftermath constructed the identities of "victims" and "survivors" in a way that shifted blame to these individuals. Conversely, there are elements of narrative that implicate an earthquake as the "villain" when

compared to another disaster (Typhoon Morakot), as seen in Su's (2012) analysis of the tenth anniversary news coverage of the Taiwan 921 earthquake. Keshishian (1997) also offers a useful study on political bias in the news for nonpolitical events by looking at two different earthquakes. In this work, she finds that the *New York Times* and *Washington Post* tended to have more sympathetic coverage of an earthquake in the Soviet Union than with Iran, which mapped onto the U.S.'s political interests in the last 1980s-early 1990s. Petersen (2014) offers another comparative study that illustrates how Hurricane Katrina and the 2010 hurricane in Haiti both were implicated in issues of race and class in news coverage, but were covered differently through difference conceptions of "risk thinking." The insights provided by these authors highlight the ways in which post-disaster coverage becomes imbued with social and political messages, whether that's in terms of a decline in coverage or as reflections of geopolitical thinking. But given that such coverage interprets past events through these lenses, the extension of this work to coverage of prediction-based natural disasters is not particularly applicable in this study.

Overall, the research discussed here provides findings regarding how the news media covers natural disasters, but little of this work informs how scholars understand reporting on future disasters. The body of literature discussed above on the New Madrid earthquake prediction (Atwood, 1994; Krug, 1993; Major & Atwood, 1997; Showalter, 1995) provides a useful starting point, but as noted earlier, earthquakes predicted in the CSZ are not usefully analogous to the New Madrid prediction given the latter's doomsday-specificity that never materialized. Looking at newspaper and news magazine coverage of the CSZ and future earthquakes will allow scholars to get better insight into the ways in which more ambiguous but impending disasters are currently covered and how they might be covered in ways that propel more individual and public action that ensures more preparedness and safety for impacted populations. Contrasting newspaper and news magazine coverage of the CSZ to Schulz's piece will provide further insight into how coverage might heighten public awareness as well.

METHOD

In order to fill this gap in natural disaster communication research, I perform a multistepped thematic analysis to understand the differences between prior coverage of the CSZ with Schulz's piece. This dataset covered newspaper and newsmagazine coverage from 1987 (when the first major research on the CSZ was published) to July 19, 2015, the day prior to the print publication of Schulz's piece. Using ProQuest's News and Newspapers research database,

I located 846 newspaper articles that directly mention "Cascadia Subduction Zone" during these years from both national and regional outlets (it should be noted that some articles in this set were repeats published in different outlets). Given the breadth of this dataset, I first began with a cursory reading of this coverage of the CSZ to identify peaks and valleys and any trends in coverage that might be analyzed more closely. Primarily, newspaper coverage increased across multiple outlets when papers reported on either notable scholarly findings recently published on the CSZ or when there was an earthquake or tsunami that bred comparisons to the CSZ. Given that "the occurrence of a currently devastating earthquake elsewhere" functions as a prominent driver of newsworthiness with earthquakes (Turner, Nigg, & Paz, 1986, p. 417) and that such stories allow for more narrative and anecdotal evidence than newswriting on scientific research, Schulz's piece bears much more in common with the former given her own narrative style and her initial focus on the 2011 earthquake and tsunami in Japan. I therefore narrowed my dataset by looking at articles written within three months after major natural disasters and identified themes across the reporting. In doing so, I analyzed coverage of natural disasters most similar to the predicted earthquake and tsunami of the CSZ, meaning other earthquakes and tsunamis. Coverage of other types of natural disasters, like wildfires or tornados, resulted in no comparison to the CSZ so my analysis only includes the types of disasters mentioned earlier. It should be noted that newspaper coverage of other natural disasters may have mentioned the Pacific Coast and earthquakes more broadly—I, however, intentionally wanted news pieces that discussed the CSZ specifically since Schulz focuses on it in such detail. After analyzing prior coverage, I then proceeded to identify ways in which Schulz's piece functioned either similarly or differently. Lastly, I look at follow-up coverage from newspapers and newsmagazines after the publication of her piece to see if any new themes emerged in news coverage.

For news-magazine articles—the type of outlet the Schulz piece is found in—I identified fewer articles on the CSZ overall. ProQuest delivered only one result prior to the publication of the Schulz piece that was a literary essay about going to college. Searching both EBSCO News and Lexis Nexus resulted in a similar desert of magazine coverage. Given that news databases did not generate results on magazine coverage, I searched for coverage within publications themselves that either share some affinity with *The New Yorker* (news magazines) or are regionally-based in large cities near the CSZ (Seattle and Portland), including *Seattle Magazine*, *Seattle Met*, and *Portland Monthly*. Since there was so little published in magazines, I did not put parameters on my search other than searching "Cascadia Subduction Zone," so that I would not be limited to post-disaster coverage like with the news pieces. Overall, I located 11 news magazine articles on the CSZ specifically

prior to Schulz's piece that were written in 2001 or later (the year in which I first identify a spike in newspaper coverage after a natural disaster).

For my analysis of coverage after the publication of the Schulz piece, I located 33 unique newspaper articles published within three months of Schulz's piece that reference the *New Yorker* piece and the CSZ specifically. I also searched through the same magazine publications previously noted and located seven articles published within the three months after Schulz's piece as well.

FINDINGS: COVERAGE PRIOR TO "THE REALLY BIG ONE"

As noted earlier, prior to Schulz's publication of "The Really Big One," newspapers and magazines (along with textbooks and other public literature) had reported on the impending doom of a CSZ earthquake, particularly in the context of new scientific discoveries or analogous earthquakes. Earthquakes that occurred within the first decade after the 1987 scientific discoveries of the CSZ and its power resulted in the first instances of natural disaster comparisons to the CSZ, but they are rather minimal overall. There are minor mentions of the CSZ in coverage of the 1989 Loma Prieta quake, the 1992 and 1994 Eureka, CA quakes, the 1993 Oregon quake, and the 1995 quake in Mexico—and such minimal comparisons to the CSZ may likely be because of a few factors, including (a) that scientists did not yet fully understand the CSZ in the early to mid-nineties in the ways they would later and (b) the quakes did not take place in offshore subduction zones, making the comparisons less apt. The biggest spikes in coverage of the CSZ in U.S. newspapers revolved around the 2001 Nisqually earthquake in Washington State, the 2004 Indian Ocean earthquake and tsunami, and the 2011 Japanese earthquake and tsunami, and I therefore focus my analysis on news coverage of these three specific events and how they are connected to the CSZ. While the Washington Nisqually quake is thought to have occurred within a plate (rather than as a result of plate subduction), the proximity of the quake to the CSZ generated more inquiry by journalists into future disasters in the area. For the latter two disasters, their similarity to the CSZ was striking given that they were caused by the type of subduction that would be seen in the predicted mega-quake in the CSZ. Interestingly, the coverage of each of these three events shifted in terms of tone. For the Nisqually Quake, reporters sent mixed messages about the level of preparedness in the region as well as the potential causes for future quakes. After the Indian Ocean quake, journalists gained more confidence in the preparedness of the region, but this confidence subsided in 2011 with coverage of the quake and tsunami in Japan. For each event, I offer a

summation of some general trends in coverage with qualitative support from news articles written within three months of the disaster.

Washington State Nisqually Quake, 2001

When the West Coast of Washington State shook on February 28, 2001, newspapers quickly sounded the alarm on what that event meant for the region. This was the first major earthquake within the region that happened after the discovery of the CSZ and evidence of its last mega-quake in 1700.[1] Within the first three months after the Nisqually earthquake, West Coast papers (largely the *Seattle Times, Seattle PI, LA Times* and *The Oregonian*), large metro papers (*LA Times* and *Chicago Tribune*) and other regionals around the country (from papers in Florida to Nevada) ran a total of 31 articles on the Nisqually quake that mention the CSZ directly (other coverage of the quake focused on the extent of damage, personal stories or other news angles). This qualifies as the first initial spike in coverage of the CSZ following a natural disaster.

In some cases, journalists decided to focus on the minimal impact the earthquake had, suggesting that the region is well prepared in general. For example, an *Associated Press* article claimed, "But officials in Seattle said Wednesday that they have spent the past decade preparing for a big quake by making building codes stricter and the public more aware of the threat." The article goes on to report that then-mayor Paul Schell said, "I think the city has been very mindful of earthquake risks.… We have no catastrophic damage" (*Associated Press*, 2001, p. A1). The AP piece made no mention of the impending "big one," almost suggesting that the region survived the earthquake that it prepared for and no one should be concerned. A journalist from the *Chicago Tribune* noted that Washington State was not as well-prepared as California, but also pointed out that "Seattle has stepped up its earthquake preparedness since 1998, when the Federal Emergency Management Agency designated the city a 'Project Impact' community eligible for funds to improve disaster readiness" (Manier, 2001, p. 1.8). And while several journalists noted that many older buildings in Seattle and the surrounding area were damaged, some made sure to point out how "Many newer skyscrapers stood unscathed, suggesting that increasingly rigorous building codes in the Pacific Northwest are doing some good" (McFarling & Reich, 2001, p. A1). One *LA Times* journalist highlighted the confidence that local officials have in the region's capacity to handle a quake as well. In this piece, King County Executive Ron Sims is quoted saying: "'For an area that's as populated as we are, with an earthquake of this magnitude, we handled it incredibly well … Any other place with a magnitude of 6.8, there would have been far more damage, far more injuries'" (Murphy, 2001,

p. A1). And some journalists pointed to the conscientiousness of the public in supporting legislation for retrofitting: "Seattle voters decided in November to pay for a costly Harborview Medical Center retrofit aimed largely at quake impacts," suggesting the area's progressiveness in terms of preparedness (Connelly, 2001, p. A2). While many of these journalists reported on the confidence of local officials, the stories nonetheless communicate an assurance to the public that they should not be overly concerned.

Other journalists, though, attempted to warn the public of future quakes by emphasizing how much more significant the "big one" will be than the Nisqually quake. For example, in an article from the *Columbian*—a regional paper in Southwest Washington—one journalist emphasized how the future CSZ quake would be the "truly" big one (in contrast to the Nisqually quake): "The strain in the Cascadia zone will continue to build, scientists believe, until an earthquake unleashes the stress in one powerful jerk—a quake that would truly be the Big One" (Robinson, 2001, p. A5). Others, like a *Seattle Times* reporter, compared the Nisqually quake to the "big one" in a way that illustrates how minor the 2001quake actually was in quantitative terms: "The movement [of the plates] appears to be increasing the pressure at the Cascadia subduction zone, the fault boundary that every 500 years or so brings the Northwest's 'Big One'—an earthquake about 100 times greater than the Nisqually quake" (Sorenson, 2001, p. A1). Other journalists went on to emphasize this fact, often with an apocalyptic tone. One reporter from *The Oregonian* painted the future event as one of epic proportions for U.S. history: "Scientists think the zone is capable of quakes that could cause a disaster unparalleled in U.S. history" (Hunsberger, 2001, p. A01). To further dramatize the impact of the quake, another reporter from the *Seattle Post-Intelligencer* placed it on a more cosmic scale, almost positioning it as part of the destruction of the entire earth. "This plate subduction is capable of producing the planet's most destructive quakes" (Paulson, 2001, p. B1). While the coverage of the Nisqually quake assured the public of the region's preparedness, it also offered these warnings about the "big one" in more dramatic terms.

That said, some of this emphasis on the severity of the impending "big one" may have been muted by confusion over the cause of the Nisqually quake. Some reporters highlighted how the quake offered a confusing data point to researchers. One reporter for the *San Francisco Chronicle* noted how researchers "are puzzled about why the damage was so limited for a quake with a magnitude of 6.8, and there are still major gaps in their understanding of the quake's mechanisms" (Perlman, 2001, p. A7). Another reporter for the *Seattle Times* quoted a research scientist offering his honesty about uncertainty surrounding the CSZ: "We don't know when. We don't know how many of these it'll take. We don't know what the current stress level is—how close we are to that rupture" (Sorenson, 2001, p. A1). Reporters also

highlighted other threats to the area besides the slab-quake experienced with the Nisqually quake. Many go on to mention the Seattle fault as being particularly dangerous and others draw connections to the mega-quake predicted in the offshore CSZ region, neither of which were the direct cause of the Nisqually quake. A few journalists point to three different sources of concern—shaking within a plate, subduction and the Seattle fault—in the way this *LA Times* reporter did: "Deep quakes like the one on Wednesday come from shaking within the de Fuca plate, as opposed to a sudden shift of the plates moving against each other. In addition to those two types of quakes, a third source of quakes in the region comes from the Seattle Fault, described by geologists as a sort of logjam produced by the North American plate" (Manier, 2001, p. 1.8). Others focused specifically on concern about the Seattle fault, perhaps minimizing the public's awareness of risk associated with the CSZ. As one *LA Times reporter* wrote: "It would have been much more devastating had it occurred on the well-known Seattle Fault, which runs directly under the center of downtown and for 15 miles in each direction" (Murphy, 2001, p. A1). And even the local *Seattle Post-Intelligencer* muddied the waters when they ran a story with the following headline: "Feb. 28 [was] only a warm-up—the 'big one' on the Seattle fault still awaits us, scientists at conference say" (Paulson, 2001, p. B1). While the Seattle fault is indeed a site of concern, the attribution of the "big one" to this fault rather than the CSZ confuses the point further. By showing scientists' confusion regarding both the Nisqually quake and the impending subduction quake in tandem with pointing to multiple sites of concern for earthquakes in the region, the message to the public may have created more confusion and apathy than anything else.

Overall, the Nisqually Quake was the first quake that brought to life the impending doom of the CSZ. With minimal comparisons in the news between the CSZ and earthquakes prior to the Nisqually Quake, this event became the first moment where journalists analogized the impending quake with a real one. In general, though, the coverage of regional preparedness seemed to suggest that the region is by and large well prepared. And while coverage drew attention to the impending "big one" of the CSZ, the reporting on multiple faults and types of quakes in the area as well as reporting on the confusion of scientists may have minimized the urgency with which the region needs to better prepare.

Indian Ocean, 2004

Three years later on December 26, 2004, a devastating 9.3 earthquake occurred as a result of the India Plate subducting against the Burma plate in the Indian Ocean, causing over 230,000 deaths. While the Nisqually quake

may have yielded a spike in coverage in large part due to its proximity to the CSZ, the Indian Ocean quake and tsunami generated a spike as well with 20 unique news articles from both regional and national outlets within three months following the event, likely due to the similarity between the CSZ and the Sumatran Subduction Zone. Journalists made connections to the CSZ in regional papers, including *The Columbian* (Vancouver, WA)*, News Tribune* (Tacoma, WA), *The Oregonian* (Portland, OR), *The Register-Guard* (Eugene, OR), *Sacramento Bee* (Sacramento, CA), *The San Francisco Chronicle* (San Francisco, CA), *The Seattle Post Intelligencer* (Seattle, WA), and *The Statesman Journal* (Salem, OR), meaning the vast majority of coverage reached only readers in Washington, Oregon and northern California via regional dailies. Only two nonregional papers—the *New York Times* and the *LA Times*—ran pieces connecting the CSZ to the Indian Ocean quake (one article each). As is shown below, journalists tended to focus on the similarity of the CSZ and Indian Ocean regions in terms of seismic threat as well as differences between the region that subtly invoked a nationalist message regarding preparedness and safety.

One of the first themes that emerged from the coverage of the Indonesian disaster is confidence that a massive earthquake is due in the CSZ. Many articles mention how scientists determined the last major earthquake in this region was in January of 1700. Journalists continue to indicate that another earthquake is assuredly due, but they often do so in a way that asks the readers to do the math regarding when the next one might be. For example, one author focuses on the interval of years between earthquakes: "Scientists say the interval between such events ranges between 200 and 1,000 years" (Robinson, 2004, p. A1). As does another: "Based on soil samples, scientists believe the fault zone last ruptured in 1700 with an earthquake of roughly 9.0 magnitude, and quakes of such size are most likely every 300 to 500 years" (Vogel, 2004, p. A12). In both cases, the journalists do not go on to extrapolate on how likely this event is in the near future; rather they leave such numerical connections in the hands of the reader in a way that appears to minimize alarm and cause for concern. The use of statistics and probability here distances the reader from the impact of the event as well since such numbers carry no personal narrative. The threat is real and analogous to the Indian Ocean quake, but it's also distant and depersonalized. Some journalists take this certainty in a different direction, however, underscoring the inevitable death and destruction of the quake: "It will happen again, and it may happen soon. Hundreds, if not thousands, of people could die" (Ross, 2005, p. A14). Across the board, though, journalists connecting the Indian Ocean quake and the predicted quake of the CSZ communicated a high level of confidence in this quake happening, perhaps in the readers' own lifetimes.

In addition to the statistical certainty that the Pacific Northwest is due for a mega-earthquake, journalists also drew strong parallels between the Indian Ocean quake and quakes of the CSZ. Some journalists focused on the similarity between the quake of 1700 and that of 2004 Indian Ocean by drawing on the expertise of researchers. Brian Atwater, one of the most commonly cited and interviewed geologists regarding the CSZ, was noted for pointing out the strong resemblance between the events: "Sunday's quake in the Indian Ocean bore an 'uncanny resemblance' to the temblor that struck the Northwest 304 years ago" (Robinson, 2004, p. A1). Whereas other journalists emphasized what seismologists understand about an impending tsunami of the same degree: "An earthquake about as strong as last week's struck Cascadia in 1700, sending tsunamis across the Pacific. Seismologists foresee a repeat. The question is, When?" (Chang, 2005, p. F1). While these journalists made comparisons to the past, others emphasized that the Indian Ocean natural disaster reflected what will likely happen in the CSZ in the future. One journalist for *The Columbian* offered a direct comparison from geologist George Priest: "The Indonesian tsunami is very similar, and likely a direct analog of what we could expect on the West Coast," (McCall, 2005, p. C2). Another journalist from the *Seattle PI* called the two regions "alarmingly similar" with their "same tectonic situation" (Paulson, 2005, p. A1) while a third from *The Oregonian* described the CSZ as "nearly a twin" to the subduction zone in the Indian Ocean (Hill, 2005, p. A01). Writing in Eugene, Oregon's *Register-Guard*, one journalist emphasized how alike the two coasts are to one another, writing: " … none matches Oregon's [coastline] more closely than that of Sumatra Island" as he described the similar subduction zones and their distance from local coastlines (Ross, 2005, p. A14). For these journalists, the similarities of what just happened in South Asia and what will happen in the Pacific Northwest are uncanny. The destruction from the Indian Ocean quake and tsunami seen across TVs in the United States could be a reality for many West Coast residents.

Even with these comparisons, though, some journalists still stressed dissimilarities of the CSZ, most notably the two writing for nonregional papers (*New York Times* and *LA Times*). The journalist from the *LA Times* minimized the threat specifically, "A similar disaster is unlikely but still possible along the West Coast, experts say" (Vogel, 2004, p. A12). Most strikingly, many of the journalists that stressed dissimilarities largely focused on the level of preparedness in the Pacific Northwest in contrast to the impacted countries of the Indian Ocean earthquake. Journalists seemed ready to reassure readers that while a similar kind of quake could happen, the Pacific Coast is not like the regions impacted in the Indian Ocean. In the same *LA Times* article noted above, the journalist goes on to write: "Unlike the Indian Ocean area, an early warning system protects the Pacific Coast" (Vogel, 2004, p. A12).

And that same form of comparison is evident in the *New York Times* article as well: "There are warning systems in the Pacific and plans up and down the coast to cope with such a disaster, which is a situation far different from that on the shores of the Indian Ocean" (Chang, 2005, p. C2). In an interesting move, both journalists here placed a heavy burden on these systems to "protect" us and "cope" with the disaster on the United States's behalf, effectively minimizing the public's need to improve such systems or protect themselves.

Efforts to contrast the two regions presents in regional papers as well. Only two days after the event, Southwest Washington's *Columbian* ran an article indicating that it's "only a matter of time" before something similar happens on the West Coast, but the journalist went on to report on the extent of tsunami-readiness in the region, indicating that some towns were well-prepared while others needed retrofitting and redesign (Robinson, 2004, p. A1). One journalist for the *Columbian* emphasized all aspects of the warning system that makes Oregon particularly well prepared: "Oregon has already taken a number of tsunami preparedness steps. Sirens, radio alerts, NASA imaging, mid-ocean buoys, signs, topographical maps, Web sites and educational programs are already in place" (Sullivan, 2005, p. C3). Some journalists went beyond just mentioning the early warning system, to detailing it with technical language that assured the reader of how much more advanced the United States is than South Asia:

> In the Pacific Northwest, scientists say a new system of offshore buoys and seafloor sensors should provide two to three hours of warning in the case of a tsunami as distant as the one generated off Alaska's shore. Real-time data from the new buoys are transmitted to 24-hour tsunami warning centers, one in Alaska and one in Hawaii, operated by the National Oceanic and Atmospheric Administration. (Robinson, 2004, p. A1)

Others relied on expert testimony to prove local readiness as in the *Columbian*'s use of Oregon's Department of Geology James Reddy's words: "The good news for Oregon and the Pacific Northwest is that we are much better prepared than the countries around the Indian Ocean to respond to an event like this" (McCall, 2005, p. C2). Some experts quoted even use a paternalistic tone in talking about Indonesia, as is the case in a *Statesman Journal* article that quoted an emergency management coordinator saying: "I certainly feel terrible that they didn't have a warning system in place." He followed-up by emphasizing the useful buoys of Pacific Northwest's detection system: "There has to be so much more work that just identifying that there has been a big earthquake. The buoys help us to pinpoint the general sense of direction and maybe the size of the tsunami, and then there is a way to communicate" (Caspar, 2004, p. A5). While some journalists pointed out

that these systems need modernizing (Vogel, 2004, p. A12), others guarantee that such technology is already being updated: "Federal and state scientists are working to upgrade tsunami detection and warning systems for the West Coast," (Adam, 2005, p. B01), assuring the public that any concerns they have about the system are being addressed. And other journalists characterized the Indian Ocean region as much more chaotic than the U.S.'s West Coast, making it seem less prepared: "But chaos reigns in Sumatra, where a civil war and suspicion of outsiders have combined with the tsunami's own havoc to make sending a team of scientists to the region problematic" (Ross, 2005, p. A14). While the two subduction zones and coastal areas are largely similar, journalists largely attempt to minimize these similarities by contrasting the levels of preparedness of the two regions.

One overall message of coverage of the Indian Ocean earthquake is: yes, it is similar to the predicted CSZ earthquake in the sense that both are within dangerous subduction zones, the coastlines are similar geographically and both are prone to devastating tsunamis. But, according to newspaper coverage, the Pacific Coast region is overwhelming different given how prepared it is. And while some journalists do in fact offer evidence that the early warning system is far from perfect, the comparison still stands—the Pacific Coast has one and the Indian Ocean doesn't. In such messaging there are elements of a nationalistic narrative that positions the United States as superior and better off. The text of such articles seems to suggest that U.S. innovation in science and technology will ultimately allow it to triumph over nature, unlike "less developed" regions of the world. What this coverage neglects to emphasize, though, is that earthquakes have no regard for peoples and nations of any stripe. The messaging here gives the public a false sense of security because of the warning system—it's out there and presumably will do its job. The coverage in this sense implies that the public understands how it works and its degree of accuracy, minimizing the apparent need for further public policy and preparedness funding and ultimately putting the American public at more risk than they realize.

Japan, 2011

In March of 2011, when Japan experienced a 9.1 earthquake and devastating tsunami, media coverage of the CSZ became more alarmist. Some of this likely goes in tandem with advances in scientific research on the CSZ—with scientists offering more studies and data, news reporters can report with more confidence as well. The direct mentions of the CSZ increased to 45 articles (as compared to 20 with the Indian Ocean quake), the highest amount of coverage to date that connects the CSZ to another natural disaster. News articles again primarily occurred in regional outlets, including *The Columbian*

(Vancouver, WA), *The Herald* (Everett, WA), The *News Tribune* (Tacoma, WA), *The Oregonian* (Portland, OR), *The Register—Guard* (Eugene, OR), *The Statesman Journal* (Salem, OR), *The Tri-City Herald* (Tri-Cities, WA), *The Seattle Post Intelligencer* (Seattle, WA), and *The Seattle Times* (Seattle, WA). Other outlets around the country mentioned the CSZ as the most analogous region in the United States, but often in a cursory way. Largely, the reporting tended to emphasize the lack of preparedness on the Pacific coast, an interesting contrast to the assuredness of preparedness seen in coverage of the Indian Ocean quake and tsunami.

In contrast to prior coverage of the CSZ, journalists began to spell out more explicitly how overdue the region was in starker terms, calling the quake in Japan "a mirror image of the tectonic rupture that occurred along the Northwest coastline 311 years ago" (Robinson & Bucks, 2011, p. A3). The region is "overdue for a date with disaster" (Guson, 2011, p. A1) and "coastal cities face a very similar disaster in their future" (Oregon State University, 2011b, para. 11). The direct language journalists used in their writing here brings more attention to the severity of the impending disaster, somewhat similar to the alarmist tone seen in the Schulz piece.

Perhaps most interestingly, many journalists tended to draw attention to how underprepared the United States is in comparison to Japan, an interesting point of contrast to the narrative of preparedness found in the coverage of the Indian Ocean earthquake and of the Nisqually quake. In an Oregon State University news release, the university notes how thoroughly prepared Japan is for this type of disaster: "Their technology, building codes, public education and other programs for earthquake preparation are exemplary, with scientific initiatives that date back to the 1890s" (Oregon State University, 2011b, para. 8), which is striking given how severe the disaster was nonetheless. Quoting Oregon State University emeritus geology professor Robert Yeats, one journalist for a Eugene, OR paper wrote, "What you are seeing in Japan today is what you will also see in our future. Except they are better prepared than we are" (Palmer, 2011, p. A9). In another piece from Oregon, the journalist pointed out how aware policy makers were of the weaknesses of the region: "The Senate leader [Peter Courtney] told the *Statesman Journal* last week that Oregon is 'woefully unprepared' for a big quake," citing vulnerabilities such as "half of Oregon K–12 schools are at risk of collapse," "an estimated 1,000 bridges along Oregon highways may fail," and "nearly a dozen coastal communities are within tsunami inundation zones," some of which "have no easy escape to high ground" (Guson, 2011, p. A1). The contrast to Japan is grim with such language—given the number of deaths with their earthquake and tsunami, the emphasis on the United States's underpreparedness paints a bleak picture of how the northwest region will survive.

Nonetheless, some reporters showed that measures were still being taken in the Pacific Northwest region after the disaster in Japan to improve The United States's inferior levels of preparedness. For the *Seattle PI*, one reporter offered evidence that city and state officials were considered upgrading the existing earthquake warning system "similar to one in place in Japan" (Rolph, 2011, para. 2) to provide earlier detection for both earthquakes and tsunamis. In a *Christian Science Monitor* piece, the journalist pointed out existing warning systems in the Pacific Ocean, but qualified them with a comparison to Japan's: "The Pacific Northwest is dotted with tsunami warning devices that could give people the critical few minutes needed to reach higher ground. But in many areas, building codes and construction have not advanced to the extent they have in Japan" (Knickerbocker, 2011, para. 7). What was a cause for celebration in the coverage of the Indian Ocean quake and tsunami turns to a source of embarrassment when compared to Japan.

And even with the United States's lack of preparedness, the political will to make necessary changes to prepare the public are noted by journalists to be minimal. In another news release by Oregon State University, former Cannon Beach mayor Jay Raskin is quoted saying: "'As a country, we have the resources and the expertise, but so far not the motivation to properly prepare,'" (Oregon State University, 2011a, para. 17). Perhaps because of this, other journalists also tended to place more burden on members of the public to be prepared and take care of themselves given what they identify as a lack of preparedness on a municipal level. Althea Rizzo—an emergency management organizer in Oregon—is quoted in one article saying, "It's so important that the individual take responsibility for their own safety, because first responders are going to be overwhelmed.... You can make decisions ahead of time whether you're going to be a victim or an asset" (Palmer, 2011, p. A9). Some journalists noted local officials asking the public to get "your earthquake supply kit ready" (Robinson and Bucks, 2011, p. A3), further indicating a lack of systematic preparedness in the region. A journalist for Salem, Oregon's *Statesman Journal* reported on a local event where members of the public "will receive pamphlets outlining how they should prepare for an earthquake or tsunami and what to do when they strike" (Anonymous, 2011, para. 14), again emphasizing that the public should not count on the state—whether in terms of preventative infrastructure design or emergency management—to solve this problem. While the responsibility placed on the individual is important no matter how prepared a country or region is for disaster, the focus on individual burden in these pieces underscores a lack of political will to address the United States's underpreparedness on a systematic level. Underpreparedness in South Asia during the Indian Ocean is characterized as chaotic and backward; but underpreparedness is the United States is an invitation to exercise individual liberties to protect oneself.

Overall, the coverage of Japan reclaimed some of the alarm seen in coverage of the Nisqually quake but did so by underscoring the lack of preparedness in the region in contrast to Japan. The comparisons between the CSZ and Japan look different than the coverage of the Indian Ocean—as noted earlier, the Pacific Coast was a symbol of preparedness in 2004; in comparison to Japan, however, according to this coverage the United States is woefully underprepared. This contrast underscores a journalistic preference to dismiss the global South (as seen with the Indian Ocean quake) and celebrate northern countries with advanced technological systems. In the case of comparisons to Japan, though, the messaging becomes less nationalistic because Japan's preparedness far exceeds that of the United States.

MAGAZINE COVERAGE

It would be neglectful in this study to ignore prior coverage of the CSZ in magazines since the *New Yorker* falls into this category of publication. The fact is, though, that very little attention has been paid to the CSZ in magazines both generally as well as surrounding the three earthquakes that generated spikes in newspaper coverage prior to Schulz's piece. The following news magazines, selected for their affinity to the *New Yorker*, contained a rather low number of articles:

- *The Atlantic*, 0 articles
- *The Economist*, 2 articles
- *National Geographic*, 2 articles
- *Newsweek*, 1 article
- *The New Yorker*, 0 articles
- *Time Magazine*, 2 articles
- *Vanity Fair*, 0 articles

For the three regional magazines near the CSZ there was just as little coverage:

- *Portland Monthly*, 3 articles
- *Seattle Magazine*, 0 articles
- *Seattle Met*, 1 article

Within this small dataset, most coverage of the CSZ is rather minimal. It's also interesting to note that most of these magazines published pieces about the CSZ not long after Schulz's piece came out. Two pieces from *Time*

magazine and one from *Portland Monthly* provide the most detail on the CSZ so my analysis attends to those articles specifically.[2]

In response to the devastating Indonesian tsunami in late 2004, *Time* published a couple of brief feature pieces analogizing the event to what *could* happen in the CSZ. In the first piece, the journalist devoted only one paragraph to the CSZ and spent the remainder of the article highlighting other regions in the United States that are vulnerable as well. The expert testimony she cites here highlights a similarly ominous message that emphasizes the grave certainty of the quake that Schulz explicates in "The Really Big One." Quoting tsunami modeler Vasily Titov saying "'It's not a question of if but when'" (Nash, 2005b, para. 2), Nash in her first *Time* piece on the CSZ instills alarm in the reader with such a shocking statement. In spite of this warning though, the minor attention to the CSZ throughout the piece as well as her conclusion minimized the threat significantly. Nash goes on to highlight the tsunami-warning system in the Pacific used by 26 countries that is being updated with new detectors. Somewhat similar, a second article *Time* ran one week later (Nash, 2005a) starts with an ominous title: "An American Tsunami" might seem to invoke some of more the fear-driven excitement surrounding Schulz's piece. But the kicker begins with "there's no cause for panic," sending an oppositional message to the headline. While the CSZ is noted to be "remarkably similar to the subterranean system that triggered the tsunami in the Indian Ocean," Nash makes sure to point out "some key differences: a tsunami warning system, better housing construction and a more rugged and less populous coastline" and reassures readers that "the death toll from a tsunami in the Pacific Northwest might be in the hundreds but not in the tens of thousands" (Nash, 2005a, p. 26). Several graphics indicate that the area is well-prepared for such an event, highlighting the "26-nation network of seismic, tidal and sea-level monitors," a pressure recorder at the bottom of the sea that "can detect minute changes in water pressure caused by a passing tsunami as small as 0.4 in. (1 cm)," and a communications buoy that would help alert the public (p. 26). Even when highlighting the possible impact on the Pacific Northwest with a detailed map, such details take a truncated and muted form in contrast to the Schulz piece. In noting the possible tsunami, Nash writes, "If a Cascadia quake were large enough, it could drive a wall of water toward Seattle and Vancouver. The Puget Basin has its own network of faults fully capable of generating large earthquakes and tsunamis" (p. 27). There is also a small cut-away of the map highlighting areas that might experience flooding up 16.4 feet from a 7.3 quake, but the graphics are given little context and position the event as something the reader understands on a distant bird's eye level, rather than on a level where they might envision themselves and their homes as part of the disaster.

In 2014, *Portland Monthly*—a more likely candidate to publish a popular piece on the local CSZ—created a survival guide for the impending destruction of the CSZ quake. Journalist Randy Gragg paints a more perilous picture than Nash in the *Time* articles, recalling some of the doomsday language from newspaper coverage of the CSZ. He writes: "If our next 'subduction zone' quake unleashes its full potential, it will be the worst natural disaster in US history" (Gragg, 2014). The piece's major focus is really on what will be impacted, what has been done to help, and what should be done. There's a mix of emphasis on existing preparedness and a need for more along with a focus on individual agency to increase preparedness with things like food, transportation and more. Within the text are humorous quips that lighten the gravity of this situation and make the event seem more like a hipster adventure than the "worst natural disaster in US history" that he mentions earlier. For example, in discussing the limits to transportation, Gragg (2014) suggests, "Get some bikes. Fuel might be tight for days, even months. You'll need to get around. And what's more fun than family bike rides? We won't have Netflix for a while." Or in discussing how people will communicate, the journalist jokingly suggests: "Smoke signals! Kidding. Well, maybe." And in offering a list of what people should include in a survival kit, Gragg (2014) writes: "Get ready for your most rustic staycation ever!" While the piece in general offers a detailed account of how lives will be impacted and what needs to be done both personally and politically to better prepare, the sprinkling of humor throughout the piece shift the topic from one that calls for urgent sobriety to a scary-but-hipster-friendly choose-your-own-adventure. In looking at the recent natural disasters of Hurricanes Harvey and Irma, public officials predict multiyear cleanup effort, such humor appears out-of-touch when thinking about the similar time for cleanup and recovery the Pacific Northwest will have.

In the case of *Time*, the articles follow along with the newsworthiness of the Indian Ocean earthquake in order to make relevant comparisons to readers. Gragg's (2014) piece, on the other hand, might seem to be closer in line with Schulz's given that a natural disaster didn't precipitate the writing. Gragg's (2014) introduction of humor makes his prose more of the literary quality that might be expected in outlets akin to the *New Yorker*. However, the pieces in *Time* and *Portland Monthly* all manage to minimize the gravity of the impending quake in ways that make it seem less threatening than many scientists believe it to be. In either case, the writing in these two outlets didn't strike panic into the public in the same way Schulz did, nor did they trigger much follow-up coverage.

SHIFTING GENRE

The generic expectations, especially for an outlet like the *New Yorker,* which publishes all varieties of poetry and prose, are much more open than they are for, say, a news piece in a national or local paper. As previously noted, the magazines analyzed featured the CSZ, but in ways that either conformed to patterns found in newspaper coverage or that minimized the severity of the situation. What Schulz accomplishes is the creation of what Jasinski refers to a "generic hybrid" (2001). While drawing on the form of prior texts in terms of scientific reporting, she moves the text to a place where the audience isn't simply given information but is brought into a drama.

One of the first markers of this difference is Schulz's use of narrative. Schulz's winning of a Pulitzer Prize for this piece in April 2016 affirms her keen use of language and storytelling. As one reviewer put it, "Instead of trying to explain in the abstract the seismology of the Cascadia Subduction Zone, Schulz walked her readers through the nitty-gritty" (Wemple, 2016, para. 4). The space for narrative writing in an outlet like *The New Yorker* allowed Schulz to tell the story in ways that much news coverage could not based on generic conventions. Additionally, her platform in this particular outlet gave her a national stage and audience, something much different from prior CSZ news coverage primarily generated in regional dailies.

Krug provides some useful language for thinking about narrative in news coverage when he highlights how the media covered the earthquake prediction in Missouri in the 1990s. One preexisting narrative structure he identifies is "filmic constructions, such as seen in the movie, *Earthquake*" (1993, p. 275), which Krug argues ultimately oversensationalized a story that ended up being a nonevent. In the case of Schulz's piece, though, the CSZ earthquake is not being locally monitored by multiple outlets on a short timeline; instead, it's an event that has been predicted for decades through updates in scientific research and has haphazardly been covered in relation to other natural disasters. The filmic narrative here functions differently than in the way Krug discusses in his piece. Rather than "finding new ways to sensationalize the story of quake prediction" (Krug, 1993, p. 276), Schulz's filmic narrative is alarmist in a more necessary direction. This lens maps more clearly onto Vincent Campbell's identification of the use of "factual entertainment" as a means to frame natural disasters (2014). In discussing factual entertainment, Campbell notes that such texts involve "a move away from traditional modes of documentary exposition toward more entertainment-oriented topics, styles and formats" (2014, p. 60). While Campbell's work focuses specifically on television as a medium for this type of factual entertainment, Schulz's literary

acumen pushes her writing into a genre that can qualify as factual entertainment as well.

With the lack of preparedness in the CSZ regions in spite of strong scientific evidence of how disastrous this quake will be, a narrative that jolts the public more into a state of listening is required for public safety. Schulz accomplishes this in a couple of ways. First, her language allows for more vivid visualization of what this earthquake might look like, particularly through her use of metaphor and personification that move beyond projected numerical impacts to where inanimate objects take center stage as actors in the drama. And, in a sense, she's accurate in framing the story this way. When she writes, "Refrigerators will walk out of kitchens, unplugging themselves and toppling over," (Schulz, 2015, para. 30) she brings to life the most mundane of objects and transforms them into characters. Similarly, the tsunami isn't simply a 45-foot wave of water; instead, "it will be a five-story deluge of pickup trucks and doorframes and cinder blocks and fishing boats and utility poles and everything else that once constituted the coastal towns of the Pacific Northwest" (Schulz, 2015, para. 36). In many ways, the people of the Pacific Northwest will take second stage to the forms and objects of destruction that will dominate the story.

Second, her piece hybridizes the genres of feature story and opinion, making it markedly different from other coverage. As seen above, news coverage on the CSZ tends to be driven by analogous disasters. For Schulz, moving away from the news genre to one that allows for more in-depth illustration as well as a policy position on the need for earthquake preparedness allowed her to capture the attention of readers in ways that previous writers had not. She does so near the end of her piece by highlighting the three public schools in Seaside, OR that will be gravely impacted by the CSZ tsunami. When the superintendent put up a bond to build a new campus outside of the inundation zone, the measure failed. She writes, "At present, all Dougherty can do is make sure that his students know how to evacuate" (Schulz, 2015, para. 43). With such a clear plea for better policy and building design, Schulz's piece again relates to Campbell's observations about factual entertainment television programs that "blend traditional documentary with other genres producing new, and oft-criticized hybrid formats … " (Campbell, p. 60). While Schulz provides a written piece on natural disaster, her break in genre functions in a similar way in that it is not simply reporting to the public what researchers know, but it acts to grip them and call them to action as well. By using such vivid illustrations and examples that draw readers from abstract numbers to real situations that deal with schools and people, her works becomes nearly filmic in its style—something a news reporter is unable to do given the generic conventions of news writing.

FINDINGS: AFTER "THE REALLY BIG ONE"

Within the first three months after Schulz's publication (between July 2015 and October 2015), several news outlets published different pieces that labeled themselves as a follow-up to Schulz's piece in some way. Regarding newspaper articles, 33 pieces were published in this time frame that directly reference both the CSZ and Schulz's article, the vast majority of which came from outlets in Oregon (20 articles).

Many of the news articles, while admitting the inevitability of the quake, attempted to temper hysteria surrounding the Schulz's piece, often with a focus on her quotation from a FEMA official who said that " 'everything west of Interstate 5 will be toast'" (Schulz, 2015, para. 13). One writer for Spokane, WA's *Spokesman Review* claimed that for Washington at least, "It almost certainly won't be as devastating as portrayed in the article" (Camden, 2015, A1). In Centralia, Washington, the *Chronicle* ran a story on a local dam that featured Timothy Walsh, the state's chief geologist with the Department of Natural Resources. Regarding earthquakes in the region, the article paraphrases him saying something similar:

> In fact, he said, if an earthquake of the entire Cascadia Subduction Zone were to occur, Washington wouldn't be as affected as the two states south of it. He also said that the Pacific Northwest isn't overdue for an earthquake of the entire zone … The timeline for the potential magnitude-9.0 earthquake in the July 20 *New Yorker* article, "The Really Big One," was misleading, he said. (Osowski, 2015)

A journalist for the *Christian Science Monitor* wrote an article confirming the level of catastrophe in the CSZ region, but also reported on all of the efforts that have been underway through the Federal Emergency Management Agency (FEMA) to protect the region and help with preparedness prior to the publication of Schulz's work (Gitau, 2015). The *Seattle Times* as well published a handful of articles that carried an almost defensive tone as if to say, "we already told you everything Schulz said." For example, on the heels of the Schulz piece, the *Times* staff issued a piece highlight the work of reporter Sandi Doughton, who has long covered the CSZ, claiming that because of her writing the Schulz piece "shouldn't surprise *Seattle Times* readers" ("If you think," 2015, para. 3). Doughton then proceeded to participate in the reddit "ask me anything" forum held soon after the Schulz piece circulated, perhaps in an attempt to reclaim her authority on the topic.

Other pieces capitalized on the news hook of the lack of preparedness of the region. In Oregon State University's *The Barometer* (a university that is known for extensive research on the CSZ), the reporter underscored how

"Oregon has a lot to do to be prepared for a natural disaster of this magnitude" (Free, 2015), highlighting buildings on campus, older parts of Corvallis and bridges as possible sites of disaster. She also highlighted the Cascadia Lifeline Program that is working to increase preparedness in the region as well as recent pieces of legislation in Oregon that will help. Oregon seems to be particularly challenged in this respect—some journalists noted how funding for preparedness is increasing in the region, but "the state would need 280 more sensor sites" in an early detection system to be as equipped as neighbors Washington and California (Dietz, 2015, p. B11). Several op-eds and staff editorials attempted to offer serious confirmation of the impending disaster along with a plea for better preparedness. The *Mail Tribune* of Medford, OR minced no words in writing: "The destruction will be worse than any natural disaster in the history of this continent, scientists say, and we are woefully unprepared" ("We are not ready," 2015, para. 6). The *Seattle Times* naturally was called to speak on the issue given how much of its population would be impacted by the earthquake according the Schulz. In an editorial, the paper pointed out how widely the CSZ had been reported on prior to Schulz's "The Really Big One," indicating that the area has long known what to do but has lacked public interest. With the pandemonium surrounding the Schulz piece, the paper took the opportunity be specific and direct with calls to action on preparedness. Creating individual emergency kits is a start, but the *Times* calls for support for a new seismic warning system, asserting that "Congress should pony up the money for the U.S. Geological Survey" to do so ("Support efforts," 2015b). One writer for the *Columbian*, after expressing fear about all that Schulz outlined, identifies all of the preparedness measures that need to be taken but are not due to public complacency:

> In specific terms, this speaks to the Northwest's lack of an early warning system, the kind that detects compressional waves at the fault line and automatically shuts down railroads and power plants, opens elevator and firehouse doors, and triggers alarms. It speaks to the poor job the region has done of establishing seismic standards for construction, of bolting homes to their foundations, of pondering the imponderable. (Jayne, 2015, p. C6)

While some journalists may have found the Schulz piece too sensational, there nonetheless was widespread agreement in news coverage that more work needs to be done in terms of preparedness for the safety of the public.

Aside from papers confirming Schulz's piece or calling cities to action, journalists also reported on increases in individual and group actions as well. One reporter for the *Register—Guard* in Eugene, Oregon noted that "The article has garnered a great deal of attention in Oregon and beyond, which makes this a good time for emergency officials to get their message

out" (Aleshire, 2015, p. A3). Some towns held events in response to the article. Chris Goldfinger, one of Oregon State University's leading researchers on the CSZ, held an event following the piece at the Corvallis Science Pub (Oregon State University, 2015). Eugene, Oregon's *Register—Guard* likewise reported on how much public interested Schulz's piece has generated, resulted in "hundreds of residents" turning out for a forum on earthquakes at the University of Oregon (Hill, 2015, A3). Later in September, the paper also reported on a publicly-open roundtable held by U.S. Representative Peter DeFazio—a longtime champion of earthquake preparedness in the region—in direct response to public concern about the article (Hubbard, 2015, p. B13). One journalist in Salem, Oregon's *Statesman Journal* focused specifically on how businesses were becoming better prepared in response to the article as well: "Businesses are taking note of the dangers laid out in a *New Yorker* article about the impending earthquake and are taking action" (Southward, 2015, p. A3) and one of the efforts to do so was the creation of a coalition of businesses and emergency planners in the region to better prepare the area. A second *Statesman* reporter attended to public action as well, again attributing it to Schulz's piece: "The high attendance [of a safety preparedness event at the Capitol building] was attributed in part to an article recently published in the *New Yorker* magazine titled 'The Really Big One,'" which the journalist notes got people talking more about the issue than they had before (Roemeling, 2015, p. 4). Some journalists focused on individual action as well, reporting that earthquake survival kit sales were at an all-time high for one company (Lacitis, 2015). Not long after the publication of Schulz's piece, one reporter in Oregon also pointed to the spike in home earthquake retrofitting (Hill, 2015, p. A1). One particular owner of a retrofitting company attributes the increase in business to the Schulz article specifically. Typically his company receives a couple requests for home retrofitting per month, but since the article he "has received more than 100 requests for seismic retrofit in the past two months" (2015a, p. A1). That said, the *Seattle Times* was less likely to attribute increased public action to the article. In reporting on new funding for a new seismic warning system, famed CSZ reporter Sandi Doughton makes sure to point out: "the funding was in the pipeline long before the [Schulz] article was published" (Doughton, 2015, para. 4). Despite some skepticism from Doughton about Schulz's article as an arbiter of change, several journalists, particularly in Oregon, noted how the article spurred public interest that generated legislative pressure and individual actions.

Interestingly, magazine coverage did not seem to change much.[3] Just within three months following the *New Yorker* piece, the same publications published the following number of articles (it should be kept in mind that when looking at prior coverage of the CSZ in magazines I began in 2001 with

the Nisqually quake, whereas here I limited the search to three months after the Schulz piece, so the timelines for coverage are different. Other magazines have published articles following the three-month window I examined and those are not included here):

- *The Atlantic*, 2 articles
- *The Economist*, 0 articles
- *National Geographic*, 1 article
- *Newsweek*, 0 articles
- *The New Yorker*, 1 article (written by Schulz)
- *Time Magazine*, 0 articles
- *Vanity Fair*, 1 article

For the three regional papers near the CSZ coverage actually declined:

- *Portland Monthly*, 1 article
- *Seattle Magazine*, 1 article
- *Seattle Met*, 0 articles

The coverage, by and large, is underwhelming in the sense that none of it does much more than confirm Schulz's claims. Whereas coverage prior to the Schulz piece seemed to minimize the future catastrophe in some ways, post-Schulz coverage largely appears to piggy-back on her work in a "me too!" fashion. Some outlets included the CSZ as part of larger feature pieces of natural disasters. One writer for *The Atlantic* in a long-form piece on natural disasters in the United States, notes how Schulz's piece "awakened many lay readers to the threat of a huge earthquake in the Pacific Northwest" (Graham, 2015, para. 36), but goes on to minimize the threat by quoting a University of Washington seismologist saying "'We're well in the window, but it's not overdue,'" perhaps in an attempt to quiet some of the anxiety as some of the news coverage did. A *Vanity Fair* writer saw an opportunity with the Schulz piece and further expounded on the fear-inducing facts (Nguyen, 2015). But she offers nothing new either (and not to mention, the headline of his story falsely suggests that the CSZ earthquake prediction is a new one). In the case of most magazine coverage after the Schulz piece, it appears as if writers and journalists are largely focusing on the writing of "The Really Big One" as the piece of news, which makes the stories simply repetitive of Schulz in most ways. In some sense, it seems as if other magazine writers see that they missed the boat in terms of a story opportunity that had been around for a rather long time.

In general, Schulz's work became a newsworthy topic in its own right. While it resulted in some eye rolling at the hysteria surrounding it (as well

as some dismay at the public's sudden attention to the topic after years of reporting), it also resulted in more direct calls for action, both at government and individual levels. While the *Seattle Times* (2015b) is more than correct in pointing out that "risk of a massive shaker has been known for years," Schulz was nonetheless able to capture the imagination of the residents of the Pacific Northwest in ways that prior coverage hadn't.

CONCLUSION

Given the variability in types of coverage of the CSZ in prior news writing, the public likely encountered Schulz's article with some uncertainty regarding the threat of the CSZ, both resulting in more panic and more public response after the publication of her article. In order to better understand why Schulz's article generated so much attention, I first illustrate here trends in newspaper and magazine coverage of the CSZ prior to her work as a point of comparison. As discussed earlier, news coverage of the 2001 Nisqually quake, the 2004 Indian Ocean quake and the 2011 Japanese quake and tsunami resulted in the highest number of direct connections and comparisons to the quake and tsunami predicted in the CSZ. Interesting, the tone of coverage shifted with each earthquake. With the Nisqually quake, danger was imminent but coverage was perhaps confusing about what to be concerned about. The Indian Ocean quake coverage largely painted the Pacific Northwest as well-prepared, with heavy nationalist overtones that promoted the United States as superior. In contrast, the Japanese earthquake and tsunami coverage told the public that the CSZ region was wildly underprepared, resulting in a rather mixed message over time about the degree of threat and preparedness in the Pacific Northwest region. Magazine coverage overall was rather scant prior to the Schulz pieces, but the articles analyzed point to more apathetic readings of the threat of the CSZ—largely by minimizing the comparison to the Indian Ocean quake or by lightening the worry of the damage through humor.

When Schulz published her piece, she accomplished something much different than prior news and magazine coverage. She pushed this earthquake prediction into the genre of factual entertainment, gripping readings with real information and believable narrative. Her work does not simply draw comparisons to other disasters nor does it attempt to minimize the harm the West Coast might face—rather her message is visceral and by its nature calls the public to action. News coverage after her work seemed to want to enjoy the fame her article had as well—within the three months following her piece, several outlets (including previously quiet magazines) responded to or augmented her claims. What Schulz's piece ultimately did was create the CSZ story as a national conversation. With most news coverage occurring in West

Coast outlets prior to her work, much of the country would have been unaware of the seriousness of the CSZ's threat. And by creating an invitational narrative, her large audience collectively gasped at the horror she paints in her story. While many journalists seem to hint at a level of dismay in her success, effectively implying "I've been reporting on this for years!" they did not find an impactful way to grip the public by disrupting generic conventions while dazzling readers with this drama. News stories without a call to action minimize public agency; editorials, often short in length, are often unable to paint a picture of both the problem and solution. Schulz, though, brings together news, research, narrative and a call for preparedness in ways that traditional news writing about natural disasters cannot due to their generic constraints. Overall, I find that prior news coverage of the CSZ sent messages that told the public different stories—in some cases, the CSZ is painted as a serious threat to the public (as in the Japanese earthquake coverage) whereas other coverage emphasized how prepared the United States is (as in the Indonesian earthquake). Such mixed messages likely resulted in a lack of understanding of the CSZ and its threat to the region. Schulz's article provided the clarity and detail that the public needed, and she did this by infusing the story of the CSZ with narrative elements that broke traditional generic conventions of newswriting in a way that asked readers to react not just with fear, but with action as well.

Questions remain after this study, though. What long-term effects can writing like Schulz's have on public action? What best practices can journalists and writers take from this situation? How can public action be sustained in situations where the date of disaster is both unknown and potentially far in the future?

In many ways, communicating the gravity of the impact of an earthquake is the CSZ is akin to communicating the impending peril of climate change. While the latter's consequences are more dire in a global sense, both disasters seem too far in the distance, resulting in less action. As Schulz points out, the CSZ "poses a danger to us today because we have not thought deeply enough about the future" (2015). Neither climate change nor the mega-quake of the CSZ can be reported on in the same way as a looming hurricane with messages about reducing risk. Rather, news coverage has to communicate the certainty that both an earthquake in the CSZ and the disasters associated with climate change *will* happen; but the matter of *when* is more ambiguous, and thus, much more challenging.

Discussion Questions

1. Why don't some people care about more distant risks like earthquakes or climate change? What persuasive appeals or arguments might work to change these minds?
2. When communicating natural disaster risks to the public, what are the ethical obligations of journalists?
3. How can journalists effectively communicate a need for public action while minimizing public fear and hysteria?
4. What other examples can you think of where the generic conventions of a text shaped how an audience engaged with a message about science, health or the environment?

NOTE

1. It's important to note here that this earthquake is thought to have occurred within the Juan de Fuca slab that runs below Washington state, meaning that it was not an offshore subduction quake that is predicted in the CSZ.

2. As noted in the methods section, locating magazine articles via library databases proved difficult, which resulted in two limitations for the magazine article analysis in this research. First, the author hand-selected the publications that seemed to share the most affinity with *The New Yorker*, meaning that other outlets the author didn't consider may have published on the CSZ. Second, the author had to locate articles by looking through the online archives of individual publications—such archives may be limited both in terms of what the editorial board decided to publish online as well as the functionality of the archives' search features as well.

3. The limitations discussed in footnote 2 apply here as well.

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Chapter 5

A "Fast and Frugal" Approach to Risk Judgment and Decision-Making and Its Implications for Natural Disaster

Kai Kuang

Earthquakes, tsunamis, hurricanes—all natural disasters and predictions about their probability and magnitude are uncertain in nature (e.g., Johnson & Slovic, 1998; Lundgren & McMakin, 2013; Skinner, Rocks, & Pollard, 2014). And Schulz (2015) reminds us:

> The Cascadia situation, a calamity in its own right, is also a parable for this age of ecological reckoning, and the questions it raises are ones that we all now face. How should a society respond to a looming crisis of uncertain timing but of catastrophic proportions? How can it begin to right itself when its entire infrastructure and culture developed in a way that leaves it profoundly vulnerable to natural disaster? (para. 41)

Scientific advancements in fields such as seismology have significantly enhanced our ability and confidence in predicting these risks; the fact that 45 years ago no one even knew the Cascadia Subduction Zone (CSZ) existed and that researchers now know that the odds of it happening in the next fifty years are one in three indicates *huge* progress (Schulz, 2015). However, risk researchers and practitioners are still stuck in between the knowledge about these risks, either environmental (e.g., earthquakes and tsunamis) or health-related (e.g., probability of cancer and results of genetic testing), and what actions could and should be taken to prevent these risks from happening, reducing the likelihood, or at least minimize the damage they will cause if they are unavoidable. As Goldfinger put it, " … the gap between what we know and what we should do about it is getting bigger and bigger, and the action really needs to turn to responding" (as cited in Schulz, 2015). Most recently, Hurricanes Harvey and Irma have shown the challenges of conveying such unprecedented yet deadly risks to the public, let alone influencing behaviors (D'Angelo, 2017). After all, how likely are people going

to take action to prepare for something that *may* or *may not* happen? What does the risk estimate mean? When seismologists suggest the odds of the big earthquake in the next fifty years are one in three, how do people interpret it? When meteorologists predict "catastrophic and life-threatening flooding" (as cited in D'Angelo, 2017), what factors influence the public's response to those predictions? How do individuals, communities, and society make sense of risks such as earthquakes and tsunamis and, more importantly, make judgments and decisions about what to do with them? Do people consider all information provided to them, or do they tend to rely on several mental shortcuts—what researchers refer to as "heuristics"—when making those decisions? These questions are at the heart of connecting risk assessment (i.e., estimates of an event's probability and potential consequence) to risk perceptions, judgment, and decision-making (i.e., the cognitive and affective processes through which individuals make sense of the risk assessment) and to risk management (i.e., how to respond to the risks at the individual and societal levels; Kunreuther, 2002).

In the past decades, scholars interested in the psychology of risk, risk perception, and risk communication sought to answer these questions, with a specific focus on how people judge, decide, and act in uncertain and risky situations and how to communicate risk information more effectively in order to influence action (for a collection of recent risk communication research, see Cho, Reimer, & McComas, 2014). For example, scholars have identified and tested the effects of crucial socio-psychological factors that influence how individuals respond to both health- and environment-related risks (e.g., Bandura, 1997; Janz & Becker, 1984; Witte, 1992). For example, constructs that have received much scholarly attention include magnitude of harm (i.e., severity; Witte, 1992), probability of risk (i.e., susceptibility; Witte, 1992), self-efficacy and response efficacy (Bandura, 1997; Witte, 1992), and benefits of and barriers to risk prevention and risk reduction actions (Janz & Becker, 1984; Rosenstock, 1974). Understanding and explicating the mechanisms of risk-related decision making is crucial for risk and health communication initiatives that seek to either persuade (e.g., convincing individuals to follow evacuation orders under hurricane forecast, quit smoking, or take a screening test) or to inform (e.g., facilitating accurate understanding about risk estimates).

Within this line of research, two areas of literature are most relevant to this chapter: risk communication and risk judgment and decision-making. Communication scholars have traditionally treated the socio-psychological factors mentioned above as if they influence risk decision-making "additively," with a heavy emphasis on proper linear models (for a discussion on proper vs. improper linear models, see Dawes, 1979). This "additive" approach is also consistent with optimal decision-making models (Bogacz, 2007;

Coombs, Dawes, & Tversky, 1970; Edwards, 1954) and the maximum expected utility theory (von Neumann & Morgenstern, 1944), both of which assume that individuals would utilize all knowledge about a risk (e.g., all components provided in a risk message) as well as their beliefs and desire to make risk judgments, although each component may have different weights in their impacts on the final decision. For example, when deciding whether to evacuate prior to Hurricane Harvey, this approach assumes that individuals would consider all factors that may influence their final decision, such as the probability of Harvey passing their local area, the severity it may cause, and how capable they are to evacuate (e.g., alternative place to stay at, distance to be traveled, how easy it is to travel long distance with children). However, alternative approaches in judgment and decision-making literature suggest that instead of utilizing all cues available and *maximizing* their expected utility, individuals may be "satisficers" (Parker, Bruine de Bruin, & Fischhoff, 2007; Schwartz et al., 2002) and may tend to rely on a few rules of thumb, or decision aids, that help them estimate and make decisions (Kahneman, 1994, 2000; Kahneman, Wakker, & Sarin, 1997). That is, people do not necessarily use all information that is available to them; instead, they may use simple heuristics that do not integrate all different pieces of information in complex ways. With the case of Hurricane Harvey, for example, if people perceive that the probability of them getting influenced by Harvey is low, they may not consider any other factors and just decide not to evacuate. Within this later tradition emerged the "fast and frugal" approach (Gigerenzer & Goldstein, 1996; Hoffrage & Reimer, 2004), which posits that when faced with uncertainties, individuals' estimates of frequencies, probabilities, and the desirability of consequences are usually based on mental shortcuts (e.g., Kahneman & Tversky, 1982; Tversky & Kahneman, 1973), and that the decisions made through these mental shortcuts are not necessarily irrational. In fact, Gigerenzer and Todd (1999) proposed that judgments and decisions made based on these mental shortcuts could be *ecologically* rational, suggesting a satisficing match between the decision maker and the environment in which the decision is made. Reliance on heuristics could be a natural result of human being's limited attention and the selective strategies we have in order to deal with our cognitive limit (Hastie & Dawes, 2010), which may *describe* the processes through which individuals judge risks and make decisions accordingly (i.e., the descriptive approach), as opposed to how they *should* decide (i.e., the prescriptive or normative approach). In the past decade, communication scholars have started to adopt this view from the judgment and decision-making literature (e.g., Reimer, Hertwig, & Sipek, 2012; Reimer, Jones, Skubisz, 2014). If this "fast and frugal" approach, as opposed to the addictive approach, describes how individuals judge, decide, and act in everyday life, then risk communication efforts that seek to motivate

people to take prevention actions may need to redesign their messages. This chapter reviews relevant literature and extends the "fast and frugal" approach to the widely cited EPPM (Witte, 1992; Witte & Allen, 2000; a recent extension of the model, e-EPPM, can be found in So, 2013) in risk communication literature; it is proposed that instead of utilizing all information related to threat and efficacy—the two key constructs related to risk proposed by EPPM—individuals may adopt simple search rule, stopping rule, and decision rule to respond to risk information. This perspective may be especially useful in risky yet uncertain situations such as natural disasters: since these risks may or may not occur, it is more efficient to rely on mental shortcuts to judge and decide what to do in response to such uncertainty. Therefore, this proposed model may offer a unique and practical approach to communication risks of natural disasters and beyond. In the following section, literature from both lines of research—risk judgment and decision-making as well as risk communication—is reviewed.

LITERATURE REVIEW

In this section, literature relevant to judgment and decision making in risky and uncertain situations is reviewed, including the normative approach, the heuristic approach, and the "fast and frugal" approach, followed by the widely used EPPM (Witte, 1992; Witten & Allen, 2000) in risk communication literature. Next, how the two lines of research—risk judgment and decision-making as well as risk communication—can be integrated is discussed. The chapter is concluded with three propositions with regard to the sequential testing of the EPPM and discussion on theoretical and practical implications for risk communication in general and for natural disasters specifically. This section starts by providing definitions to key terms including judgment and decision.

Defining Judgment and Decision

A judgment, broadly speaking, refers to "an opinion about what is (and will be) the status of some aspect of the world" (Yates, 1990, p. 6), for example, a probability judgment about one's risk of getting breast cancer. A decision is any action taken that is intended to produce favorable outcomes over alternative outcomes, the process of which should be conscious, voluntary, but also uncertain (Mantkelow, 2012; Pitz & Sachs, 1984; Yates, 1990). Indeed, uncertainty characterizes most, if not all, judgment and decision-making processes, especially when it relates to environmental or health risks; decision makers are uncertain about either the information at hand, the outcome(s) associated

with each alternative, or about their own preferences (Kahneman, Slovic, & Tversky, 1982; Slovic, Fischhoff, & Lichtenstein, 1982).

Given its prevalence and significance, research on judgment and decision making under uncertain situations has received much scholarly attention from a range of disciplines (e.g., economics, psychology, philosophy). In general, research in this area has focused on two approaches: a *prescriptive*, or *normative* approach that seeks to understand how decisions should be made under uncertain situations; and a *descriptive* approach that seeks to *describe* how these decisions are actually made, as the literature suggests there tends to be substantial deviations between the two (see Slovic, Fischhoff, & Lichtenstein, 1977 for a review). In the following section, key propositions from both approaches are reviewed.

Normative Approaches

Early investigations of judgment and decision making focused much on optimal decision-making models (Coombs et al., 1970; Edwards, 1954), proposing that people should determine the best course of action, after considering their beliefs and desires, in a way that maximizes the expected outcomes. For example, the expected utility theory (von Neumann & Morgenstern, 1944) suggests that when choosing from two or more prospects, people should always choose the prospect with the highest expected value (EV), which is calculated by adding the values of the outcomes multiplied by the probabilities of the outcomes being obtained. In other words, individuals should consider the utilities of all alternatives as well as the weights associated with the likelihood to make decisions. It would seem reasonable that decisions made after considering the values and probabilities of all outcomes will always lead to satisfactory results; however, cases exist when a seemingly wise choice would lead to disappointing outcomes. Fischhoff's article (1988) gave an example of people who fasten their seatbelts in hopes of saving their lives in an accident may find themselves trapped under water if the car drives off a bridge. Despite how satisfied people are with their decisions, the expected utility theory suggests that individuals would act in ways that help them maximize the expected value. The literature does provide evidence indicating that people behave quite consistently with the axioms of the theory (e.g., Fishburn, 1981; Hey & Orme, 1994)—that " … they behave as though they were maximizing the expected value of utility and as though the utilities of the several alternatives can be measured" (Simon, 1959, p. 257).

However, in real-life situations, do people always make choices so as to maximize the expected utility? The literature shows substantial departure from how people *should* make decisions versus how they *actually* make decisions, especially when it comes to probability judgments (Bell & Raiffa,

1988; Camerer & Weber, 1992; Mantkelow, 2012; Reimer et al., 2014). In risk communication, for example, Reimer and colleagues (2014) discussed challenges in communicating numeric and probability risk information in order to convince people to undergo breast cancer and protest cancer screenings. Connecting research on probability judgment and risk communication, they offered evidence-based recommendations to communication numeric risk information. In explaining the discrepancies between how people should make decisions and how they actually make decisions, Simon (1959) suggested that people may want to maximize utility under situations where clear and simple choices are present and not much uncertainty and ambiguity is involved; however, real-life situations could be "so complicated that the theory of utility maximization has little relevance to real choices" (p. 259). In other words, while the general idea that people try to optimize their decisions makes intuitive sense, it may not be as useful if it does not accurately represent how people actually think. In some cases, while individuals would like to optimize their decisions, they may be bounded by external factors that limit their choices. For example, residents who live in neighborhoods close to pipes consisting of lead or high levels of radon do not necessarily have the financial mobility to move, despite their desire to mitigate these risks.

In the same "family" of the expected utility theory is the prospect theory (Kahneman & Tversky, 1979, 1982), which contends that values and probabilities of outcomes both influence individuals' decisions. Prospect theory proposes three phases in one's decision-making process: (1) a translation phase when the individual looks into each prospect and transforms outcomes into subjective values and probabilities into decision weights; (2) a combination phase where the two are combined into a comprehensive subjective value as a whole; and (3) a final decision phase where one prospect is selected. The key distinction between expected utility theory and prospect theory lies in the translation phase: while expected utility theory proposes that probabilities are directly combined with values, prospect theory suggests that people tend to "translate" probability into decision weights and then apply them to the values. Such information is then taken into consideration, together with one's beliefs and desires in making the decision. Although distinct from expected utility theory, prospect theory retains the key propositions that decision making is a process of combined evaluation of utility and probability judgment, which makes it an adaptation of, but not a total departure from expected utility theory.

The Heuristic Approach and Dual Process Models

Research on how people should make decisions and how they actually make decisions reveal that individuals do not always act as calculated, skillful

decision makers. This led to investigations on intuitive judgment and decision making, heuristics, and biases (e.g., Hoffrage & Reimer, 2004; Kahneman et al., 1982). From this approach, individuals may make judgment and decision based on simple rules of thumb, or heuristics, as opposed to utilizing all information given or considering probabilities of all prospects. For example, the representative heuristic suggests that people may judge the probability of an event or a sample based on the extent to which it is "similar in essential properties to its parent population" and the extent to which it "reflects the salient features of the process by which it is generated" (Kahneman & Tversky, 1972, p. 431). Reliance on these simple rules, according to this perspective, is sufficient for individuals to make judgment and decide.

The distinction between heuristic, automatic thinking and calculated, controlled thinking necessitates a brief review of dual process models, which propose that two kinds of processes or systems exist simultaneously: an effortless automatic process and a reasoning process that involves intentional thinking. Wason and Evans (1975) coined the term "dual processes" to refer to the nonlogical and logical factors that influence reasoning and decision making, which have also been labeled as Type I (automatic, outside conscious awareness) and Type II (controlled, deliberate with effort) thinking. Automatic thinking focuses on the use of simple rules and associations without conscious awareness, while controlled thinking includes deliberative reasoning such as imagination and scenario building (*cf.* formal thinking; Inhelder & Piaget, 2013; Piaget, 2002). The heuristic-analytic theory that was proposed later also posits that heuristic processes may operate before analytic processes (Evans, 1984, 2006).

In examining the role of heuristics, Zajonc (1980) suggested that the affective information processing system to which we devote our feelings is separate from the cognitive processes. Empirical investigations conducted within this line of research suggest that people tend to have automatic responses to most of the stimuli given, sometimes without even realizing it (e.g., Bargh & Chartrand, 1999; Chen & Bargh, 1999). Slovic and colleagues referred to this automatic evaluation of goodness versus badness evaluation as the affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2002) and suggested that affect may facilitate rational reasoning and decision making (see Bechara, 2011 for a review on emotion and reasoning). Recent developments in dual process models research propose the possibility that people have two minds in one brain (Evans, 2003), an old mind and a new mind (Evans, 2009, 2010), or a mind at war with itself (Stanovich, 2004). Possibilities about a tri-process theory have also been considered (Stanovich, 2009).

Critiques of the dual process models also emerged in response to the dual process models. For example, Gigerenzer and Regier (1996) argued that it would be hard, if not impossible, to separate Type I and Type II thinking.

Specifically, their critique was in response to Sloman's (1996) argument that associative system and rule-based reasoning are distinct processes. Instead, Gigerenzer and Regier (1996) argued, both systems can be considered rule-based; in fact, "the very same rules can underlie both intuitive and deliberate judgments" (Kruglanski & Gigerenzer, 2011, p. 97). Different from past research that views decisions made based on heuristics as "biased" and "irrational" (e.g., Hastie & Dawes, 2010; Kahneman & Tversky, 1996), Gigerenzer's research programs maintain the stance that the use of simple and intuitive rules in judgment and decision making can be not only efficient but also effective and accurate. Their approach is also known as the "fast and frugal" approach, which was popularized by Gigerenzer and Goldstein (1996) and expanded in more investigations conducted within this line of research (e.g., Gigerenzer, Czerlinski, & Martignon, 1999; Gigerenzer & Engel, 2006). This approach and its connection to risk communication in the following section are introduced in the next section.

A Fast and Frugal Perspective

Different from the earlier approaches that assume a computational, complex decision-making strategy, research from the fast and frugal decision heuristics posits that when faced with uncertainties, individuals' estimates of frequencies, probabilities, and the desirability of consequences are usually vague. This is a natural result of human being's limited attention and the selective strategies in order to deal with our cognitive limit (Hastie & Dawes, 2010). This corresponds with the findings of the National Mathematics Advisory Panel (NMAP) (Perie, Moran, & Lutkus, 2005) and the Program for International Student Assessment (PISA) (Lemke et al., 2004). Such programs used representative samples of students in the United States, including those about to enter the workforce or career preparation, to assess the national mathematical performance. Their results showed that students had basic knowledge and skills, but were not mathematically proficient or advanced. Put differently, while a situation may require much complicated deliberation and calculation to be solved normatively (i.e., people *should* consider all information available and maximize expected utility), we may not have the cognitive abilities to achieve it. Alternatively, even if we do, it does not mean that individuals always engage in such calculations when faced with a complex situation. It may be preferred that we make intuitive judgments as opposed to optimize every one of our decisions, as intuition-based processes are more likely to be quick and easy. Importantly, people may tend to rely more on intuitions if they are likely to be accurate (Gigerenzer & Goldstein, 1996).

Therefore, instead of computing all information available and maximizing the expected utility, as suggested from the normative approach reviewed

earlier, individuals may tend to rely on a few rules of thumb or decision aids that can help them estimate and make decisions. That is, people do not necessarily use all information that is potentially available to them (e.g., Hoffrage & Reimer, 2004; Reimer, Mata, Stoecklin, 2004). Rather, they "take the best"—the most important or relevant piece of information to them—and leave the rest of the information out of their judgment and decision-making process. This may be highly crucial to consider in the context of natural disasters. For instance, individuals rarely pay attention to earthquake forecast or preventative actions that can help reduce earthquake damage if they do not live in areas where probabilities of earthquakes are high; residents living in the Midwest may not have much detailed information about what hurricanes can do in terms of wind, storm, and heavy rain—it just is not as relevant. More importantly, the simple heuristics do not integrate multiple pieces of information in complex ways. Instead, it is proposed that people maintain an adaptive toolbox (Gigerenzer & Selten, 2001) that consists of various building blocks of heuristics, such as search rules, stopping rules, and decision rules. For example, the recognition heuristic proposes that people search for information to judge and decide (i.e., search rule); when they recognize one piece of information but not the other, they use that cue and stop there (i.e., stopping rule). In other words, they follow the "take-the-best" principle and do not need additional information to make their judgment; they would just decide based on that key piece of information (i.e., decision rule; Goldstein & Gigerenzer, 2002). In sum, the fast and frugal approach proposes that only limited amount of information that is the most important and relevant is used to make judgments and decisions due to these cognitive constraints and goals of efficiency. This is a major distinction compared to the aforementioned normative and expected utility approach, which assumes that values and probabilities of all prospects are and should be considered. As one example, a reader who comes across a news article on the high probability of earthquakes in California may stop processing additional information if he/she does not live in California and does not know anyone living in that area. They take the "best" piece of information—in this case, that the earthquake risks take place in a state that does not apply to them—and decide there is no need to continue reading.

If human minds are cognitively bounded by nature and only use parts of the information to make judgment and decisions, are individuals able to make accurate estimates and effective decisions in their daily life? This approach suggests that in fact, the frugal nature of the strategy does not necessarily result in inaccurate estimation or irrational behavior. On the contrary, oftentimes, these simple heuristics are robust to noises in the environments and can predict as accurately, if not more, as complex strategies do (Gigerenzer, Todd, & the ABC Research Group, 1999). For instance, someone who

perceived high probability of being influenced by Hurricane Harvey and severe consequences that could result from it may decide to evacuate, despite the challenges of evacuation. In that case, people make accurate judgments and good decisions based on key pieces of information and ignore the other factors, which makes the process ecologically rational and efficient (e.g., Hoffrage & Reimer, 2004).

Since this descriptive approach suggest that individuals do rely on a limited amount of information provided to make judgments and decisions under many circumstances, it is crucial for risk communication scholars to identify what cues they use, when they use different cues, and what are the conditions under which they use different cues, if the human minds are ecologically rational (Hoffrage & Reimer, 2004; Rieskamp, Busemeyer, & Mellers, 2006). That is, heuristics exploit environmental structures and utilize the information structure in the environment to make judgments and decisions based on the evolved abilities (Gigerenzer et al., 1999).

One of the fast and frugal heuristics that is the most relevant to risk communication research is the one-reason decision-making strategy, which suggests that people exclude consideration of certain alternatives (Nisbett & Wilson, 1977). A comparable example of this in political communication is how people vote for political candidates based on their stance on one issue that matters the most to them. In such cases, instead of optimizing, this strategy is in search of satisficing solutions: people make decisions about whether or not to perform the risk prevention behavior based on the extent of their satisficing solutions. Individuals would terminate their search of information when they find a result that satisfies their aspiration level (Simon, 1992); importantly, people would start with the most important aspect from a series of attributes and select the first option that is a clear winner on that attribute (Gigerenzer, 2004).

Important for risk communication researchers to consider are situations when one single cue is not sufficient to make a judgment. For instance, if a particular attribute cannot distinguish among multiple alternatives, individuals will need to look up more cues, although the final decision is still based on one of those cues. This process can be referred to as sequential decision making. More specifically, people first consider one attribute. If it distinguishes the alternatives clearly, a decision is made. If, in some cases, a conclusion cannot be easily reached, individuals consider another cue, and so forth, until a decision can be made. In the following section, a sequential decision-making model of the EPPM (Witte, 1992) is proposed to explain and predict individuals' risk judgment and their decision making with regard to a risk preventative action.

Extended Parallel Process Model (EPPM)

The EPPM (Witte, 1992) is one of the most used theoretical framework in risk communication and fear appeal literature. It identifies threat and efficacy as two of the key constructs important to communicating risk and motivating risk prevention or reduction behaviors (e.g., Rimal & Real, 2003; Witte, 1992). The model predicts a two-way interaction between threat and efficacy such that threat motivates action, while perceived efficacy determines whether the action is taken for the purpose of danger control (i.e., protective) or fear control (which inhibits protective behavior). A significant body of research has reported the effectiveness of these two constructs as predictors of self-protective behavior (e.g., McKay, Berkowitz, Blumberg, & Goldberg, 2004; Morrison, 2005). Researchers conducted empirical investigations on how to communicate threat and efficacy effectively so as to promote intended changes in beliefs, attitudes, and intentions (e.g., Cameron, Witte, Lapinski, & Nzyuko, 1998; Smith et al., 2008).

Viewed from the judgment and decision-making perspective, existing theories that seek to explain how various components in risk messages influence individuals' judgments and decisions with regard to their beliefs, attitudes, and behaviors, assume that individuals response to the risk message and act based on the "additive" or the normative approach. In other words, it assumes that individuals would utilize all components provided in a risk message to make their judgments, although each component may have different weights in their impact on the final decision. For example, the health belief model (HBM) suggests that individuals tend to give weights to the potential benefits of the recommended risk prevention or reduction actions and the costs associated with the action (i.e., the barriers) when making the decision about their behavior (Rosenstock, 1974). Researchers have empirically tested the HBM on a number of health behaviors such as vaccination (e.g., Larson, Bergman, Heidrich, Alvin, & Schneeweiss, 1982), and adolescent fertility control (e.g., Eisen, Zellman, & McAlister, 1985). Following the normative approach, researchers tend to assume that all components in a risk message, such as information about removing certain perceived psychological, physical, and financial barriers to conducting a risk prevention behavior, would function together in influencing people's risk preventative behavior and regression models were used in many of these empirical investigations to find a best fit.

With this regard, the EPPM (Witte, 1992) is slightly different as it has an implied sequential order in the effects of risk messages, such that threat precedes efficacy in their impacts on risk prevention behaviors. According to the model, perceived threat determines motivation of conducting self-protective behavior, while perceived efficacy influences whether danger

control or fear control is initiated. Perceived threat and efficacy propose four combinations of response to a health risk message: high-threat high-efficacy, in which individuals will be motivated to protect themselves from the health risk by performing the recommended behavior in the message (danger control); high-threat low-efficacy, in which people are motivated to take self-protective actions, but due to their low efficacy, they tend to avoid information that emphasizes their high-risk health status (fear control); low-threat high-efficacy individuals, who perceive strong efficacy beliefs yet do not perceive themselves as at risk; and low-threat low-efficacy, in which people do not consider themselves to be vulnerable to the risk, nor do they think they are capable of undertaking the actions to avert the threat. If individuals make their judgment and decisions based on one piece of information at a time, a sequential decision-making model of the EPPM may serve as an alternative model that describes how people actually make decisions about whether to take risk preventative actions. In the following section, this alternative sequential decision-making model is introduced, and implications for risk communication research and practice are discussed.

Sequential Decision-Making Model in Risk Communication

Threat

A threat refers to "a danger or harm that exists in the environment whether individuals know it or not" (Witte, 1992, p. 114). Researchers identified two types of threat in health communication: actual threats and perceived threats (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic et al., 1982). Perceived threats are different from actual threats in that they are cognitions or thoughts about the threats. Research has shown that perceived threat, or people's cognitions or thoughts about a threat or harm, is a key variable in persuasive processes. Despite the actual likelihood of an earthquake's occurrence in the Cascadia subduction zone, for example, individuals may have varying levels of perceived threat and act based on their *perceptions*, instead of scientific evidence from improvements in technology and forecasting.

The construct of perceived threat is oftentimes operationalized with its two dimensions, perceived severity of the threat, and perceived susceptibility to the threat (Witte, 1992). Beliefs about the magnitude and significance of the threat are perceived severity, while individuals' beliefs about their risk of experiencing the threat are perceived susceptibility to the threat. More specifically, perceived severity is operationalized by emphasizing the severe consequences of a particular risk, and perceived susceptibility is operationalized by pointing out the participants are at a high risk of certain diseases or hazard.

While the literature in risk communication takes these two dimensions as indicators of overall perceived threat, they are two related yet distinctive constructs. In fact, research suggest that susceptibility and severity are functionally different, are negatively correlated under some conditions, and elicit different emotional responses (e.g., So, Kuang, & Cho, 2016). For example, when individuals perceive a threat to be highly severe, they tend to underestimate the probability of the risk: people living in areas prone to earthquakes such as the Cascadia subduction zone may overestimate how likely smaller-scale earthquakes will happen, while underestimating the likelihood of earthquakes with higher severity. Similarly, in the case of Hurricanes Harvey and Irma, local residents may have underestimated the destructive effect of heavy rain caused by hurricanes (D'Angelo, 2017).

According to the fast and frugal perspective, people may not use all information available to them to make judgments and decisions, due to the constraints in human minds' cognitive abilities. Their intuitive judgments only rely on a limited amount of information. In other words, individuals ignore the information that is not useful. Since susceptibility refers to individuals' beliefs about their own risk of experiencing a threat, it is reasonable to posit that people would ignore the rest of a risk message if they do not perceive themselves to be at risk—susceptibility serves as the first cue they would use to make the judgment. If they are not susceptible to the threat, they simply stop searching more information about it, and decide they do not need to perform any risk prevention behavior.

On the other hand, when individuals realize their level of susceptibility is high, they would continue information search to learn about how severe this risk is—the perceived severity of the threat. If they are at high risk, but the threat is not severe, they may make their judgments on that cue and decide no action is required to prevent the risk. If they perceive themselves to be highly susceptible to the risk, which is severe, they would proceed to looking for more information and look for the next cue that can help them make the final decision.

In persuasion theories such as the EPPM (Witte, 1992) and protection motivation theory (PMT; Rogers, 1975, 1983), both threat and efficacy appraisals are initiated by the exposure to a risk communication message: people appraise the threat of a hazard and the efficacy of recommended behavior. Individuals' evaluations of these two aspects will influence their belief, attitude, and behavioral intention (Witte, 1992). For example, people evaluate the threat of a hazard. When perceiving great threat, individuals will be more motivated to begin the second appraisal, which is the evaluation of the efficacy of the recommended response. When threat is perceived as trivial or irrelevant, there is no motivation for individuals to process the message further. The evaluation of the efficacy will be examined superficially or the process

will not even be started. Overall, the level of perceived threat determines whether a message will be accepted or rejected, that is, the individuals' reaction to the message (e.g., Witte, 1992).

Efficacy

Efficacy, according to Bandura (1997), refers to an individual's perceptions of his or her ability to produce an outcome or to perform a behavior, or the ability of an external entity (e.g., another person, object, or course of action) to achieve that outcome or behavior. In the area of health communication research, the general sense of efficacy is often categorized into self-efficacy and response efficacy (e.g., Rogers, 1983; Witte, 1992). Self-efficacy is defined as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1997, p. 71), whereas response efficacy relates to one's belief that to perform a recommended response to a threat can indeed avert the threat (e.g., Zhao & Cai, 2009).

Theoretical frameworks suggest that response efficacy plays an important role in the process of persuasion. In the literature, oftentimes response efficacy was examined together with self-efficacy. While self-efficacy relates more to one's belief about whether he/she is able to perform a recommended behavior (e.g., Witte, 1992), response efficacy refers to the belief that performing the recommended behavior will reach the functional outcome. This is to say, response efficacy is a prerequisite for an individual to consider whether he/she is capable of performing the recommended behavior, and furthermore, for him/her to carry out the recommendations.

Many theories and studies adopt this assumption. For example, PMT assumes that an individual's assessments of (a) severity of the health event, (b) probability of the event occurring, (c) belief in the efficacy of a coping behavior to remove the threat (coping response efficacy), and (d) the individual's perceived ability to carry out the recommended behavior (self-efficacy) are crucial in influencing their view of health communication. The results of many studies that used PMT suggest that the perceived efficacy of the recommendations to achieve the desired outcome is the most important predictor of behavioral intentions (e.g., Struckman-Johnson, Gilliland, Struckman-Johnson, & North, 1990; Tanner, Hunt, & Eppright, 1991).

Literature also suggests the different effects between the types of coping information received (response efficacy vs. self-efficacy; Rippetoe & Rogers, 1987). Rippetoe and Rogers (1987) found an interaction between response efficacy and coping mode. They argued that compared with the low-response-efficacy condition, the high-response-efficacy information strengthened intentions to engage in the use of a rational problem-solving approach to the

possibility of breast cancer. In addition, their belief that the recommended behavior was ineffective led to more fatalistic and religious attitudes toward the threat. Therefore, when individuals appraise a dreadful situation as having no effective coping response, that is, when they maintain low response efficacy, they either attempt to resign themselves to the situation or engage in a form of acceptance either philosophical (fatalism) or spiritual (religious faith) (Rippetoe & Rogers, 1987).

Response efficacy is especially important in specific contexts such as vaccination. Research showed that individuals' perceived response efficacy of a particular vaccine is a key determinant of their orientation toward perceptions that immunization is effective and safe (Russell, Injeyan, Verhoef, & Eliasziw, 2004), which in turn serves as a prior condition for them to consider adopting the recommended behavior. On the other hand, response efficacy is a prerequisite for appraisals of self-efficacy. If individuals do not perceive the act to be effective, they are not likely to evaluate their own ability to conduct the act.

Therefore, when individuals perceive high level of susceptibility and severity, they look for information about how effective the recommended behavior is in terms of its ability to prevent the risk, that is, the response efficacy of the behavior. If the response efficacy is not highly effective, they may be reluctant to take any actions, and enter the fear control stage proposed by the EPPM. If, however, their perception about the response efficacy of the action is high, they would continue information search.

Lastly, even though the perceived susceptibility, severity, and response efficacy are all relatively high, individuals still may not take any action if they do not think they are capable of conducting the behavior themselves (self-efficacy). Only when they perceive themselves to be capable of performing the behavior would they decide to act upon this risk which they are highly susceptible of and which is severe. Therefore, this sequential alternative of the widely adopted EPPM (Witte, 1992) proposes that individuals make judgment and decisions in response to risk based on the following "fast and frugal" heuristic rules (also see Figure 5.1):

The search rule: the order of important for individuals to search information is: susceptibility, severity, response efficacy, and self-efficacy.

Stopping rule: individuals stop the search as soon as they reach a "no" for any of the reasons.

Decision rule: individuals make the judgment and decide in accordance with what that reason suggests.

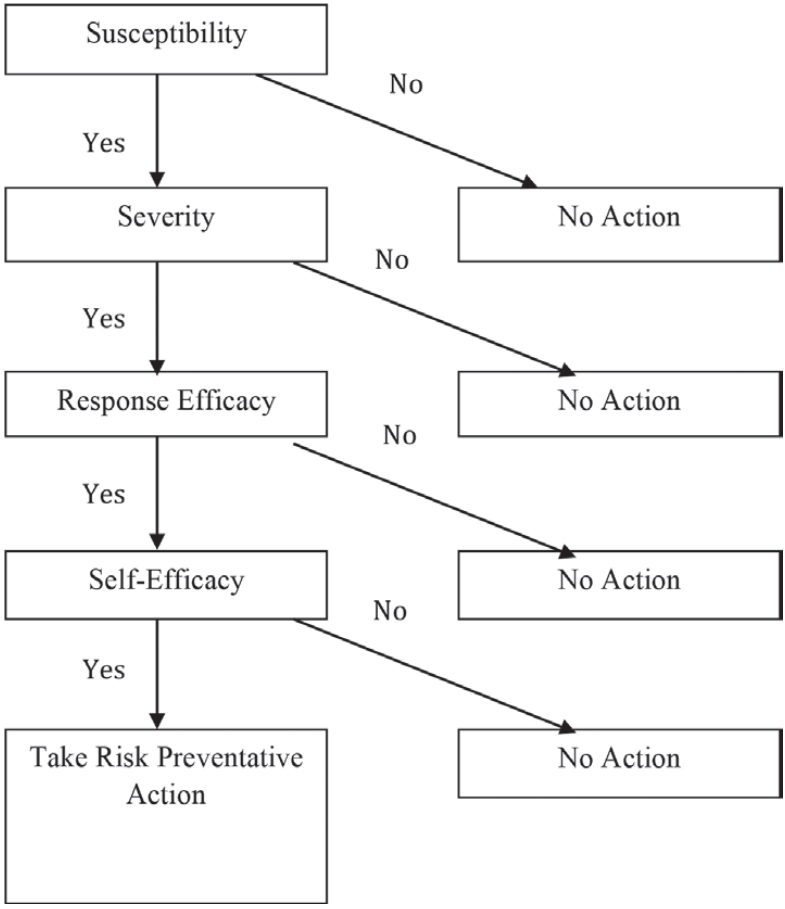

Figure 5.1. A sequential risk judgment and decision-making model. *Figure created by author.*

DISCUSSION

The field of risk judgment and decision making and risk communication has a long tradition of interdisciplinary research. For example, research on behavioral decision theory has been conducted by scholars from psychology, philosophy, and economics collectively (e.g., Edwards, 1954; Pitz & Sachs, 1984; Slovic et al., 1977). Communication scholarship has just started to join this interdisciplinary effort of understanding how people respond to risks, and more importantly, how to communicate risks more effectively based on these novel approaches (for a collection of theories and research on risk communication, see Cho et al., 2015). This chapter joins this multidisciplinary effort

and seeks to connect risk communication research with the rich literature on judgment and decision-making and applies it to the context of natural disasters. Theoretical and practical implications are discussed.

First, building on and integrating literatures from both psychology and communication, this chapter proposes a sequential alternative of the widely adopted EPPM (Witte, 1992; Witte & Allen, 2000). In recent years, risk communication scholars have recognized the importance of theories and practice connecting risk judgment and decision making and risk communication research (e.g., Reimer et al., 2013, 2014; Reimer, Russell, & Roland, 2015). More interdisciplinary examinations connecting these two lines of research would be beneficial to addressing the questions proposed at the beginning of this chapter: in addition to scientific developments that help us make more accurate predictions about natural disaster risks, it is necessary to better understand how individuals make sense of such information, what motivates them, either individuals, organizations, or the society, to take actions to prevent and/or reduce these risks. It may not be sufficient, for example, to know that the odds of an earthquake happening in the CSZ—such information is crucial—but also central to this problem is how the odds are interpreted, understood, and used to make decisions about what to do when facing the risk of the big earthquake. If people judge and decide about the risks in accordance with the model proposed in this chapter, then efforts should be made to relate risk messages about the earthquake (or any other environment- or health-related risks) to the target audience in this sequential manner, in order to motivate risk prevention and risk reduction actions. In this way, we can start to address the gap between the knowledge we have about the natural disaster risk at hand and what to do to prepare for them. More descriptive models about judgment and decision making are needed to better communicate natural disaster risks such as the anticipated CSZ earthquake and motivate people to take risk prevention and reduction actions.

Second, in response to risk, either health-related risks such as illnesses or environment-related risks such as earthquake or climate change, it is assumed that people would behave as if they are rational and that they would consider the information given to make the "right" choice, as long as the "right" pieces of information are presented in an effective way. However, if we take the fast and frugal approach and view people as decision makers who tend to rely on mental shortcuts and heuristics to assess and decide, then effective risk communication does not necessarily mean more information communicated to these individuals, who may be ecologically rational *satisficers* as opposed to *maximizers*. Specifically, the concept of ecological rationality refers to the degree to which a heuristic is adapted to the structure of an environment (e.g., Gigenrezer et al., 1999; Hoffrage & Reimer, 2004). Different from the coherence criteria, which are primarily concerned with the laws of logic and

probability theory and do not necessarily demonstrate how they help us to make useful decisions in the real world, the correspondence criteria examine how decision-making strategies are related to the external world. Individuals may perceive decision problems and evaluate probabilities and outcomes differently based on various framing of the same problem, because our rationality is bounded—our minds try to adjust to and correspond with the information in the environment (e.g., Gigerenzer & Selten, 2001). That is to say, individuals would systematically adjust to the environment and utilize corresponding strategies to make judgments and decisions. The mind is sensitive to the information structure in the environment and will adjust to it. For example, as mentioned in Schulz (2015), tsunamis are considered closest to being completely unsurvivable—once individuals perceive that there is nothing they can do to prepare for a tsunami (such perceptions may or may not be accurate), they may engage in avoidance as a coping mechanism and stop processing information in the risk message (Lazarus, 1981; Lazarus & Folkman, 1984). The question, then, is how we can make use of these systematic and predictable shifts and correspondents of human minds to the environment to better communicate risk information. Future research should look into other ways of connecting the risk communication and risk judgment and decision-making literature, both of which has much to offer in terms of better explanation and prediction of people's risk-related behaviors (Reimer et al., 2014). Equally important is attention to contextual factors and how different kinds of risks (e.g., earthquakes, tsunamis, climate change, and health risks) influence risk communication processes and outcomes.

Last, this sequential decision-making model has practical implications and can contribute to understanding how individuals' judge and make decisions under situations of risk and uncertainty and how to communicate risk information more effectively. In situations where people rely on fast and frugal heuristics to decide how they would act in response to risk, less information in risk communication that is directly relevant to their decision-making heuristics may be crucial—in those cases, less information could mean more effectiveness. In addition, given that people make decisions about risk in an ecologically rational way, risk and health communication practitioners should seek to identify how to utilize knowledge on people's ecologically rational minds to help them make better-informed decisions.

Discussion Questions

1. Reflect on how you make decisions during risky and uncertain situations. How do you decide what to do in response to a risk? Do you take a *normative* approach or a *descriptive* approach?

2. Do you think people tend to analyze the situation carefully and consider all factors, or do they rely on some general guidelines and only consider the most important factor(s) when making judgments and decisions about a risk?
3. Do you think people make judgments and decisions in different ways depending on the situation? What factors influence how they make a decision in response to either an environmental risk (e.g., earthquake, hurricane) versus a health risk (e.g., cancer risks)?

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Part III

LOCAL AND GLOBAL CASE STUDIES

Analyzing Demographic, Attitude, and Economic Factors in Natural Disasters

Chapter 6

Public Risk Perception Attitudes on Flooding by Different Societal Sectors

An Investigation Based on the August 2016 Flood in Louisiana

Do Kyun Kim and Phillip Madison

Geologists and others have indicated that around 900 AD, a 7.5-magnitude earthquake trembled along the Cascadia Subduction Zone (CSZ) (*History of Earthquakes in Cascadia,* 2011), generating a massive tsunami that devastated the region and indigenous peoples of the Pacific Northwest with its flooding (Schulz, 2015).

> Those who cannot get out of the inundation zone under their own power will quickly be overtaken by a greater one. A grown man is knocked over by ankle-deep water moving at 6.7 miles an hour. The tsunami will be moving more than twice that fast when it arrives. (Schulz, 2015, para. 35)

Moving forward more than a millennium, Louisiana experienced its worst flooding in known history. What do these natural disasters share in common, and how can we learn about the CSZ from major flooding in Louisiana?

Humans have reported a weariness about floods since the narrative of Noah building the ark to save the various species of the Earth from God's punishment. And so it seems that the innate fear of natural disasters will remain until the end of human history because natural disasters can lead to immense damage to personal and community properties and also determine life or death. While people have constantly prepared for such natural disasters, perfect preparedness may not be possible, as history continuously demonstrates that we are likely to experience bigger and stronger natural disasters (e.g., Hurricanes Harvey, Irma, Jose, and Katia in 2017 alone) than what humans are prepared for currently. As technology has developed, humans have adopted it to enhance disaster preparedness. For instance, many satellites are used to forecast weather all over the world, and people have developed

different devices to predict a variety of natural disasters and to alert communities and nations.

Risk perceptions for natural disasters differ due to a variety of influential factors (Messner & Meyer, 2006). People in Japan who often experience earthquakes may have a higher level of risk perception for earthquakes, while people in Louisiana may have a higher risk perception for hurricanes and floods because of the frequency of such natural disasters in each location. However, it is still unclear how risks are perceived due to the cognitive complexity of humans in judging risks and the social and cultural factors that influence risk perception (Wachinger, Renn, Begg, & Kuhlicke, 2013). In fact, risk perception of natural disasters has been a complex issue, as it depends on the type of disaster and individuals' different perspectives. Therefore, it is important that academic research contributes to first clarifying or unknotting risk perceptions by type of natural disaster (e.g., earthquakes, floods, hurricanes, and tsunamis). Among many types of natural disasters, floods are historically the most common and destructive (Federal Emergency Management Agency [FEMA], n.d.). Based on the seriousness of floods and the need for rigorous risk perception research on natural disasters, this chapter focuses on the public risk perceptions of floods. To accomplish this task, this chapter explored the case of a historic flood in Louisiana in 2016.

Beginning Thursday, August 11, 2016, southern Louisiana experienced devastating 1,000-year flooding. The rain did not stop for four days, and the President of the United States (U.S.) declared it a major disaster for Louisiana. The Louisiana governor John Bel Edwards also declared a "state of emergency." More than 30,000 people were rescued and at least 40,000 homes were damaged by this unprecedented event (Liberto, 2016). According to FEMA, more than 66,000 people filed for relief assistance.

Natural disasters do not discern between individuals or communities; the Louisiana flood affected not only flood zones, but locations that had never flooded, and most flood victims did not have flood insurance (Isidore & Vasel, 2016). Only 42% of structures in flood zones were covered by flood insurance and, worse, only 12% of homes outside of designated flood zones were insured for floods. Based on this experience, this chapter investigates public risk perception attitude (RPA) regarding flooding.

Specifically focusing on the Louisiana flood of 2016, this chapter investigates how different groups of people have different risk perceptions and how such information can be a foundation of risk perception research and practical preparedness for flood damages. In order to accomplish this task, this chapter identifies key variables that categorize people and may affect their RPAs. The present chapter will first review the literature on RPA and specify its scope within flood-related literature, while reviewing factors related to public RPA identified in the focal variables.

Figure 6.1. 2016 Flood in Louisiana. *Photograph taken by author.*

Based on the need for a strategic approach to increase public awareness and enhance the practice of crisis preparation, this study greatly contributes to specifying RPA research with a comprehensive set of groups and also offers a systematic design for crisis preparation and management at both community and state levels. Finally, this chapter includes a discussion of how the findings from this study can be applicable to areas beyond Louisiana, such as the CSZ, for increasing public risk perceptions of flooding, and offering practical advice for communities to prepare for other types of natural disasters. Due to tectonic activity, the CSZ is particularly prone to devastating flooding induced by earthquake-related tsunamis. Therefore, the findings in this study may be of particular interest to those living in the Pacific Northwest.

LITERATURE REVIEW

Natural Disasters as Risk

Media report extraordinary natural disasters almost every year in order to inform and educate the public about natural disaster risk and preparedness. The general public often observe cacophony between what the public is supposed to act upon and what the public actually does in the face of natural disaster (Slovic, 1986). In reality, whenever communities experience natural disasters, people often talk about the importance of risk perception and preparedness. It is difficult, however, to find cases of successful preparedness for and response to natural disasters, although both the frequency and severity of natural disasters have increased (FEMA, n.d.). While climate change is behind the increase in devastation caused by many natural disasters, collective actions and policies on preparation and responses to disasters is still low, insufficient, or moderate, at best (Leiserowitz, Maibach, Roser-Renouf, Rosenthal, & Cutler, 2017). In relation to insufficient public preparedness, Sjöberg (1998) suspected that actual risk perception may be weaker than previously believed, and pointed out that attitudes and moral values may play more crucial roles instead.

According to Pinkau and Renn (1998), risk perception of disasters in general can be approached in four dimensions. The first one is a religious and historical approach. From the beginning of human history, many societies and individuals have thought of disasters that influence personal lives, such as illness and natural disasters, as punishment from God sanctioning the sinful behaviors of human beings. As the modern era arrived, perception about risk became analytical, separating danger and risk. Luhmann (1990) explained danger as an external threat that people should flee instead of coping with, while risk is identifiable and manageable. Based on this clarification, the modern study and movement in the field of risk management is rooted in the concept that mitigating or managing risk requires people's action.

The second dimension of risk is related to advances in technology, medicine, and hygiene. Such advances have increased the ability for human beings to cope with risk and rationalize attitudes and behaviors in response to risk. As a result, the risks and dangers of the past become no greater than those in the present, and some of them are no longer threats.

The third dimension is closely related to the second dimension. Advances in technology have contributed not only to individual or social ability to cope with or find solutions for risks, but may also actually prevent the occurrence of risks. For example, the flu vaccine helps people reduce chances to get the flu even before they are exposed to it.

In the fourth dimension, the definition of risk management has included larger areas than the past. Nowadays, the subject of risk management encompasses not only individuals, but also societies because of the growing importance of public goods and economy, as well as broad areas of individual well-being. Instead of physical safety, mental health is a rapidly growing area of focus in public health. In addition, many efforts to prevent further climate changes and engage governments in many countries through large-scale collaborative works seek to prevent environmental risks from growing harsher and more frequent. For example, the Paris Agreement, in which 159 international parties participate as of June 2017, "aims to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius" (United Nations [UN], 2017).

Economic situations also influence the movements related to preparedness for natural disasters. According to Knaus and Renn (1998), in times of economic difficulty, employment becomes a major social issue, while environmental protection receives a higher level of public attention. In June 2017, U.S. President Trump announced that the United States would withdraw from the Paris climate accord, abandoning one of the greatest international efforts to protect climate change. The major reasons to withdraw were associated with the U.S. economy. As President Trump stated "I was elected to represent the citizens of Pittsburgh, not Paris" (Shear, 2017). Therefore, local economies can certainly affect risk perception attitudes.

Focusing on floods, risk perception has a distinctive feature of higher unpredictability and lower perceived threat. For example, earthquakes and hurricanes have been well perceived as life-threatening natural disasters and are usually detected by the variety of warning systems developed over several decades. People, however, may think of floods as less devastating than hurricanes and, therefore, may not consider them as threatening. Instead they may be perceived simply as heavy rain over a short period of time. In reality, floods and their devastating consequences regularly make news. However, most homeowners' insurance in the United States have flood insurance as an option, while requiring hurricane coverage in certain hurricane-prone areas.

The consequence of low awareness and unpreparedness for flooding is severe. When Louisiana had its historic flood in August 2016, most flood victims did not have flood insurance. In fact, nearly seven of eight residents in East Baton Rouge parish did not have flood insurance and the damage was equal to or even more severe than a hurricane (Calder, 2016). Uninsured flood victims could not claim their damages to their insurers. Moreover, many insurance companies often avoid covering damages caused by unnamed tropical

storms and hurricanes (National Association of Insurance Commissioners, 2017); the Louisiana flood of 2016 was an unnamed storm.

Factors Affecting Risk Perception on Natural Disasters and Flood

Flood Zones and Flood Insurance

A number of studies have identified factors that affect the public risk perception of natural disasters. The present study selected topically relevant factors related to floods that are frequently identified in studies of crisis and risk communication. The first factor in this study is whether or not someone lives in a labeled flood zone. FEMA (2016) conducted a survey in 2013 to investigate the general population's awareness of flood risk, knowledge of specific ways to mitigate flood risk, perceptions of barriers to mitigation activities, and understanding of steps taken to reduce risks. The recent FEMA results showed that three out of ten people believed their community was at risk of flooding, and only 10% of survey respondents stated they believed their residences were at risk.

Living in flood zones is directly connected to having flood insurance. Before the 2016 flood in Louisiana, most residents in Louisiana were unsure about whether they lived in a flood zone and/or believed they were safe from a flood because their properties were not in a labeled flood zone (Louisiana flood victims unaware they live in a flood zone, 2016). In most states, the state government and/or residential mortgage companies require flood insurance depending on the zone of living (e.g., proximity to bodies of water, areas of adequate drainage, etc.). For example, the state of Louisiana requires flood disclosure for any transaction of residential property (Louisiana Real Estate Commission, n.d.) and, if a house is within a flood zone, mortgage companies require buyers to have flood insurance to purchase a house. Meanwhile, a large number of people in Louisiana who live in nonflood zones acquire flood insurance because of frequent rain throughout the year. Based on all this information, this study assumed people may have different Risk Perception Attitudes (RPAs), depending on the zones in which they live, and whether they have flood insurance.

Experience of Floods

The next factor considered in this study was whether or not respondents were previous flood victims at some point in their lives, including direct experience with the 2016 flood in Louisiana. Previous studies show that direct experience with disasters enhances public risk perception (de Man & Simpson-Housley, 1988; Hansson, Noulles, & Bellovich, 1982; Kates,

1962; Payne & Pigram 1981). According to Whitmarsh (2008), few climate change prevention efforts are effective because of the remoteness (time lag) of notable negative consequences. She argues that because the public rarely experiences the immediate negative consequences of climate change, its risk perception is low, as demonstrated by people rarely changing their behaviors in ways that align with the prevention of climate change. In terms of direct experience, both recent and past experiences can affect people's risk perception. Blennow and Sallnãs (2002) investigated risk perception among non-industrial private forest owners and found people who experienced hazards during the past five years had higher risk perception than those without such experience. Based on such research outcomes, whether or not one has a direct experience would also be a factor affecting individuals' RPA on floods.

Business Ownership

Whether or not someone owns a business may affect RPA. Lam, Arenas, Pace, LeSage, and Campanella (2012) analyzed business owners' reopening processes in New Orleans after Hurricane Katrina in 2005 and found the size of business was a significant predictor of their ability to reopen in timely manners. Specifically, larger businesses showed higher probabilities of reopening than smaller ones. According to Stewart and Roth (2001), entrepreneurs whose primary goal is venture growth have higher risk propensity than managers focusing more on producing family income. Therefore, business owners may have higher risk perception than nonbusiness owners.

Homeownership

Homeownership may also have a similar pattern in relation to RPAs, although little research investigates relationships between homeownership and RPA. Homeowners may have higher risk perceptions of floods and be more likely to secure their properties than lessors. Alternatively, homeowners may worry somewhat less if they have flood insurance. Based on these assumptions, this study hypothesizes that business owners and homeowners will differ in RPA.

Dependents

This study also tested a demographic/cultural factor: having dependents in the same house (e.g., kids and grandparents) and the associated personal responsibilities for caring for them. In general, there is little risk perception research that has tested having dependents as a variable. In spite of little research focusing on the influence of having dependents and resulting risk perception, this study considered this variable and included this demographic

factor as a cultural variable since Louisiana has traditionally had a strong family-oriented culture (Trepanier, 1991). In people's everyday lives, consideration of family is often a strong determinant in behavioral choice and decision-making (see Beatty & Talpade, 1994; De Bourdeaudhuij, & Van Oost, 1998). In addition, individuals with dependents undeniably feel a level of responsibility to protect them. In this study, we related to people's preparedness for and protection from floods, and counted having dependents as a testable variable. We predict that people with dependents will have higher RPA than those who do not.

Gender

In terms of gender, early studies of gender differences in risk perception often showed differences between females and males. For example, Greenberg and Schneider (1995) conducted research to figure out if males and females have different level of concerns for environmental risk, and analyzed national data and an aggregate of 10 local data sets. Their analysis revealed females showed higher concern on local technological, behavioral, and land use hazards in general. Bord and O'Connor (1997) also used survey data to argue the difference between gender in risk perception about environmental risks, depending on types of risk, such as waste sites and global warming. However, as similar studies have indicated over time, the gender difference in risk perception is not consistently supported.

As noted earlier, sometimes females show higher risk perception than males, but not all the time. Thus, Eckel and Grossman (2008) reviewed results of studies exploring for any systematic difference between males and females in perceiving risks. They assumed that if females have higher sensitivity to risks than males, that sensitivity is reflected in their decision making, including choice of profession (earnings), investment decisions, and what products to buy. The result of their review still shows inconsistency in risk perception between men and women when exposed to risks, showing the results are different case-by-case, and that research conditions may influence risk perception. These inconsistent results highlight the importance of conducting research on this phenomenon, with the study at hand focusing on risk perception toward floods. Therefore, this study predicts a difference in RPA by gender.

While the factors explained above are categorical variables, the next three factors are continuous variables: age, perceived economic status (income), and education level.

Age

Age has been one of the most commonly chosen variables for risk perception research. For example, Hanson, Vitek, and Hanson (1979) interviewed people who experienced a destructive tornado in Florida to assess their risk perception on future disasters and found age was positively associated with the level of people's risk perception of tornados. However, Peacock, Brody, and Highfield (2005) examined demographic characteristics contributes to hurricane risk perceptions of single-family homeowners in the same state, Florida, and found the opposite; age was negatively associated with people's hurricane risk perceptions. As shown in these examples, studies dealing with the relationship between age and risk perception of natural disasters present inconsistent results. Regardless the inconsistency of results, as Wachinger, Renn, Begg, and Kuhlicke (2013) pointed out, age has been one of the most frequently tested variables in risk perception studies. The present study predicts differences in RPA by age.

Perceived Economic Status (Income)

Income has commonly appeared as a variable in disaster research and is closely related to an individual's ability to recover from flood damages; this study added income to the pool of test variables. Previous research, however, shows mixed results regarding the relationship between income level and risk perception. For example, according to Savage (1993), women with lower levels of income and education have higher risk perception than others with less income and education, while Sjöberg (2000) argued income is not a factor affecting risk perception. Nevertheless, this study included a perceived economic status variable for testing and clarification of its influence on RPA. To measure income level, the present study used perceived economic status, instead of asking participants' income directly, to avoid participants' reluctance to reveal personal/privacy information. Although nondirectional, this study predicts differences in RPA among people of different economic statuses.

Education Level

Education level is another variable that has been commonly tested in risk perception research, and was chosen for this study as well. A large body of research has found that people with different educational levels show different levels of risk perception on climate change (e.g., Lave & Lave, 1991; Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015; Lujala, Lein, & Rød, 2015) and natural hazards (Wachinger et al., 2013). This study hypothesizes that there will be a difference in RPA among people with different levels of education.

Based on all these considerations and previous research, the present study focused on ten factors—flood zone, flood insurance, floods experience, business ownership, homeownership, dependents, gender, age, perceived economic status, and education level—that may affect the public RPA.

With these variables, this study tested ten hypotheses as follows:

H1–1: People who live in flood zones have different RPAs than those who do not.
H1–2: People with flood insurance have different RPAs than those without.
H1–3: People who are flood victims have higher RPA than those who are not.
H1–4: Business owners have higher RPA than employees.
H1–5: Homeowners will have different RPAs than lessors.
H1–6: People who have dependents (e.g., kids, spouse, elderly people) have higher RPA than those who do not.
H1–7: Males and Females have different levels of RPA.
H1–8: Different age groups have different levels of RPA.
H1–9: RPA will vary among groups with different perceived household economic status.
H1–10: People of different levels of education have difference levels of RPA.

METHOD

Survey Instrument Design

Based on the hypotheses introduced above, this study investigated how ten selected factors affect public risk perceptions regarding floods. This study focused on two types of risk perception—perceived susceptibility and perceived severity—and employed the instrument developed by Rimal and Real (2003). Although their research focused on risk perception regarding skin cancer, their instrument is applicable for measuring public risk perception for diverse types of risks, while maintaining its validity (Mead & Rimal, 2016).

To measure perceived susceptibility, their questions asked participants' perceptions of different lengths of time between the recurrences of a specific risk. Specifically, they asked participants questions about their vulnerability to a risk in the next year, two years, and five years on a Likert scale. Second, perceived severity was measured with three questions: (1) How deadly would it be? (2) Would it destroy both me and my family? and (3) Would it be impossible to recover from? The same Likert-type scale was used to measure both respondents' perceived susceptibility and severity (Rimal & Real, 2003; Rimal & Juon, 2010). We used the same wording and a 5-point Likert scale for our survey to measure these two specific elements of risk perception,

while contextualizing the items for floods. RPA is then calculated as a mean between perceived vulnerability and severity.

To identify key variables categorizing different groups of people, this chapter considered previous research and empirical paths. First, Wachinger et al., (2013) systemically reviewed more than 300 European studies (post 2000) on risk perception of natural disasters and selected 35 studies for a detailed review that explored risk perceptions among different groups of people. Including Wachinger, et al.'s meta-analysis focusing on European countries, our study reviewed other risk perception studies conducted Asian and the United States. In addition, the selection of key variables for this study considered the number of citations and relevance of the studies listed by the EBSCOhost research database. Second, for empirical experiences, the study in this chapter reviewed newspaper articles and categories for governmental statistical records, especially FEMA. As a result, this chapter investigated the following variables: (1) residential area, (2) having previously been a flood victim, (3) business ownership, (4) possession of flood insurance, (5) support of dependents, (6) homeownership, (7) gender, (8) age, (9) household income, and (10) education level.

Living (or not) in a flood zone, having insurance, being flood victims, being business owners, being homeowners, having at least one dependent, and being male, were binary variables and coded as "1," with their opposites coded as "2." The continuous variables age, perceived economic status (income), and education level were measured on 5-point Likert scales. As mentioned above, to measure income level, this study used perceived economic status, instead of asking participants' income directly, to avoid participants' reluctance to reveal personal/privacy information. Age categories included (1) 18–29 years old, (2) 30s, (3) 40s, (4) 50s, and (5) 60s and older. Perceived economic status was also measured at the interval-level and included potential responses of (1) Low, (2) Low-to-middle, (3) Middle, (4) Middle-to-high, and (5) High. Similarly, education categories included (1) Elementary Education, (2) Middle School Education, (3) High School Education, (4) College Education, (5) Grad School or Higher.

Participants and Data Collection Procedure

After receiving IRB approval from a southern U.S. university, this study employed an online survey tool (Survey Monkey) and collected data through the social networking service Facebook. The first page of the online survey included a consent form that explained the research in a detailed manner as directed by the IRB at the host university. Initially, researchers recruited volunteer students in three junior- and senior-level college classes in the field of communication and asked them to post the survey link to their Facebook

pages once a week for three weeks. A total of 58 students participated in this data collection procedure and showed our research team their Facebook pages with our survey links.

Students then shared surveys through social media with their connections. The participants' Facebook posts with the survey link contained a couple of sentences of invitational message and provided the names of the department and university conducting the research. Although the data collection began through students' Facebook pages, due to the networking nature of social media, the data shows a higher proportion of general adults than college students. The total number of general public participants (N=413) was much higher than that of student participants (N=303) by the end of the data collection period, resulting in a strong snowball sample.

Initially, we received a total 820 returned surveys. However, we excluded 104 responses from analysis due to missing data on the focal variables of perceived susceptibility to flooding and perceived severity of flooding. As a result, 716 complete surveys were entered for data analysis. Respondents were asked if they were college students or not and, although college students may differ in terms of SES, home/business ownership, etc., they are as at-risk for natural disasters as other people in their communities. A series of t-tests revealed no significant differences in the focal variables of RPA and ISE between student respondents and other respondents. Therefore, all of the analyses for this study were conducted without separating student groups from general publics.

Respondents were mostly female (78.7%) and lived in south Louisiana (90.6% with 2.6% in northern Louisiana and 4.6% living out of state); 56.3% were not college students. Almost 60% of respondents indicated they were 18–29 years old, 12% indicated they were in their 30s, 9% indicated they were in their 40s, 12% indicated they were in their 50s, and around 5% indicated they were in their 50s. Respondents were relatively well-educated, with 14% reporting a high school education, 69% reporting a college education, and 14% reporting graduate school or higher. Perceived economic status demonstrated a fairly standard distribution among respondents, with 6% reporting low status, 22% reporting low-to-middle status, 49% reporting middle status, 19% reporting middle-to-high status, and 3% reporting high status.

Analysis

To measure the differences in RPA, this study employed independent samples t-tests for hypotheses with nominal independent variables dividing groups: H1–1, H1–2, H1–3, H1–4, H1–5, H1–6, and H1–7. Since age (H1–8),

Table 6.1. t-Test Results: Risk Perception Attitude (RPA) by Groups

		Yes (=1)		*No (=2)*				
Variables		*M*	*SD*	*M*	*SD*	*t*	*df*	*p*
Live in flood zone?								
	RPA	2.60	0.78	2.33	0.75	4.19	716	0.00**
Flood victim?								
	RPA	2.49	0.76	2.38	0.76	1.52	716	0.13
Business owner?								
	RPA	2.24	0.71	2.43	0.77	-2.18	716	0.03*
Flood insurance?								
	RPA	2.42	0.76	2.39	0.77	-0.71	716	0.48
Dependents?								
	RPA	2.40	0.84	2.41	0.71	-0.11	716	0.91
Homeowner?								
	RPA	2.31	0.77	2.48	0.75	-2.98	716	0.00**
Gender (Male:Y, Female:N)								
	RPA	2.17	0.78	2.46	0.75	-4.01	713+	0.00**

(* $p < .05$ / ** $p < .01$; +Indicates N has missing or refused responses)

perceived economic status (H1–9), and education level (H1–10) variables are continuous, RPA was tested through correlation analyses.

RESULTS

Focusing on the factors identified through the literature review, this study first examined seven hypotheses for RPA. These seven factors included binary answers, "Yes" or "No," which led to t-tests, and three factors were continuous variables tested with Pearson correlations. The results of t-tests revealed those groups who do not live in flood zones, do not own homes, do not own businesses, and are female, had statistically significant higher RPA, while the hypotheses involving flood insurance, being a flood victim, and having dependents were statistically insignificant (See Table 6.1).

Correlation tests with three continuous variables, age, perceived economic status, and education level revealed that perceived economic status was statistically significant and negatively correlated with RPA, while perceived economic status and age were not significantly correlated with RPA (see Table 6.2: Correlation Results). In other words, as perceived economic status increases, risk perception decreases. Those of lower SES have greater RPA.

Table 6.2. Correlation Results among Key Variables

	RPA	*Age*	*Perceived Economic Status*	*Education Level*
RPA	1			
Age	-0.04	1		
Perceived Economic Status	-0.21**	0.24**	1	
Education Level	-0.08	0.07	0.17**	1

(* p < .05 / ** p < .01)

DISCUSSION

Natural disasters are far more critical events in human lives than other disasters in which the causes and consequences can be anticipated. Many times, as in the case of the 2016 Louisiana Flood, human lives are at stake, and the aftermath itself is often unpredictably destructive. Therefore, it is important to construct effective crisis management plans in all the phases of crisis (Coombs, 2007a, b): (1) pre-crisis, (2) crisis response, and (3) post-crisis. The pre-crisis phase is concerned with prevention and preparation. The crisis response phase is when management must actually respond to a crisis. The post-crisis phase looks for ways to better prepare for the next crisis and fulfills commitments made during the crisis phase including follow-up information. In all these processes of crisis management, public risk perception attitude (RPA) is directly related to crisis management at all levels, while information seeking efficacy (or ability) is a core skill that enhances the effectiveness of crisis management. Hence, this study focused on RPA and conducted comprehensive research investigating group differences in RPA.

Recall that previous research and other existing information has left unclear the relationships between living in a flood zone (e.g., FEMA, 2016; Louisiana flood victims unaware they live in a flood zone, 2016), homeownership, gender (e.g., Bord & O'Connor, 1997; Eckel & Grossman, 2008), age (e.g., Hanson, et al., 1979; Peacock, et al., 2005; Wachinger, et al., 2013), perceived economic status (Sjoberg, 2000), education level (e.g., Lave & Lave, 1991; Lee, et al., 2015; Wachinger, et al., 2013) and RPA. Other research has found clear ties between business ownership (e.g., Stewart & Roth, 2001) and RPA. Our data analysis revealed those groups who live in flood zones, do not own homes, do not own businesses, and are female, showed higher RPA. In addition, perceived economic status was negatively correlated with RPA. This result implies campaigns or interventions for improving RPA would be more effective when targeting those who live in nonflood zones, own homes and business, are males, and shows higher economic status. As observed from the

2016 flood in south Louisiana, damages from floods are unpredictable and unbound to any geographical location or demographic categories. Therefore, it is important to enhance the effectiveness of campaigns and intervention by targeting those who have low RPA, regardless their geographical locations or demographic categories. Such targeting would follow standard segmentation practices used in advertising, public relations and marketing, focusing strategic message placement in a variety of social and traditional media.

The concept of pre-crisis response is currently in the news on an international scale, as the United States has pulled out of the Paris Agreement. According to *The Paris Agreement,* its:

> central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives. The Agreement also provides for enhanced transparency of action and support through a more robust transparency framework. (UN, 2017)

Although the United States has removed itself from the Paris Agreement (Rucker & Johnson, 2017), around 150 other nations have continued their participation. The global mentality is that crisis preparation is vital for human survival, and enhancing RPA will play a role. The present study offered valuable insight into RPA that may have value and utility on a global scale, not only for climate change, but for earthquakes, tsunamis, and other types of disasters.

Another issue that appears far less in the RPA literature, but is often seen as newsworthy during and after a disaster, is the topic of people's pets and what can happen to them afterward. In the United States, we increasingly see pets as targets of the crisis response phase. Organizations such as Disaster Animal Rescue Team (NRN-DART) have established missions to help pets in times of disaster (2017). As Sjöberg (1998) noted, RPA may have greater connection to senses of morality and attitudes, and many people who keep pets share such affective bonds with their animals rather than exclusively cognitive bonds.

Finally, with the 2016 flood in Louisiana behind us, we will have many more natural disasters to cope with and survive. Schulz (2015) argues the Pacific Northwest has been an historical target for tsunamis induced by shifts in various tectonic faults within the CSZ. The area has not seen the last of

such seismic and oceanic activity, and currently is ill-prepared for a disaster on such a predicted scale:

> In the Pacific Northwest, the area of impact will cover some hundred and forty thousand square miles, including Seattle, Tacoma, Portland, Eugene, Salem (the capital city of Oregon), Olympia (the capital of Washington), and some seven million people. When the next full-margin rupture happens, that region will suffer the worst natural disaster in the history of North America. (2015)

Although part of the devastation will come from the earthquake tremors and aftershocks themselves, the subsequent tsunami may be more worrisome, and will take a far greater toll in property and human lives. Based on the thousand-year flooding in Louisiana in 2016, the authors offer our survey data of disaster victims and subsequent findings to explore the factors that affect risk perception attitudes (RPA) with earthquakes in the Pacific Northwest. The findings of the present study offer insight into how potentially affected areas should incorporate the concept of RPA into information campaigns designed to help people prepare—and survive—once "The Really Big One" hits the Pacific Northwest.

Between efforts at altering global warming and rising sea temperatures (including coastal erosion; see Zhang, Douglas, and Leatherman, 2004) in the pre-crisis phase and explaining the hazards that both humans and pets may experience in the post-crisis phase, and the potential for a future crisis in the Pacific Northwest, our data suggest attention during both pre- and post-crisis phases may assist in developing reasonable RPAs among crisis-prone publics. Furthermore, the findings in this study provide valuable assets for those living under the threats of earthquakes, tsunamis, floods, and other natural (and possibly even manmade) disasters. Risk perception is a vital variable that researchers should continue to explore to enhance preparedness and reactions to such natural disasters. The present study has demonstrated certain life and demographic conditions that affect RPAs; those in charge of disaster preparation should consider them carefully when preparing for disastrous local events.

LIMITATIONS AND FURTHER RESEARCH

First, RPA is not a fixed variable and may change over time within a sample. This study relied on cross-sectional data, which does not account for the dynamics involved with the passage of time. Future studies should consider using time-series data or other means to create longitudinal studies of RPA associated with natural disasters. Second, the data was collected within

months of the historic flooding that brought south Louisiana to its knees. RPA may have been at unusual highs during the data collection period. Again, future research should incorporate longitudinal studies to assess the dynamics of RPA before, during, and after natural disasters. Third, these studies relied on self-reports. Although self-reports are not without their merits, additional multimethod studies would be of great use. Content analysis of social media, qualitative interviews and/or focus groups, and possibly even "big data" collected from electronic devices across a disaster-stricken region may provide a broader picture of RPA and how to manage it at each of Coombs' (2007a, b) phases of crisis response.

Finally, feeling uncertain is an uncomfortable state of mind that generally leads human beings to find ways to reduce it (Berger & Calabrese, 1975). Related to the nature of uncertainty associated with natural disasters, individuals who possess a high level of RPA—those who may feel uncertain or may be vulnerable to natural disasters—would try to reduce their uncertainty. Therefore, in consideration of the effectiveness of communicative interventions, this study suggests that uncertainty reduction methods may include education for seeking information by using communication technologies including web-searching, emails, social media and other means that may be available in isolated situations.

Discussion Questions

1. How strong is the relationship between risk perception attitude and actual behavior change for natural disaster preparedness? In other words, has the increase of risk perception attitude really led behavior changes to prepare for future natural disasters?
2. Are factors affecting risk perception attitude different by types of natural disasters (e.g., earthquakes, tsunami, and wildfire)? If so, what are the factor differences among different natural disasters?
3. What are the unique factor(s) affecting risk perception attitude on a major natural disaster in your town (or culture)?
4. Do you know the locations and contact information of emergency shelters for victims of natural disasters in your town? If you don't know, where can you get information about the shelters in your town?

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Chapter 7

Economic Evaluation of Multi-Hazard Risk Information in Japan

Implication for Earthquake Risk Communication

Hiroaki Matsuura and Keiichi Sato

"Earthquake, Thunderbolt, Fire and Father"

(Japanese old saying about four major terrors in daily life)

Communicating disaster risks to the public is a crucial component of natural disaster mitigation and preparedness strategy. This chapter discusses issues of risk communication by using hazard maps of earthquake and other natural disasters in Japan. The aim of this chapter is to provide Japan's experience of disaster risk communication using hazard maps and help U.S. Americans better prepare for the next Cascadia megathrust earthquake.

> The devastation in Japan in 2011 was the result of a discrepancy between what the best science predicted and what the region was prepared to withstand. The same will hold true in the Pacific Northwest—but here the discrepancy is enormous. (Schulz, 2015, para. 27)

The Cascadia Subduction Zone (CSZ) off the west coast of North America, ranging from northern California to southern British Columbia, could deliver within the next 50 years the worst earthquake and resulting tsunami people in the region have ever experienced (Atwater et al., 2016). In a 2013 report, the Cascadia Region Earthquake Working Group estimates that if a magnitude 9.0 earthquake happens, the number of deaths may exceed 10,000 and more than 30,000 people could be injured. This would also result in economic losses of up to $70 billion (Cascadia Region Earthquake Working Group, 2013).

In the 1980s, the Cascadia fault was believed to be benign by most researchers. A line of research, most notably by Atwater and Satake, identified that the most recent major Cascadia earthquake occurred with an estimated magnitude of 8.7–9.2 in 1700 (Nelson, Atwater, Bobrowsky, &

Bradley, 1995; Satake, Shimazaki, Tsuji, & Ueda, 1996; Yamaguchi, Atwater, Bunker, Benson, & Reid, 1997). This megathrust earthquake caused a tsunami that struck the coast of Japan, and might have been connected to the Bonneville Slide and the Tseax Cone eruption in British Columbia at that time (Higgins, 2009; Pringle, O'Connor, Schuster, Reynolds, & Bourdeau, 2002). The probability of the next Cascadia megathrust earthquake has ranged from 10 to 40% within the next 50 years. The 2012 report published by the U.S. Geologic Survey estimated the probability of a magnitude 9.0 earthquake at roughly 10% within the next 50 years (Goldfinger et al., 2012). But this number only applies to the northern part of Cascadia. It increases up to about 37% down in the southern part of the CSZ (located offshore, ranging from Cape Mendocino, CA to Florence, OR). The debate is far from settled. A recent study estimated even higher probability of the megathrust earthquake in Oregon, Washington, and British Columbia (Goldfinger et al., 2017).

Understanding the risks and potential consequences of the next Cascadia earthquake and its associated disasters are crucial for promoting risk awareness among the public, for designing evacuation procedures and for future economic planning in the region. However, limited information is available to help us prepare for the next Cascadia earthquake.

In order to understand the nuances of what the CSZ region is up against, we can look at other areas of the world more familiar with earthquake disasters. Japan has had many large earthquakes and has a higher earthquake risk than anywhere else in the world. This is because the country is situated in a complicated plate boundary where the Pacific plate, the Philippine Sea plate, the Eurasian plate and the North American plate meet. The most recent megathrust earthquake with a magnitude of 9 or greater occurred in the Japan Trench subduction zone, where the North American plate and the Pacific plate met in 2011. On March 11, 2011, one of the biggest earthquakes in recorded history stuck the Tohoku region, which is located in the northern part of Honshu (main) island. The earthquake with a moment magnitude of 9.0, together with the subsequent tsunami, caused extreme devastation to life, property, and infrastructure across wide areas of the Eastern Japan region. The National Police Agency of Japan confirmed 15,893 deaths, 2,572 missing, and 6,152 injured in the disaster (Headquarters for Emergency Disaster Countermeasures, 2017).

Like the Cascadia megathrust earthquake, the next Nankai Trough megathrust earthquake has been anticipated for decades by researchers, but has not yet occurred (Ando, 1975). The Nankai Trough is perhaps the world's best studied subduction zone, where large earthquakes have repeatedly occurred in a 90 to 150-year cycle (Earthquake Research Committee, 2013).[1] Nankai Trough is structurally quite similar to CSZ. According to the thermometric classification, both subduction zones are classified into a

warm-slab subduction zone, which is characterized by the slow subduction of young oceanic crust (Wang, Wada, Kaneda, Goldfinger, & Ito, 2008). The government's figures put the odds of a magnitude 8.0–9.0 Nankai Trough earthquake at 70% within the next 30 years (Earthquake Research Committee, 2013).

This chapter discusses issues of risk communication by using hazard maps of earthquakes and other natural disasters in Japan. Given the relatively high probability of the next Nankai Trough megathrust earthquake and the fact that earthquakes are part of daily life in Japan, Japanese people have a relatively high awareness of earthquake risks. According to a public opinion survey in 2013, 80.4% of Japanese people have imagined that they and/or their family would be victims of an earthquake and 89.2% of people had done at least some preparation for earthquakes (Cabinet Office, 2013). On the other hand, people in Oregon have a relatively low awareness of earthquake risks. A 1999 survey by the Oregon Department of Geology and Mineral Industries showed that only 39% of respondents think an earthquake will occur in Oregon within the next 10 years and only 28% of Oregon residents are prepared for an earthquake (Oregon Natural Hazards Workgroup, 2003).

How can we effectively promote public awareness and help people to prepare for the potential megathrust earthquake in the CSZ? Unfortunately, people living in the major cities in the CSZ are quite unprepared for the next megathrust earthquake. This chapter evaluates risk communication efforts regarding earthquakes and other natural disasters in Japan by using a hedonic pricing approach. Our main interest is to figure out what types of disaster risk information can reduce perceived amenity value of land, which ultimately leads to the reduction in land price in the real world, and how can we improve the effectiveness of earthquake risk communication in order to ensure that more people will behaviorally respond to the disaster risk information provided.

EARTHQUAKE PREPAREDNESS IN JAPAN

Japan is more prepared than any other country on the planet for potential earthquake hazards. In 1961, the Disaster Countermeasures Basic Act (Act No. 223 of 1961) was first enacted. This act has been continuously reviewed and revised based on lessons learned from other large natural disasters, such as the Great Hanshin Awaji Earthquake of 1995 and the Great East Japan Earthquake of 2011.

As part of the government's effort to communicate the risk of earthquakes and related natural hazards, hazard information has been regularly produced and disseminated to the public. Hazard information allows people to calculate

the risks of natural disasters before they actually occur and assess and prepare for potential damage. Since natural disasters are closely tied to a specific location, hazard maps are widely used to disseminate and educate residents of the region. As early as 1951, Japan had already prepared a seismic hazard map (Kawasumi, 1951). Since 2005, the National Seismic Hazard Maps have been prepared by the Headquarters for the Earthquake Research Promotion of the Ministry of Education, Culture, Sports, Science and Technology (Headquarters for Earthquake Research Promotion Earthquake, 2014). According to a public opinion survey in Japan in 2013, hazard maps published by central and local governments are the third major source of disaster information after TV/radio news program and TV/radio programs on disaster preparedness (Cabinet Office, 2013).

While hazard maps can be effective tools for promoting risk awareness among the public, for designing evacuation plans, and for helping to determine residential and work locations, there are several drawbacks to using hazard maps for risk communication.

First, assessing disaster risk is a probabilistic exercise. It is extremely difficult for even seismologists to assign the appropriate probability of disaster occurrence. Any hazard maps would communicate the hazard poorly if the risks are seriously underestimated or, indeed, overestimated. Unfortunately, the scientific understanding of earthquakes does not yet allow for precise earthquake prediction. For example, the 2010 version of a seismic hazard map in Japan predicted less than 0.1% probability of shaking with a JMA seismic intensity scare of "6-lower" in Tohoku within the next 30 years. However, within two years the Great East Japan earthquake occurred. Stein and his colleagues pointed out that the reason for this failure of prediction is that Tohoku had no historical records of magnitude 9 or greater earthquakes,[2] and this fact backed an incorrect hypothesis that large earthquakes would not be a major threat to this area (Stein, Geller, & Liu, 2012). The damage expectation and the probable occurrence for the next Nankai Trough earthquake have been revised by government agencies as a result of this failure of prediction (Cabinet Office, 2012; Headquarters for Earthquake Research Promotion Earthquake, 2001).

The second drawback of hazard maps is that it is worrying that such inaccurate information may affect the value of real estate or other economic activities. There are concerns that the information on hazard maps decreases the value of real estate in the identified high-risk area. There are also opposite risks that the information on hazard maps may be treated as safety information and increase the value of real estate that is actually dangerous.

Third, hazard maps should be easy to understand and easy to use for evacuation purposes. Users of hazard maps should be aware of the limitations and

uncertainties of the information they contain. However, such background information is often not available or accessible by the users of hazard maps.

Fourth, even if hazard maps are accurately and properly prepared by experts, hazard maps cannot be an effective communication tool if users of hazard maps overestimate or underestimate the risks of natural disasters described in them. People face different risks in their everyday life. If people overestimate the risks of earthquake and underestimate the risks of other disasters, they may end up increasing their total disaster risk.

Despite these limitations, hazard maps are believed to be a useful tool that helps local government and communities understand the risks of an earthquake they may experience. Single hazard maps are good enough for this purpose, but recently the development of multiple hazard maps is expected to provide local governments and communities with science-based data for a comprehensive understanding of existing risks in their area. The next section discusses the issues of multiple hazard assessment and a hedonic approach before we go into the analysis of multiple hazard risk information by using a hedonic approach.

MULTIPLE HAZARD RISK INFORMATION

Earthquakes are not the only natural disaster we should be concerned about in everyday life. The impacts of one natural disaster are often exacerbated by interactions with other disasters (Marzocchi, Mastellone, Di Ruocco, Novelli, & Gasparini, 2009). For example, megathrust earthquakes can trigger tsunamis, sediment disasters, volcanic eruptions, and cause flooding. As mentioned previously, the Cascadia earthquake of 1700 caused a tsunami that struck the coast of Japan, and possibly connected to the Bonneville Slide and the Tseax Cone eruption in British Columbia (Higgins, 2009; Pringle et al., 2002; Satake et al., 1996). However, existing risk assessments mostly focus on a single type of disaster. There are two different approaches in evaluating multiple hazard risks: the Multi-Hazard Risk Assessment (MHRA) and the Hedonic Pricing Approach. These two approaches have not previously been compared in the literature. We will explain each method in this section and provide advantages for employing a hedonic pricing approach over a multi-hazard risk assessment approach to analyze earthquakes and other natural disaster risks in Japan.

Multi-Hazard Risk Assessment (MHRA)

MHRA was developed to combat the limitations of the single-hazard risk assessment (Armonia Project, 2006; Di Mauro, Bouchon, Carpignana, Golia,

& Peressin, 2006; Marzocchi, Selva, et al., 2009). The method is based on the single-hazard risk assessment, but also considers hazard interactions. The aim is to develop a more comprehensive understanding of risk by assessing and mapping either the relative danger or expected losses due to the occurrence of multiple natural hazards in a specified area (Armonia Project, 2006; Dilley, 2005). Two major MHRA approaches exist to date: one to develop a risk index and the other uses a mathematical statistics approach (Liu, Siu, Mitchell, & Xu, 2016).

In the risk index approach, risk is computed as the product of hazard, exposure and vulnerability. Risk analyses are carried out separately for each risk and then combined into a single index. On the other hand, in the mathematical statistics approach, risk is computed as the product of probability and consequence. These two risk assessment approaches are distinct, in that the risk index method primarily serves to support an understanding of the relative importance of hazard, vulnerability and exposure of multiple risks, and the interaction between these elements in the overall determination of risk (Shi, 1996; Wisner 2004). On the other hand, the mathematical statistics method expresses risk as probabilistic loss, and is useful in estimating human lives and economic losses from potential future disaster (Shi, 1996; Wisner, 2004).

In the United States, for example, FEMA developed a methodology and software program called the Hazards U.S. Multi-Hazard (HAZUS-MH) by using a mathematical statistics method (Federal Emergency Management Agency [FEMA], 2017). This program allows a user to estimate losses from damaging earthquakes, hurricane winds, and floods before a disaster occurs. The State of South Carolina hazards assessment 2008 was conducted by using risk an index approach (SCEMDOAG, 2009). This covers a more comprehensive list of disasters, from coastal events, to geophysical events, to human-induced hazard events, to climate-hazard events. Surprisingly, Japan does not currently have any comprehensive multi-hazard risk assessment maps.

While the MHRA approach is quite intuitive and straightforward, the examination of multiple hazard risk poses additional challenges. First, we do not always have a sufficient set of information on the hazard, exposure, and vulnerability (or probability and consequence) of natural disasters in order to calculate accurate risks in each location. Second, this method strongly depends on the availability of data of adequate quality, resolution, and recording length in each natural disaster. Third, the researchers of MHRA face a complex problem of aggregating different types of disaster risk information. Other professional judgments are also required to compute overall risks in each location.

Hedonic Pricing Approach

The hedonic pricing approach is commonly used for economic evaluations of amenity (dis-amenity) that directly affect market prices of land or other goods. The method was originally developed by Court, but later reinvented by Griliches (Court, 1939; Griliches, 1961). Rosen (1974) further popularized this approach in economics by connecting this approach with economic theory. The hedonic pricing method is based on the assumption that products can be considered aggregates of different attributes with different units and scales. This trait is ideal because we can analyze different types and attributes of hazard risks in a single regression without worrying about aggregating different types and attributes with different units. Since natural disasters are mostly exogenous and tied to a specific location, risks or perceived risks of natural disasters can be reflected in local land and housing prices.

Although the hedonic pricing approach is capable of analyzing multiple disasters with different units in a single equation, much of the literature focuses on the effect of a single natural disaster in Japan and the United States. For example, Brookshire and his colleagues (1985) examined the effects of the disclosure of an earthquake hazard map in California by using the hedonic pricing approach. They found that the disclosure of hazard maps have a significantly negative impact on land prices (Brookshire, Thayer, Tschirhart, & Schulze, 1985). Researchers in Japan also examined the effect of an earthquake on land and housing prices by using the same approach. Nakagawa and his colleagues found that housing and land prices are substantially lower in the areas with substantial exposure to earthquake risk in the Tokyo metropolitan area (Nakagawa, Saito, & Yamaga, 2007, 2009). There are also some studies on the disclosure of flood hazard maps. Several studies found that land prices are substantially lower in the areas in a flood plain in Japan and the United States (MacDonald, White, Taube, & Huth, 1990; Miyata & Abe, 1994; Shilling, Benjamin, & Sirmans, 1985).

The hedonic pricing approach focuses on subjective risk perceptions of consumers rather than objective risk measures by professionals (Kniesner, Viscusi, Woock, & Ziliak, 2007). People behaviorally respond to the different dimensions of natural disaster risks inasmuch as people know about them. The assumption in almost all previous studies is that the subjective risk assessments can be proxied by objective measures of risks. This is distinct from the MHRA approach, where risk is computed as the product of the objective measurement of hazard, exposure and vulnerability. In the MHRA approach, professionals cannot compute risk if one or two of the components of risk (hazard, exposure and vulnerability) is missing. In the hedonic approach, however, we do not need all sets of data to evaluate the risks of natural disasters. If people know only "hazard of earthquakes," they will respond

to it without acknowledging the exposure and vulnerability of earthquakes that are unknown to them.

This chapter employs the hedonic pricing approach to evaluate multiple natural disaster risks in Japan, and it improves on previous literature on the topic due to the following. First, many studies have focused on the effects of one single disaster on the housing market. In contrast, this chapter examines the effects of five different natural disasters (i.e., earthquakes, floods, sediment disasters, tsunamis, and volcanic eruption) and their interactions with land prices in Japan. Second, there has been no comprehensive MHRA study to date in Japan due to the rigorous set of data required. Fortunately, the hedonic pricing approach is much less data-demanding than the MHRA approach. We do not require accurate, timely, comprehensive and reliable data of all exposure, hazard, and vulnerability. Third, this approach allows us to avoid complex aggregation problems among different dimensions of disaster risks. The coefficients of hedonic regression tell us which natural disasters or components of risk people really care about.

The rest of the chapter examines the effects of five different public disaster risk information areas (i.e., earthquakes, river flooding, sediment disasters, tsunamis, and volcanic eruption) on land prices in Japan. Using 250m-mesh level of disaster risk information data, matched with postal addresses of published land price monitoring points, we analyze the following effects: (1) the 30-year probability of an earthquake occurrence with a Japan Meteorological Agency seismic intensity scale of upper-6 or more, (2) the 30-year probability of river flooding (or an above-floor flood inundation), (3) the sediment disaster prone area, (4) distance from seashore, and (5) distance from active volcanic vent on the published land price.

The next two sections provide an overview of the data used and explains estimation methods used in this chapter before presenting the results of the empirical analysis. The final section concludes with key takeaways in preparing for the next Cascadia earthquake based on our findings from our Japan case study.

BACKGROUND DATA

Japan has faced not only earthquakes and floods, but also sediment disasters, tsunamis, volcanic eruptions, and other natural disasters. The government of Japan is diligently working to develop a nation that is more resilient against these natural disasters by periodically updating a wide variety of disaster risk measures and constantly incorporating the latest scientific knowledge of them. According to a public opinion survey in 2013, 80.4% of people have imagined that they and their family would be victims of an earthquake one

day (Cabinet Office, 2013). This was followed by tornado, gust, and typhoon (48.1%), river flood (19.6%), tsunami (17.8%), sediment disaster (13.2%), heavy snow (9.7%), and volcanic eruption (5.9%). We exclude two weather-related hazards (i.e., tornado, gust, and typhoon and heavy snow) from this list in our analysis, because these two are more likely to be captured by real-time hazard detection rather than long-term risk assessment.

Earthquake Risk Information

The National Seismic Hazard Maps in Japan have been prepared by the Headquarters for Earthquake Research Promotion at the Ministry of Education, Culture, Sports, Science and Technology since 2005 (Headquarters for Earthquake Research Promotion Earthquake, 2014). The National Seismic Hazard Maps for Japan consist of two types of maps that are different in nature: the Probabilistic Seismic Hazard Maps (PSHM) and the Scenario Earthquake Shaking Maps (SESM). In this study, we use the former. The PSHM show the relation between seismic intensity value and its probability of exceedance[3] within a certain time. This exceedance probability is calculated by combining the earthquake occurrence model, seismic source model and subsurface structure model to calculate the predicted probability of different intensity levels at each 250-mesh code level (Headquarters for Earthquake Research Promotion Earthquake, 2014). The data on earthquake information comes from the Japan Meteorological Agency (JMA) seismic intensity scale ("shindo"), which measures shaking on the earth's surface. This is distinct from the Moment Magnitude Scale, which attempts to describe the energy released by the earthquake. JMA seismic intensity scare is graded from 0 to 7. We use the 30-year probability of earthquake occurrence with the JMA seismic intensity scale of upper 6 or greater in this analysis. Figure 7.1 shows the 30-year probability of earthquake occurrence with the JMA seismic intensity scale of upper 6 or greater.

River Flooding

The Flood Control Act (Act No. 193 of 1949) requires river administrators such as the Ministry of Land, Infrastructure, Transport and Tourism and prefectural governments to designate river flood inundation areas. The act also requires municipalities to prepare and disseminate flood hazard maps to the residents of municipalities with potential river flood inundation areas.

Flood hazard maps along major rivers are created based on flood simulations. The amendment of the Flood Control Act in 2015 introduced disaster reduction measures for the largest-scale river flood. Before 2015, river flood inundation areas were identified by simulation with the hypothetical

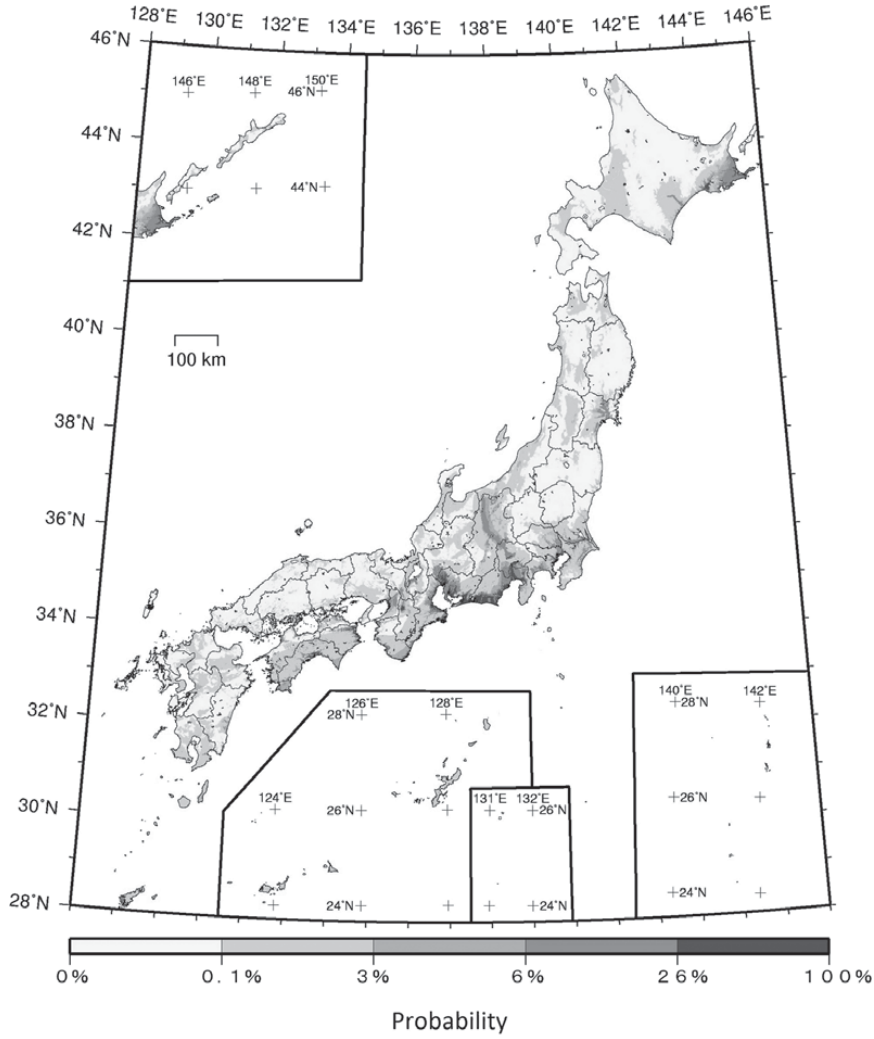

Figure 7.1. The 30-year probability of earthquake occurence with the JMA seismic intensity scale of upper 6 or greater. *Photo taken by first author.*

rainfall events with return periods of 100 or 200 years. However, after this amendment, flood inundation areas must be identified by simulation with the hypothetical rainfall events of multiple magnitudes up to a possible maximum scale.

According to the hazard map portal site of the Ministry of Land, Infrastructure, Transport and Tourism, as of December 2015, 1,310 out of 1,718 municipalities (76.3%) published flood hazard maps by printing materials (2007–present). In addition, they released 1,226 published hazard maps online to the public.

The data are downloadable from the National Land Numeral Information Download Service. The original data are given as polygon data of flood inundation areas in each municipality. Following the method of Sato and his colleagues, we calculate the 30-year probability of flood inundation above floor level occurrence (Sato et al., 2016).[4] The final data on the 30-year probability of above floor inundation occurrence are provided by 250-mesh code level.

Tsunami

The revision of the Flood Control Law of 2015 also requires prefectural governors to create hazard maps for flooding from inland waters, storm surge, and tsunamis. However, the coverage of these hazard maps is much lower than the river flood hazard maps. For flooding from inland waters and storm surge, only 17.7 and 6.5% of municipalities published hazard maps, respectively (Ministry of Land Infrastructure Transport and Tourism, 2007–present). People living in more than 80% of municipalities have no way of knowing these potential hazards. Since we cannot analyze disaster risks that are unknown to residents in the hedonic pricing approach, we exclude flooding from inland waters and storm surge from the analysis.

For tsunamis, 567 or 33% of municipalities published hazard maps regarding a potential tsunami (Ministry of Land Infrastructure Transport and Tourism, 2007–present). Although such information is relatively new and two thirds of municipalities do not provide such information, people generally have a good sense of tsunami risk simply by calculating the distance of their own house from coastal lines. Thus, we use the distance from the coastal line as a proxy for the risk of tsunami.

A dummy variable of within 1.5km distance inland from the seashore was defined as 1 if a land price monitoring site is within 1.5km distance inland from the seashore, otherwise the value was set to 0. A dummy variable of within 0.5km distance inland from the seashore was defined as 1 if a land price monitoring site is located within 0.5km distance inland from the seashore, otherwise the value was set to 0.

Sediment Disaster Prone Areas

Sediment disaster is defined as a disaster where houses, roads and land are buried through the collapse of land mass of sediment (Sediment Disaster Prevention Publicity Center, 2016). Sediment disasters include debris flow, landslide, slope failure and others. The act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas of 2000 (Act No. 57 of 2000) requires prefectural and city governments to investigate the geography, precipitation, land use and other factors in water-vulnerable areas approximately every five years. Information from these investigations is used to create the designation of sediment disaster prone areas, commonly known as "yellow zone." This is an area vulnerable to sediment disasters where residents in the area are at risk of their lives and health.

The data used are from the map of designation of sediment disaster prone areas downloadable from the National Land Numeral Information Download Service. A dummy variable for the sediment disaster prone area was defined as 1 if a land price monitoring site is located in the sediment disaster prone area, otherwise the value was set to 0.

Volcanic Eruption

Since its establishment in 1974, the Coordinating Committee for Prediction of Volcanic Eruption (CCPVE) has reviewed activities of volcanoes throughout Japan and selected a list of active volcanoes. Based on these results, the Japan Meteorological Agency first published the National Catalogue of the Active Volcanoes in Japan in 1975. In 2003, the CCPVE adopted the internationally accepted definition of active volcanoes as " … volcanoes which have erupted within the past 10,000 years, and/or volcanoes with current fumarolic activity" (Japan Meteorological Agency, 2013). Based on this new definition, the committee reselected active volcanoes, publishing the new National Catalogue of the Active Volcanoes in Japan in 2005. As of June 2017, there are 111 active volcanoes in the catalogue.

Explosive volcanic eruptions can cause widespread tephra dispersal. Tephra particles larger than 64mm (so-called "volcanic bombs" or "volcanic blocks") that are ejected from a volcanic vent can go in any direction without being affected by wind and can cause serious damage to life, property and infrastructure. However, they rarely reach more than about a three-kilometer radius from the vent since they are quite heavy. Taking the risk of volcanic bombs/volcanic blocs into account, we calculate the distance of each land price monitoring site from the nearest active volcano. Then, we create the following dummy variables. A dummy variable for within 3km distance from the nearest active volcano defined as 1 if a land price monitoring site

is located within 3km distance from an active volcano, otherwise the value was set to 0.

Lapilli (2–64mm) that are released upward by the heat of the eruption will fall out farther from the volcano. Lapilli are affected by wind direction. Since wind direction differs from season to season, and is often different at higher levels, the amount of lapilli fall and the consequent damage in any place will depend on the time or year in which the eruption occurs, as well as the strength of the eruption. However, we know that most particles greater than a millimeter in size will fall within 30 kilometers of the eruption (Association for the Geological Collaboration in Japan, 2014). Thus, we simply use distance from active volcanos as a proxy to take risks of lapilli from a volcanic eruption. Dummy variables for within 30km distance from active volcanos was defined as 1 if a land price monitoring site is located within 30km distance from an active volcano, otherwise the value was set to 0.

How far away can ash (<2 mm) be deposited? We can learn from the Hoei eruption of 1707, which is one of the biggest volcanic eruptions in Japanese history. The last eruption of Mount Fuji, Japan's tallest mountain, started on December 16, 1707. This eruption was ranked as a VEI 5 according to the Volcanic Explosivity Index and the ash blanketed the surrounding areas, reaching as far as 100km away (Chesley, LaFemina, Puskas, & Kobayashi, 2012). Although there were no deaths directly associated with the Hoei eruption, many people's daily lives were affected as a consequence of the volcanic activity.

A dummy variable for within 100km distance from active volcanoes was defined as 1 if a land price monitoring site is located within 100km distance from an active volcano, otherwise the value was set to 0. Since there are no deaths associated with the Hoei eruption, we use this dummy variable only for the purpose of a robustness check.

Land Price Data

This study uses Published Land Price (Koji-Chika) data published on January 1, 2015. The Land Appraisal Committee, under the Ministry of Land, Infrastructure, Transport and Tourism, publishes land prices of monitoring sites selected by the Committee as of January 1 every year since 1970. Published land price is a survey of "fair" market value by the qualified appraisers. Generally speaking, "price" means the "transaction price" in economics. However, lands are a special kind of durable goods that are sold only infrequently. Each transaction price is mostly determined by one-to-one negotiation, rather than competitive market or auctioning. Thus, information asymmetries are common in the land market.

The Published Land Price has been used as a benchmark for the transaction of land. The disclosure of the published land price is increasingly considered to be critical to establishing transparent and fair land market transactions. The price is now used as a bench mark for land transactions in private deals, real estate appraisal, valuation of public land acquisition, an estimate for compensation for compulsory land acquisition by the government, and other transactions (Shimizu & Nishimura, 2006). The data are downloadable from the Land Comprehensive Information System and Library webpage of the Ministry of Land Infrastructure Transport and Tourism (2017).

Other Control Variables

Omitted variable bias in multiple regression occurs when excluded omitted variables are correlated with both the explanatory variable of interest and the outcome variable. In this study, we control for variables that are potentially correlated with both land price and our variables of natural disasters. These control variables come from the Published Land Price in 2015. The variables include building structure characteristics variables (wood flame dummy, light-gauge steel dummy, steel reinforced concrete dummy, and reinforced concrete dummy), road variables (national road dummy and prefectural road dummy), building coverage ratio, floor-area ratio, acreage, and distance to the nearest railway station. Building coverage ratio stands for the ratio of the Building area divided by the land area. Floor-area ratio stand for the ratio of Total floor area divided by Land area.

METHOD

The hedonic pricing model decomposes land price into various components, such as disaster risks and other traits of the land that affect the price. We estimate the following regression:

$$\log\left(LANDPRICE_{i,c,m}\right) = \begin{array}{l}\alpha_m + \beta_1 * Earthquake_c + \beta_2 * Flood_c + \beta_3 * Landslide_i + \\ \beta_4 * Volcano_{3km\,i} + \beta_5 * Volcano_{30km\,i} + \beta_6 * Tsunami_{1km\,i} + \\ \beta_7 * Tsunami_{5km\,i} + Xb + \varepsilon_i\end{array}$$

where the dependent variable is the logged published land price as of January 1, 2015 in monitoring site i in 250m grid cell c in municipality m. We include the municipality fixed effects as well as the probability of earthquake occurrence, probability of river flooding, a dummy variable for sediment

disaster prone areas, a dummy variable for within 3km from active volcanoes, a dummy variable for within 30km from active volcanoes, a dummy variable for within 0.5km inland from the seashore, and a dummy variable for within 1.5km inland from the seashore. X is a set of other control variables that includes log(building coverage ratio(%)), log(floor-area ratio(%)), log(acreage(m^2)), wood flame dummy, light-gauge steel dummy, steel reinforced concrete dummy, reinforced concrete dummy, water supply dummy, gas dummy, sewage dummy, national, prefectural, municipality and private roads, and second, third, and fourth quartile dummy variables for distance from the nearest railway station. The estimated parameters of the model provide information about the relative contribution (significance and magnitude of effect) of natural disasters and any given land features.

RESULTS

Table 7.1 presents the summary statistics of the data used in the analysis. Published land price and its associated data are given as point data. There are 23,363 data points (land price monitoring site) in the Published Land Price in 2015. The probability of earthquake occurrence and probability of river flooding occurrence are given as 250-meter mesh data. We use these data alongside matched postal addresses of the published land price monitoring point in Japan. Average probability of earthquake occurrence in all 23,363 monitoring sites is 11.2%. About 2.4% of these sites record the probability of earthquake occurrence at more than 50%. Probability of river flooding or above-floor flood inundation is 7.6% on average. About 1.1% of them record the probability of river flooding at more than 50%. About 16.8% of the monitoring sites are located in sediment disaster prone areas. Only 0.1% are located within 3km from an active volcano, but 11.4% are located within 30km from an active volcano. Just 5.9% are located in the areas within 0.5km from the seashore, while 15.3% are located within 1.5km from the seashore.

Table 7.2 presents the correlation matrix of the disaster risk information variables. Earthquake risks are positively correlated with river flooding and tsunamis, but negatively correlated with sediment disasters and volcanic eruption risks. A high probability of earthquake occurrence (more than 50% probability in the next 30 years) is positively correlated with river flooding and tsunamis, but negatively correlated with sediment disaster risks. The correlation between a high probability of earthquake occurrence and the proximity of active volcanoes seems to be a little inconsistent. The probability of earthquake occurrence in the area between 3 and 30 kilometers from an active volcano is 1.4 times as high as the probability of those in the area further than

Table 7.1. Descriptive Statistics

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Published land price in 2015	23,363	180214	773822	530	34000000
Log(Published land price in 2015)	23,363	11.2	1.1	6.3	17.3
sLog(Building coverage ratio)	23,345	4.1s	0.2	3.4	4.4
Log(Floor-area ratio)	23,345	221.6	123.9	50	1300
Log(Acreage)	23,363	5.6	0.9	3.8	13.9
Wood dummy	22,828	0.626	0.484	0	1
Light-gauge steel dummy	22,828	0.235	0.424	0	1
Reinforced concrete dummy	22,828	0.106	0.308	0	1
Steel reinforced concrete dummy	22,828	0.031	0.173	0	1
Water supply dummy	23,363	0.996	0.062	0	1
Gas dummy	23,363	0.645	0.478	0	1
Sewage dummy	23,363	0.873	0.333	0	1
the 2nd quartile dummy for distance from the nearest station	23,363	0.217	0.412	0	1
the 3rd quartile dummy for distance from the nearest station	23,363	0.283	0.45	0	1
the 4th quartile dummy for distance from the nearest station	23,363	0.25	0.433	0	1
National road dummy	23,363	0.058	0.234	0	1
Prefectural road dummy	23,363	0.103	0.304	0	1
Municipality road dummy	23,363	0.79	0.407	0	1
Private road dummy	23,363	0.03	0.172	0	1
Probability of earthquake occurrence	23,363	0.112	0.132	0	0.682
Probability of earthquake occurrence >50% dummy	23,363	0.024	0.152	0	1
Probability of river flooding occurrence	23,363	0.076	0.132	0	0.982
Probability of river flooding occurrence >50% dummy	23,363	0.011	0.103	0	1
Sediment disaster prone area dummy	23,363	0.168	0.374	0	1
<3km distance from active volcanoes dummy	23,363	0.001	0.032	0	1
<30km distance from active volcanoes dummy	23,363	0.114	0.318	0	1
<0.5km distance from seashore dummy	23,363	0.059	0.235	0	1
<1.5km distance from seashore dummy	23,363	0.153	0.36	0	1

Table 7.2. Correlation Matrix of Disaster Risk Information

		Earthquake		*River Flooding*		*Sediment disaster prone area*	*Volcanic eruption*		*Tsunami*	
		Prob.	*>50%*	*Prob.*	*>50%*		*<3km*	*<30km*	*<0.5km*	*<1.5km*
Earthquake	Prob.	1								
	>50%	0.5376	1							
River Flood	Prob.	0.2397	0.1114	1						
	>50%	0.0719	0.0550	0.4501	1					
Sediment disaster prone area		-0.1034	-0.0136	-0.1173	-0.0090	1				
Volcanic eruption	<3km	-0.0177	-0.0050	-0.0120	0.0097	0.0070	1			
	<30km	-0.0294	0.0177	-0.0185	0.0046	0.0235	0.0894	1		
Tsunami	<0.5km	0.0338	0.0531	-0.0590	0.0093	0.115	0.0374	0.0105	1	
	<1.5km	0.0649	0.0689	-0.0399	0.0100	0.1175	0.0197	0.0175	0.5877	1

30 kilometers from an active volcano. However, the probability of earthquake occurrence is 0 in the area within 3 kilometers from any active volcano vents.

Table 7.3 presents the results of the regression analysis. The dependent variable is the log published land price. By this way, we can interpret a regression coefficient of each disaster risk variable as the% change of published land price with respect to a one-unit increase in a disaster risk variable, holding all other variables constant.

In the first column, explanatory variables include probability of earthquake occurrence, probability of river flooding occurrence, a dummy variable for sediment disaster prone areas, a dummy variable for within 3km of an active volcano, a dummy variable for within 30km of any active volcanoes, a dummy variable for within 0.5km inland from the seashore, and a dummy variable for within 1.5km inland from the seashore as well as municipality

Table 7.3. Regression Results

Dependent Variable=Published Land Price	*(1)*	*(2)*	*(3)*	*(4)*
Probability of earthquake occurrence	0.279	-0.00892		
	(0.2970)	(0.1200)		
Probability of earthquake occurrence >50% dummy			-0.0305	-0.0606
			(0.0355)	(0.0462)
Probability of river flooding occurrence	0.0615	-0.0382		
	(0.0746)	(0.0423)		
Probability of river flooding occurrence >50% dummy			-0.0894**	-0.0924***
			(0.0368)	(0.0289)
Sediment disaster prone area dummy	-0.270***	-0.116***	-0.281***	-0.116***
	(0.0313)	(0.0200)	(0.0302)	(0.0207)
<3km distance from active volcanoes dummy	-0.173	-0.0916	-0.169	-0.0872
	(0.2400)	(0.1710)	(0.2430)	(0.1740)
<30km distance from active volcanoes dummy	-0.0305	0.00185	-0.0296	0.00159
	(0.0278)	(0.0134)	(0.0276)	(0.0137)
<0.5km distance from seashore dummy	-0.210***	-0.112***	-0.209***	-0.111***
	(0.0319)	(0.0215)	(0.0322)	(0.0216)
<1.5km distance from seashore dummy	0.112**	-0.00716	0.120**	-0.00661
	(0.0483)	(0.0257)	(0.0528)	(0.0265)
Municipality fixed effects	YES	YES	YES	YES
Other control variables	No	YES	No	YES
Number of observations	23,363	22,810	23,363	22,810
R-squared	0.78	0.904	0.78	0.904

*** p < .001. Note: Standard errors are in parentheses. All standard errors are clustered at prefecture level. Control variables include Log(building coverage ratio), Log(floor-area ratio), Log(acreage), wood flame dummy, light-gauge steel dummy, steel reinforced concrete dummy, reinforced concrete dummy, water supply dummy, gas dummy, sewage dummy, national, prefectural, municipality and private roads, and second, third and fourth quartile dummy variables for distances from the nearest railway station.

fixed effects. A 1% increase in probability of earthquake occurrence is associated with a 0.3% increase in land price, but not at a significant level.

In the second column, we further include other control variables in the specification. A 1% increase in probability of earthquake occurrence is associated with a 0.009% decrease in land price, but not at a significant level again.

In the last two columns, we include a dummy variable for high earthquake probability occurrence (>50% within the next 30 years) and high river flooding probability occurrence (>50% within the next 30 years) instead of a probability of earthquake and river flooding occurrence. The coefficient of high earthquake probability (>50%) is still not at a significant level, but we find that the coefficient of high river flooding probability (>50%) is associated with a reduction in land price at a significant level. The last column of Table 7.3 shows that a dummy variable for high river flooding probability (>50%) is associated with a 9.2% reduction in land price. The dummy variable for sediment disaster prone areas and the dummy variable for areas within 0.5km inland from the seashore are significantly associated with land price across specifications. The last column of Table 7.3 shows that a dummy variable for sediment disaster prone areas is associated with an 11.6% reduction in land price, while a dummy variable of within 0.5km inland from the seashore is associated with an 11.1% reduction in land price. The result indicates that the risk of high river flooding probability, sediment disaster, and tsunamis are more visible and are perceived as a significant threat to the public.

Table 7.4 reviews the robustness of the results in Table 7.3 by examining the nonlinearity of the effects of earthquakes, river flooding, sediment disaster, volcanic eruption, and tsunamis on land price. For river flooding, the price significantly decreases when the 30-year probability of river flooding is more than 50%. This supports the main specifications of Table 7.3. The coefficients of dummy variables for areas within 0.5 and 1.5 kilometers from the seashore are significantly associated with a reduction in land price, while the coefficient of dummy variable for areas within 2.5km is not significant. This also supports our specifications in Table 7.3. None of the coefficients of earthquake occurrence probability and volcanic eruption are significant. The results of Table 7.4 support the specifications in Table 7.3.

Table 7.5 checks the interactions among different types of natural disaster risks. The coefficients of the interaction between the dummy variable for areas where earthquake occurrence is at more than 50% probability and the dummy variable for areas within 0.5km and 1.5km inland from the seashore are significantly negative. This is understandable since most victims in the 2011 Great East Japan earthquake were caused by the tsunami, rather than the earthquake and its associated building collapse. We also find that more than a 50% probability of river flooding, sediment disaster prone area, and within

Table 7.4. Nonlinearity of the Effects of Earthquakes and Other Natural Disasters

Earthquake		*River flooding*		*Sediment disaster*		*Volcanic Eruption*		*Tsunami*	
>10%	-0.014	>10%	-0.0103	located	-0.117***	<3km	-0.0869	<500m	-0.110***
	(0.0193)		(0.0228)		(0.0193)		(0.1720)		(0.0214)
>20%	-0.0193	>20%	0.011			<30km	-0.000747	<1.5km	-0.0409***
	(0.0347)		(0.0298)				(0.0137)		(0.0148)
>30%	0.00137	>30%	0.036			<100km	0.0214	<2.5km	0.0569
	(0.0302)		(0.0537)				(0.0167)		(0.0360)
>40%	0.0129	>40%	-0.0222						
	(0.0393)		(0.0563)						
>50%	-0.0691	>50%	-0.104***						
	(0.0637)		(0.0382)						

Note: Standard errors are in parentheses. All standard errors are clustered at prefecture level. Control variables include Log(building coverage ratio), Log(floor-area ratio), Log(acreage), wood flame dummy, light-gauge steel dummy, steel reinforced concrete dummy, reinforced concrete dummy, water supply dummy, gas dummy, sewage dummy, national, prefectural, municipality and private roads, and second, third and fourth quartile dummy variables for distances from the nearest railway station.

Table 7.5. Interaction Terms between More Than 50 Percent Probability of Earthquake Occurrence and Other Natural Disaster Information

	Coefficient	*S.E.*
Probability of earthquake occurrence >50% dummy	-0.0270	0.0356
Probability of earthquake occurrence >50% dummy in the area within 1.5km from seashore	-0.1504**	0.0646
Probability of earthquake occurrence >50% dummy in the area within 0.5km from seashore	-0.2770*	0.1439
Probability of earthquake occurrence >50% dummy in sediment disaster prone area	0.0681	0.0448
Probability of earthquake occurrence >50% dummy in the area with the probability of inundation >50%	0.1187	0.0727
Probability of earthquake occurrence >50% dummy in the area within 30km from volcano	-0.0755	0.0530
Probability of river flooding occurrence >50% dummy	-0.110***	0.0298
Sediment disaster prone area dummy	-0.118***	0.021
<3km distance from active volcanoes dummy	-0.0684	0.1776
<30km distance from active volcanoes dummy	0.00814	0.0117
<0.5km distance from seashore dummy	-0.1056***	0.0212
<1.5km distance from seashore dummy	-0.0003	0.0263

*** p < .001; ** p < .01; * p < .05. Note: Standard errors are in parentheses. All standard errors are clustered at prefecture level. Control variables include Log(building coverage ratio), Log(floor-area ratio), Log(acreage), wood flame dummy, light-gauge steel dummy, steel reinforced concrete dummy, reinforced concrete dummy, water supply dummy, gas dummy, sewage dummy, national, prefectural, municipality and private roads, and second, third and fourth quartile dummy variables for distances from the nearest railway station.

0.5 kilometers from the seashore are significantly associated with a reduction in land price with the absence of high earthquake occurrence probability.

DISCUSSION

This chapter evaluates the earthquake and its associated disaster risks in Japan using the hedonic pricing method. Unlike literature covering the MHRA method, the hedonic approach does not require a rigorous and complete set of exposure, hazard, vulnerability, probability, or consequence data. This method also avoids the problem of aggregating different dimensions of disaster risk data and other professional judgment to integrate the multi-dimension of disaster risks into a single one. On the other hand, the hedonic approach relies on the risk perceptions of laypeople and their behavioral responses to the disaster risks. Since people are unable to respond to the risks that are unknown to them, we are unable to evaluate disaster risks that are more visible for researchers than lay people.

By employing the hedonic pricing approach, we assess how people evaluate the risks of earthquake, river flood, sediment disasters, tsunamis, and volcanic eruption risks that are likely to be known to them. First, unlike previous literature, we do not find a negative effect in the probability of an earthquake or high probability of an earthquake (more than 50%) on the published land price (Brookshire et al., 1985; Nakagawa et al., 2007, 2009). However, a high probability of an earthquake is associated with a 15% (27%) reduction in land price in the areas within 1.5km (0.5km) inland from the seashore. This indicates that people do not respond to the risk of large earthquakes alone, but people, in fact, respond to a high probability of large earthquakes when such a risk is combined with the risk of a tsunami.

Second, we do not find the negative effect of river flooding on published land prices, but find that these prices significantly decrease in the area where the 30-year probability of river flooding is particularly high (more than 50%). This is not surprising because many of these high-risk areas are very close to the river. If people live near the river, they are likely to recognize the risk of river flooding.

Third, a dummy variable for the sediment disaster prone area is significantly associated with a reduction in land price across all specifications, indicating that the risk of sediment disaster is visible and perceived as the most significant threat. This is understandable because under Real Estate Business Law, information on whether land is located in sediment disaster prone areas or not must be disclosed to the customer at the time of a real estate transaction.

Fourth, the dummy variable for areas within 0.5km from the seashore is significantly associated with a reduction in land price across all specifications, indicating that people do recognize the risk of a tsunami. People are more likely to know the risks of a tsunami because of the distance from the seashore being quite visible.

In sum, people responded to sediment disaster and tsunami risks, but not river flooding risks below a relatively high threshold. In addition, people do not respond to earthquake risks and volcanic eruptions, but when high earthquake probability is linked with tsunami risk people do respond.

How can we promote further public awareness and prepare for a potential megathrust earthquake in the CSZ using the results of this chapter? We have three key takeaways in preparing for the next Cascadia earthquake based on the results of our analysis.

First, the results of this chapter suggest that people do not respond to the risk information of an earthquake alone, but when combined with the risk information of a tsunami they respond to the high risk of an earthquake. This suggests that the risk communication of earthquakes can be more effective if such risk information is presented alongside the risk information of a tsunami.

Second, people do respond to the risk information of sediment disasters more than any other disaster. This implies that the disclosure of risk information in real estate transactions can be a powerful risk communication tool. In the United States, some states (cf. Alaska, Hawaii, and Oregon) mandate a seller to disclose certain natural hazard such as earthquake, flood, and fire upon the transfer of real property, while other states do not (cf. Florida and Idaho) (Englin, 2006). Mandating the disclosure of some natural disaster information in the process of real estate transactions is suggested in order to promote transparent and fair real estate transactions.

Third, people have a good sense of sediment disaster and tsunami risks over other risks. This suggests that a risk comparison of earthquake risks with more visible risks such as sediment disaster and tsunami occurrence can be effective. For this purpose, further development of the MHRA approach is seen as beneficial. The dissemination of hazard maps based on the MHRA approach affects laypeople's risk awareness, judgments and perceptions, and ultimately influences risk assessment based on the hedonic pricing approach.

This chapter showed that land price or perceived amenity value of land do not respond to the risk information of earthquakes even in Japan where public awareness of earthquake risks is quite high. However, the effective multi-hazard risk assessment, together with strategic risk communication and real estate transaction regulations may promote further risk awareness of earthquakes among the public, and will thus help to prepare for the next megathrust disaster in the Nankai Trough and CSZ.

Discussion Questions

1. Why do land price or perceived amenity value of location do not respond to earthquake risks, but do respond to river flood, sediment disaster, and tsunami risks in Japan? Do you think that we [would] find similar results in the United States?
2. How can we improve our current risk communication strategy regarding the potential megathrust earthquake? Can you think of a case where high public awareness would not motivate people to prepare for the next megathrust earthquake?
3. What are the drawbacks of overestimating the probability of a large earthquake occurrences? Is overestimating earthquakes different than when we overestimate the risks of other natural disasters?

NOTES

1. This is a much shorter return period than the one in the Cascadia megathrust earthquake, which is about 150–500 years.
2. Actually, there was a study showing that large tsunamis had struck the area in 869 (Minoura, Imamura, Sugawara, Kono, & Iwashita, 2001).
3. The probability of exceedance is the probability that a certain ground motion or intensity is reached or exceeded at a site within a specified time period. One example is the 30-year probability of an earthquake occurrence with the JMA seismic intensity scale of upper 6 or greater.
4. Please refer to Sato et al. (2016) for the exact procedure.

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Part IV

COMMUNITY, ORGANIZING, AND RESILIENCE

Pragmatic Considerations

Chapter 8

Families, Companion Nonhuman Animals, and the CSZ Disaster

Implications for Crisis and Risk Communication

Julie M. Novak and Ashleigh Day

The Pacific Northwest is projected to experience a massive earthquake, aftershocks, and a tsunami in the near future. This anticipated disaster is referred to as the Cascadia Subduction Zone (CSZ) and the science that discovered it was nothing short of miraculous:

> Still, the reconstruction of the Cascadia earthquake of 1700 is one of those rare natural puzzles whose pieces fit together as tectonic plates do not: perfectly. It is wonderful science. It was wonderful *for* science. And it was terrible news for the millions of inhabitants of the Pacific Northwest. (Schulz, 2015, para. 24)

The CSZ likely will demolish coastal communities along northern parts of California, Oregon, Washington and southern parts of Canada, while severely impacting more inland communities, including ones in Idaho (Schulz, 2015). Subsequently, when the initial disastrous events disrupt the functioning of structures or systems and those disruptions spread throughout the structures or systems' other components, these effects, referred to as cascading effects, can be "major contributors to the amplification of disaster impacts" (Xie et al., 2014, p. 338). Natural and manmade structures, along with infrastructures, will be devastated. Not only will the survival and well-being of human-animals be jeopardized but also that of all living creatures, flora and fauna alike.

When families plan for (if they plan) and respond to disasters, they are asked to consider the impact on the members of their household. Much of the rhetoric and disseminated information focus on the human-animal members (e.g., Federal Emergency Management Agency [FEMA], n.d.), even though the majority of United States (U.S.) households are composed of human-animals *and* companion nonhuman animals (American Society for the Prevention of

Cruelty to Animals [ASPCA], n.d.; American Veterinary Medical Association [AVMA], 2012). Research suggests that family decision-making attempts to ensure the well-being of the entire family (e.g., Brackenridge, Zottarelli, Rider, & Carlsen-Landy, 2012; Taylor, Lynch, Burns, & Eustace, 2015). Therefore, the many organizations charged with the task of planning for, preparing for, and managing disasters would benefit from understanding and attending to the impact that companion animal guardianship can have on families' decision-making and actions. Past disaster experiences and lessons learned only underscore this imperative call, such as those learned from Hurricane Katrina involving the transportation and sheltering of nonhuman animals (e.g., Anderson & Anderson, 2006; Irvine, 2009).

Approximately two-thirds (84.6 million) of U.S. households include a companion animal (ASPCA, n.d.; AVMA, 2012). Vermont ranks first as the state with the highest percent (70.8%) of households with at least one companion animal, while Massachusetts ranks last (50.4%). In the Pacific Northwest, Oregon ranks fourth (63.6%), Washington ranks sixth (62.7%), and Idaho ranks ninth (62%). Although California ranks forty-third, 52.9% of households include a companion animal (AVMA, 2013; Balas, 2013). Companion animals are "domesticated or domestic-bred animals whose physical, emotional, behavioral and social needs can be readily met as companions in the home, or in close daily relationship with humans" (ASPCA, 2017, n.p.). Rather than refer to these animals as "pets" and the humans as "pet owners" in this chapter, the most frequently used vernacular in popular conversations and professional reports, we purposefully use the terms "companion animals" and "companion animal guardians" (abbreviated as "guardians" throughout this chapter). We think these terms better reflect the shared relationships between nonhuman animals and human-animals in the home. Moreover, the terms emphasize subject-subject mutuality among companion animals and guardians, despite unequal degrees of dependence, instead of subject-object dominance, which ownership implies.

Before continuing, it is important to define some distinctions between "disaster" and "crisis," which are largely ones of emphasis and origin, and how these terms will be used in this chapter. Whereas disasters typically affect an entire community or society, crises typically have a more limited scope. Disasters typically refer to a specific event; in contrast, crises can be a single event or multiple events (see Seeger & Sellnow, 2016; Sellnow & Seeger, 2013). Disasters can be thought of as a function of some general hazard that threatens a community and mandates a response (Perry, 2007). Disasters can be distinguished from "emergencies" by their need for greater levels of response and aid (Coombs, 2010). The requirement for response is a similarity that disasters and crises share. There is not a clear or clean difference between the definitions for disasters and crises. This may be partially

due to the numerous academic disciplines that study such phenomena and the trajectories of the research in each one. With regard to our discussion in this chapter, we will use the word disaster when referring to the CSZ (the popular vernacular) and crisis or risk when referring to the communication approach (the vernacular of the communication discipline).

We also find it important to briefly note the differences and similarities between crisis and risk communication. Crisis communication is an ongoing process that aims to create shared meaning with and between impacted individuals, groups, communities, and (responding) agencies within the context of a crisis (Sellnow & Seeger, 2013). Crisis communication's purpose is to prepare groups, communities, individuals, and agencies for extant threats and harm presented by a crisis, aiming to reduce, limit, and/or facilitate planning, preparedness, response, and recovery capabilities (Sellnow & Seeger, 2013; Ulmer, Sellnow, & Seeger, 2015). In contrast, risk communication explains probabilities of harm occurring at a future date with the goal of influencing individual behaviors (Sellnow, Ulmer, Seeger, & Littlefield, 2010). Although distinct, crisis communication often includes risk communication, since all crises present risk(s) that can emerge throughout the unfolding of a crisis.

Public health and safety are top priorities during disasters, like the anticipated CSZ. Traditionally, public health, risk, and safety have been defined in terms of human needs—even within the disaster planning and emergency response communities. This narrow centering of humans is referred to as anthropocentrism. Anthropocentrism situates humans as the most significant entity in the universe and privileges human values and experiences over those of other entities such as (companion) animals and nature. This communicatively constructed perspective with deep Western roots views humans as separate from and superior to other entities and systematically permeates within our public policy approaches. In this chapter, we challenge this perspective by thinking all entities have equal value and should be given equal consideration. Unfortunately, when planning for or responding to a disaster, the choice appears to be to focus on humans rather than companion animals. This is an all too often a dichotomized, false choice. What is important to note is that "there is clear evidence that the safety of humans and animals is intertwined during disasters" (Thompson et al., 2014, p. 217). As media reports documented during Hurricanes Harvey and Irma in 2017, we saw the well-being of guardians linked to the well-being of companion animals and vice versa. Many photos showed guardians physically carrying companion animals in their arms, or in carriers, as they trudged through floodwaters to safety.

The purpose of this chapter is to explicate the impact of human–companion animal relationships and the role/function of crisis communication in all disaster stages of the anticipated CSZ disaster. First, we explore

human–companion animal relationships and their impact on health and well-being. Second, we articulate how effective crisis communication requires an understanding of families with companion animals and their necessary inclusion throughout disaster planning, response, and recovery. Third, we propose crisis communication recommendations for families and response organizations in the Pacific Northwest as we argue for deliberate planning, response, and recovery, aligned with the pre-crisis, crisis, and post-crisis stages. We employ examples and lessons learned from past disasters in the United States and throughout the world. We include suggestions for crisis communication activities and messages that will help *all* community members—humans and companion animals—and position humans (guardians and organizational officials) to make informed decisions pertaining to exigencies of the CSZ disaster. Given the projected magnitude of the CSZ and its consequences, society will need employment of all the best practices and full utilization of developed resiliencies to manage the devastation. Finally, we pose specific questions for our readers to elicit dialog and encourage further inquiry on this topic … and beyond.

HUMAN–COMPANION ANIMAL RELATIONSHIPS

Fields like sociology, anthropology, ecology, biology, veterinary sciences, and psychology have studied the phenomenon of human–companion animal relationships for decades (e.g., Albarella & Trentacoste, 2011; Amiot & Bastian, 2015; Borgi & Cirulli, 2016; Sanders, 2003; Yorke, 2010). It is, however, a newer area of inquiry for communication studies, only gaining disciplinary traction in the last 10 years (e.g., Plec, 2013; Schutten, 2008). Individual perception of what constitutes a relationship is important to consider. The communicative construction of such relationships can impact one's identity definition, and thus perception of what constitutes family. As we know from the Communication Theory of Identity (CTI), personal perceptions of the different frames of identity (i.e., personal, enacted, relational, and communal) are communicatively (de)constructed (Hecht, 1993). Put differently, "identity is both a sense of self and communication or enactment of self, resulting in the articulation of four different levels or frames of identity that merge the individual with the society around him/her" (Wadsworth, Hecht, & Jung, 2008, p. 67). Therefore, our human identities can be influenced by many entities and elements, such as companion animals.

For many guardians, their frames of identity and societal interactions are not confined to the human species alone. Rather, they are interspecies and evoke internatural communication, which explores "the exchange of intentional energy between humans and other animals as well as communication

among animals and other forms of life" (Plec, 2013, p. 6). This can be seen via the intentionality behind many guardians' motivation to live with and care for companion animals, whom often become daily interactional partners. Communication in these interspecies interactions often requires different types of communication other than verbal and/or the use of linguistic symbols, which are commonly used in human-to-human interactions. Even individuals who are not guardians to companion animals or do not identify with/in a human–companion animal relationship have an interest served as they, too, depend on the safety and well-being of community members who do. This topic is imperative for scholarly and professional attention, especially as individual perceptions of "family" and relational identity are not strictly confined to one's own species, but can be multispecies—as is the case with many human–companion animal relationships (Entis, 2016; Plec, 2013; Sanders, 2003; Taylor et al., 2015; Zane, 2015). For these reasons, human–companion animal relationships and families cannot be undervalued or excluded in disaster planning and management.

Human-animal relationships have existed for millennia. Some animals, such as dogs and cats, have transcended into mainly being considered companions—versus commodities or working animals—in many Western communities. This may be most apparent in high-income countries such as the United States and United Kingdom (U.K.) (AVMA, 2013; AVMA, 2012; Royal Society for the Prevention of Cruelty to Animals [RSPCA], 2017). Other animals, however, are trained to work and perform tasks for individuals with disabilities such as service animals. Therapy animals (also called "emotional support" or "comfort" animals) are not considered service animals under the Americans with Disabilities Act (ADA). Although therapy animals support individuals in a variety of ways, they are not granted the same legal standing as companion animals. Therefore, they are not protected by federal law and do not have the same rights as service animals to accompany guardians in human-only spaces, such as governmental evacuation shelters (Brennan & Nguyen, 2014). Said differently, only service animals are permitted in governmental evacuation shelters, not therapy animals or companion animals.

Companion animals are considered family members in many households. They are often regarded as partial to full participants within the family system and contribute to shaping relationships among human members (Cain, 1983; Entis, 2016; Sanders, 2003). More specifically, 50% of guardians' view companion animals as full family members, while 36% view them as partial family members (Associated Press [AP], 2009). Companion animals can foster social communication and relational maintenance between/among humans (Greenbaum, 2004; Sanders, 2003). Additionally, companion animal relationships may positively impact all aspects of health

including physical, mental, social, and spiritual well-being. These benefits are experienced by humans throughout our lifecycle. Some human–companion animal relationships positively impact early childhood development (Carlisle, 2015; Endenburg & van Lith, 2011; Melson, Peet, & Sparks, 1991). Positive impacts of human–companion animal relationships have also been reported among elderly individuals. Consistent social and emotional support is often difficult to obtain for elderly individuals. However, it is important for their health and well-being (Chen & Feeley, 2014; Tremethick, 1997). Companion animals have been found to provide this vital and necessary support (Anderson & Anderson, 2006; MacNamara & Moga, 2014). Elderly populations have also reported high levels of companion animal attachment and positive health benefits from human–companion animal relationships and/or interactions (Krause-Parello, 2012; Stanley, Conwell, Bowen, & Van Orden, 2014). Moreover, there is evidence to suggest that human–companion animal relationships are meaningful and provide beneficial experiences, especially for individuals with persistent health issues (Brooks, Rushton, Walker, Lovell, & Rogers, 2016). Although positive and sometimes life-changing benefits have been an outcome of human–companion animal relationships, they are nonetheless subject to criticism, lower status, and less opportunity than relationships between/among humans.

As noted, human–companion animal relationships have demonstrated significance and importance in many peoples' lives. However, these interspecies relationships are not equally valued like relationships between humans. This anthropocentric ideology has attributed human–companion animal relationships as anthropomorphic "folk delusions" (Sanders, 2003), which is a bias that limits the validity of interspecies relationships and connections. This echoes the "commonsense of science" standpoint that has long rejected the validity, seriousness, and uniqueness of human–companion animal relationships (Rollin, 1997). Unequally valuing these relationships is an issue, especially when we consider that the majority of U.S. households include companion animals. Furthermore, the Pacific Northwest is home to many of these households. As such, crisis communication and disaster planning, response, and recovery must account for these populations and recognize their relationships as relevant—not only to lived realities and personal conceptualizations of family, but also in disaster decision-making. Next, we will explain why guardians and companion animals must be accounted for through examining implications for crisis communication. When this population is not accounted for, there can be negative outcomes which past disasters have illustrated.

IMPLICATIONS FOR RISK AND CRISIS COMMUNICATION

Crisis communication rarely considers families composed of humans and companion animals. Disaster planning in the Pacific Northwest has minimally included household guardians in community planning, much of which consists of expert-developed, online, informational documents that are available to motivated, information-seeking guardians but not widely disseminated otherwise (e.g., Oregon Humane Society, n.d.). Moreover, companion animals and their guardians have played no role in the community exercises that have taken place to assess preparedness for the CSZ disaster (e.g., Cascadia Rising 2016 Exercise, 2016). By not including guardians in disaster planning and preparation, organizations risk ongoing oversight of their needs and underappreciation of the many natures and multiple functions of communication. Communication is relational in nature. It is the means through which guardians form their relationships with the companion animal(s) in their lives, and the means through which crucial relationships are built with/in/among communities. Communication is also the means for the creation of understanding. Communication is also informative, critical, and discriminative in nature. It helps to enact and coordinate activities; create, gather, and disseminate relevant information; and foster informed decisions. Under the exigencies of external time constraints as experienced during disasters, effective communication becomes very important. Therefore, failure to include this population within the larger framework of crisis and risk communication surrounding the CSZ disaster is problematic.

The survival and well-being of all family members is critical to consider during and after disasters. This is one reason why crisis communication must be inclusive to families composed of humans and companion animals in all aspects of disaster planning, response, and recovery. As previous research related to all types of disasters confirms, including local community members in disaster activities has been essential for successful outcomes (Eisenman et al., 2009; Falconi, Fahim, & O'Sullivan, 2012; Kapucu, 2008; McComas, 2003; Mei et al., 2013; Paek, Hilyard, Freimuth, Barge, & Mindlin, 2010; Perko, van Gorp, Turcanu, Thijssen, & Carle, 2013; Terpstra, 2011). Based on this extant research and their findings/suggestions, it seems to suggest that including guardians and their companion animals in such activities would be necessary, as they too are members of the local community that have communicative exigencies. Such inclusion helps to enact communication processes and create messages that reflect the multiplicity of voices and citizen/organizational publics in our communities that correspond to local understandings

of cultural/geographical place and its unique and defining characteristics of identity.

The goal of maximizing the constitutive and contextual dimensions of crisis communication in communities, however, requires more than inclusion of citizen publics. Additionally, engagement needs to be fostered via dialogic (two-way) and horizontal conversations, rather than one-way or top-down conversations. Unlike "outreach" or "involvement," which implies short-term communication or information dissemination with local citizen publics, engagement moves beyond this. Dialogic engagement aims to work *with* local citizen publics, who help to define the needs and goals and to facilitate information flows, feedback loops, and message adjustments/refinements. Furthermore, dialogic engagement is not akin to managed engagement as this implies an overarching power structure and predetermined limits or boundaries (McComas, 2003; Steelman & McCaffrey, 2013). To summarize, dialogic engagement grounded in foundation of authentic and participatory communication begins in the pre-crisis stage and continues throughout the crisis stages as is further explicated in the next section.

Guardianship of companion animals has concerning implications for crisis communication and disaster planning, response, and recovery. How does a guardian plan in advance for a disaster? What does it mean if a guardian has not planned or prepared in advance? A guardian may ask: Do I hear or see communication and/or messages that relate to my family composition and dynamics? Have disaster organizations and governmental officials planned for and prepared infrastructure, systems, and employee training for families composed of humans and companion animals? Examples of decision-making scenarios regarding possible separation from and/or death of a companion animal include: "Can I take my family, which includes a dog, on the public bus when evacuating?" "How will my child manage the trauma and recovery of the disaster if we cannot take our therapy dog with us to the shelter in a temporary relocation city?" "How will my 89-year old mother function if her cat of 12 years cannot be with her?" "Does it matter if my companion animal is an official service or therapy dog?" "Do I go to work if my entire family is not safely evacuated?" "Will I be reunited with my cat?" "Will my cat die if I leave her behind?" "If I let my dog loose when I evacuate, what type of life or death will he have?" "Will responding officials shoot my companion animal dead as I know happened to some during Hurricane Katrina?" "Is it a public health risk to let my dogs loose if they cannot evacuate with me?"

During Hurricane Katrina, many families had no means of transportation for evacuation of their companion animals. Complicating this further was that companion animals were neither permitted on government evacuation boats, helicopters, or vehicles nor in evacuation shelters due to policies that were not companion animal-inclusive (Akhtar, 2012; Irvine, 2009; Lowe,

Rhodes, Zwiebach, & Chan, 2009). Many speculate that these restrictive policies and lack of consideration for companion animals and their guardians are reasons that some residents failed to evacuate (Irvine, 2009). This also led to the abandonment of an estimated 104,000 companion animals in the New Orleans area (Louisiana SPCA, n.d.; Taylor et al., 2015). Only 15,500 companion animals were rescued and of those rescued, less than 20% were reunited with their guardians (Louisiana SPCA, n.d.). As may be evident, this low rate of reunion has the potential to become a burden on communities as well as animal-related organizations that are charged with the task of caring for abandoned/lost animals. Or the animals that are not lucky enough to be reunited with their guardians could become stray or feral, which presents other issues regarding health, safety, and care.

Many of Hurricane Katrina's abandoned companion animals did not survive or were shot by police officers. This was devastating for guardians (and non-guardians) who witnessed or later heard of these cruel and ignorant actions (Irvine, 2009). These unfortunate experiences subsequently sparked the creation and passing of the Pets Evacuation and Transportation Standards (PETS) Act (2006) (Irvine, 2009). Although this legislation was a positive advancement, there are debates of its functionality, implementation, and overall usefulness. This law has initiated a more serious conversation about the impacts of/on companion animals during disasters, yet many have voiced concerns about its practical implications given the stipulations regarding issues with reimbursement, the level of implementation by responding agencies, etc. (e.g., AVMA, n.d.).

Without inclusion and engagement of families composed of humans and companion animals in crisis communication activities and messages, it is unlikely that organizations or governmental officials will formulate effective disaster planning, response, and recovery activities and messages for families composed of both companion animals and humans. Such oversight would be a "failure in foresight" (Sellnow & Seeger, 2013). This often leads to serious repercussions when a disaster event is triggered or unfolding (Sellnow & Seeger, 2013). These repercussions can include frivolous endangerment of guardians, companion animals, families, and even crisis responders due to a lack of companion animal-friendly options during a disaster, increased financial costs, and other prolonged or mitigatable effects. As Oregon ranks fourth (63.6%), Washington ranks sixth (62.7%), Idaho ranks ninth (62%), and California ranks forty-third (52.9%) of households in the United States that include a companion animal(s), it is advisable and knowledgeable that CSZ disaster plans, preparedness activities, response, and recovery efforts—at individual and organizational levels—account for companion animals and their guardians (AVMA, 2013; Balas, 2013).

THE CSZ DISASTER AND THE THREE-STAGE MODEL OF CRISIS

The anticipated CSZ disaster looms over the Pacific Northwest, and is increasingly receiving more attention locally, regionally and nationally. Nevertheless, we continue to think about the CSZ disaster as a future event. The word "future" permits us to highlight the meaningfulness and relevancy of time and our vantage point of viewing disasters as phenomena with a time continuum. Heuristic models typically cut the time continuum into sections that correspond to developmental stages. One of the most widely used models is the three-stage model: pre-crisis, crisis, and post-crisis (Sellnow & Seeger, 2013). This model approach is used to "identify and examine specific stage-related features of crisis and link them to particular communication exigencies and strategies" (Sellnow & Seeger, 2013, p. 30). In other words, the temporal stages correspond to different manifestations of risk and crisis, and, thus, different grades of potentialities and consequences. The selection of actions and the communication strategies will likely be substantively different and/or differently deliberated/disseminated pending the stage of the crisis.

Crises unfold over time and are divided into stages. The *pre-crisis stage* is characterized by the anticipation of, beginning of, or development of an emerging threat and its interaction with a system (Sellnow & Seeger, 2013). Planning and preparedness efforts (communicatively constructed and enacted) are appropriate actions during of the pre-crisis stage. A shift to the *crisis stage* occurs when a trigger or warning event takes place, which is often accompanied by non-routine disruption(s), uncertainty, extreme emotions, etc. The crisis stage mandates a response(s), both psychically and communicatively. Lastly, the *post-crisis stage* emerges when turmoil decreases or, in some cases, completely dissipates. During this recovery period, response evaluation and investigations of blame, cause, etc. typically begin and some order is reestablished. Discourse that is aimed at recovery and forward-focused renewal is ideal during this stage. Although we will discuss these as separate stages in what follows, it is important to note that there are many overlapping and intersectional elements across the three stages. It is useful to think of these stages set within a continuous loop, rather than a linear continuum with linear progression.

Although other heuristic models exist such as Fink's (1986) four-stage model, Turner's (1976) six-stage sequence of failure in foresight, and the Centers for Disease Control and Prevention's (CDC) Crisis and Emergency Risk Communication (CERC) model (see Sellnow & Seeger, 2013), and many more, the three-stage model's simplicity, and the corresponding crisis communication strategies, should not be undervalued. Simplicity and clarity

are needed when communicating about disasters to the public (Seeger, 2006). To do this in an effective manner, relationships with organizations and citizen publics are essential during pre-crisis. Similarly, appropriate simplicity makes developing and coordinating relationships within and across organizations and target populations more expedient and effective.

As argued, there has been unacceptably limited proactive attention to families with companion animals in the event of a disaster. The recent publication of Schulz's (2015) article in the New Yorker about the CSZ disaster brings pre-crisis attention to this potential disaster and provides a timely opportunity to examine the issues and (in)actions to date and propose crisis communication suggestions by utilizing pre-crisis, crisis, and post-crisis stages as the framework. To keep it vivid and real, we will include multiple examples from past crises and disasters.

Pre-Crisis Stage

Due to the large numbers of companion animals in the Pacific Northwest and their significance in many families, planning and preparation documents for citizen publics are a mainstay during the pre-crisis stage. FEMA's website at www.ready.gov contains a Portable Document Format (PDF) document entitled "Prepare for Emergencies Now: Information for Pet Owners" (FEMA, n.d.). The document cites the American Kennel Club, ASPCA, AVMA, and Humane Society of the United States (HSUS) as partners in the development of the informational document. The document encourages guardians to (1) prepare by creating an emergency supply kit, (2) plan by thinking through what they will do at the start of emergency, and (3) stay informed by knowing about different types of emergencies that are typical in their community. (Note: the FEMA website is not exclusively for the CSZ disaster.)

FEMA states the emergency supply kit should contain food, water, medicines and medical records, a first aid kit, a collar with ID tag, harness, or leash, a crate or pet carrier, sanitation materials, a picture of the companion animal and the family together, and comforting items. When planning, the document suggests creating a plan to get away, developing a buddy system, talking to a veterinarian about planning, and gathering contact information for companion animal treatment. Lastly, it encourages staying informed by regularly accessing local and state government sources in addition to www.ready.gov. Similar resources include: the HSUS's (n.d.) "Pet Disaster-Preparedness Kit," the Oregon Humane Society's (n.d.) "Including your Pets in Disaster Preparedness Plans," the Washington State Animal Response Team's (n.d.) online resources, or local resources such as Clackamas County's (n.d.) animal-inclusive disaster preparedness family plan. The American Red

Cross (n.d.) has a resource guide specifically for the Cascades region, which addresses the CSZ disaster as well as "pet preparedness."

FEMA, the American Red Cross, and HSUS are national organizations with regional offices organizations and thus provide resources for the entire Pacific Northwest on their respective websites. Regional contacts may include local/state Bureau of Emergency Management, the FEMA Region X office that supports Alaska, Idaho, Oregon, and Washington, or the FEMA Region IX office that supports Arizona, California, and Nevada. Additionally, each state government, such as Oregon.gov and Washington.gov, has a website and posts much of their planning and preparedness work and resources about the CSZ. Local governments frequently do too.

The devastating experiences of families with companion animals during Hurricane Katrina revealed the inadequacy of plans and preparedness for the needs of such families. After seeing the struggles of guardians and companion animals during Katrina, President George W. Bush signed into law the PETS Act. The Act stipulates that local and state emergency management organizations include service and companion animals in disaster plans and authorizes FEMA to rescue and transport them during disasters (Irvine, 2009). Additionally, it paves the way for funds that would encourage companion animal-friendly shelters and provide monetary assistance for individuals and/or companion animals during disasters. Unfortunately, little evidence of any implementation can be found beyond documents that urge guardians to plan and prepare (Irvine, 2009; Travers, Degeling, & Rock, 2016). Individual guardian responsibility and accountability for companion animals during disasters persists as the assumed norm.

In June 2016, the Cascadia Rising Exercise took place. This was the largest multistate functional exercise in the Pacific Northwest, which simulated the CSZ disaster to examine and verify "catastrophic CSZ plans; the ability of Emergency Operations Centers (EOCs), throughout the whole community, to coordinate and communicate priorities and objectives; to share situational information; and to request, order, and transport life-saving resources to the area's most heavily impacted" (Cascadia Rising, 2016, p. iv). More than 20,000 individuals from local, state, federal, tribal, Department of Defense, and nongovernmental entities participated in this exercise, which was preceded by two years of preparatory training between 2014 to 2016. The exercise attempted to reveal the adequacy of plans and the capabilities, or lack thereof, to carry out the actions outlined in the plans (i.e., preparedness). The exercise prompted organizations to leverage collaborative partnerships, address unforeseen exigencies, and ultimately confirm and/or revise crisis plans. Of note, the simulation had no plans or activities that considered the plight of families with companion animals.

As articulated by crisis communication experts, the best practices for crisis communication (Seeger, 2006) prioritize pre-crisis planning. Specific communication activities during the pre-crisis stage include developing partnerships with the publics, listening to the publics' concerns and understanding the publics, collaborating and coordinating with credible sources, and sending messages of self-efficacy. Therefore, we encourage organizations involved in CSZ planning to organize gatherings, face-to-face and virtual, in order to meet with guardians and engage in dialogue about their lives and survival questions, concerns, needs, and wants in light of the CSZ disaster. In addition to listening, understanding, and partnering with citizen publics, working in partnership with them will help to identify credible sources and spokespersons and develop characteristics necessary for messages to be perceived as timely, accurate, and useful (Seeger, 2006; Steelman & McCaffrey, 2013). Messages built in partnership with citizen publics (rather than developed only by experts and related organizations) improve pre-crisis planning and preparedness actions, including disaster risk reduction practices (DRR) (Darroch & Adamson, 2016).

Well-developed partnerships with HSUS and local chapters, veterinarians, animal rescues and shelters, crisis responders, and guardians are needed surrounding the CSZ disaster. These groups and individuals often provide credible information, necessary education, and training surrounding companion animals in the context of disasters, and trusted spokespersons. For functional collaborations, it is usually best that partnerships begin during the pre-crisis stage and develop over time with accumulated, shared experiences of working together. These collaborations should occur across and within various community and organizational levels (e.g., local, tribal, state, regional, federal/national). These collaborations should establish a system to relay planning and preparedness information back and forth to all relevant publics.

Agencies and professionals charged with responding to the CSZ disaster should participate in pre-crisis trainings for companion animal search and rescue. This training would include communication goals, strategies, and skills for interacting with publics, such as responding to media inquiries and distraught guardians as well as learning about the behavior and communication signs that are typical of companion animals and their guardians under distress in disasters. The International Fund for Animal Welfare (IFAW), for example, sponsors animal responder trainings in disaster-prone areas, such as Baton Rouge, Louisiana (International Fund, 2012). It is important that responders, including volunteers, understand what to do if they come across a companion animal in a disaster (Irvine, 2007).

As we learned from Hurricane Katrina and Hurricane Rita, there should be a system in place for rescuing, sheltering, and identifying rescued companion

animals. This is important not only so that guardians can be reunited with their companion animals, but also to effectively use the time and energy of rescue personnel and resources (Heath & Linnabary, 2015). This was a severe problem during Hurricane Katrina and Rita, as loss of power inhibited the use of electronics for a long period of time and there was not a detailed protocol in place for training workers/volunteers or recording rescued companion animals (Anderson & Anderson, 2006; Irvine, 2009).

Clearly disaster-relevant decisions can be described as significant choices, therefore, "there is an ethical obligation to provide all the relevant information" to publics (Sellnow et al., 2010, p. 155). This includes providing all relevant information to families with companion animals. Crisis, health, and risk professionals in the CSZ area must become knowledgeable about the guardians in their communities, partner with them, understand their needs, and then identify/develop *with them* the necessary and relevant information. Such information should be based on the potential effects and concerns that would arise from the anticipated CSZ disaster. Stressing general disaster planning and preparedness is paramount. This is especially salient during the pre-crisis stage as proactive planning and preparedness can limit risks, injury, and costs.

To manage effectively and efficiency, despite the pressures of time in a crisis, communication must be informed, intentional, and purposeful. To do this, local households, community professionals and organizations, responding agencies, and governmental authorities should prioritize pre-crisis communication planning and preparedness. This would necessitate involvement at all governmental and organizational levels. Even more importantly, local families and community-wide representation should not only be involved, but engaged.

Crisis Stage

The crisis stage mandates response, both communicatively and physically. The ability to make rational, informed decisions is dependent on access to quality and relevant information (Sellnow & Seeger, 2013). As crisis communication is built on the ethical tenet of helping individuals make informed choices, information about companion animal preparedness and general inclusion of guardians in crisis communication and response efforts must be present in CSZ plans and protocol. We argue this because people's risk perception is not only impacted by their ability to access quality and credible information, but it is also impacted by their personal experiences and relationships, such as those between a guardian and their companion animal(s).

Human-animal relationships can shape guardians' disaster risk perception. For guardians, risk perception can be influenced by their bond with

their companion animal(s), recognition of the animal's "life value," risk framing, as well as action paralysis (Trigg, Thompson, Smith, & Bennett, 2016). Guardians' risk perception is important for crisis communicators to consider in planning and managing the CSZ disaster because it can influence their decision-making surrounding protective actions, such as evacuation. Companion animal guardianship can impact decisions to prolong or fail to evacuate as well as decisions to return prematurely to an unsafe disaster area because guardians that evacuated without their companion animals want to return to search for them (Brackenridge et al., 2012; Day, 2017; Hesterberg, Huertas, & Appleby, 2012; Hunt, Bogue, & Rohrbaugh, 2012; Lowe et al., 2009). For example, during the 1997 Yuba County, California floods, households with companion animals were less likely to evacuate when compared to households without companion animals (Heath, Kass, Beck, & Glickman, 2001). Many guardians cited reasons pertaining to a lack of resources to evacuate with companion animals, such as not owning an animal carrier or having multiple companion animals. Larger companion animals, such as horses, pose even more of a challenge for guardians who should evacuate because transporting them can be a more difficult task (FEMA, n.d.).

The inability to evacuate *with* one's companion animals not only threatens a guardian's decision to evacuate, but it can also exacerbate feelings of distress. For example, 44% of residents that did not evacuate during Hurricane Katrina decided to shelter-in place because they did not want to leave their companion animals behind (Louisiana SPCA, n.d.; Fritz Institute, 2006). This is better understood when we consider that guardians with high levels of commitment to companion animals are less likely to evacuate, especially if animal-friendly evacuation shelters or lodging are not available (Brackenridge et al., 2012). This can be further complicated when companion animals are not permitted in evacuation vehicles, such as buses or boats (Leonard et al., 2009).

Psychological distress is a common result for guardians when their companion animals are left behind during a disaster (Leonard et al., 2009). This is in addition to the distress that they feel from the disaster event itself. Guardians that were affected by the April 1994 tornado in West Lafayette, Indiana reported refusal to evacuate unless their companion animals could accompany them, attempts to reenter a dangerous area to search for their companion animals, and high levels of anxiety when separated from their companion animals that lead to psychosomatic disturbances (Heath & Champion, 1996). Some guardians even refused to receive medical care for their own injuries until they could assure their companion animal's well-being (Heath & Champion, 1996). The lack of crisis and risk communication that is inclusive to guardians and their companion animal(s) may threaten aspects of health and safety. This is a primary reason why crisis and risk communication

for the CSZ disaster must consider this population, especially as it relates to evacuations.

In the event of a CSZ disaster, there will likely be a call for evacuations. If guardians' risk perception of the CSZ disaster is overridden by their desire to protect and not abandon their companion animal(s), it is possible that they will fail to evacuate—especially if animal-friendly shelters and resources are not available or identifiable. Nevertheless, crisis/risk communicators will stress the mandatory nature of evacuation. When such messages are delivered, it is important for crisis/risk communicators to have considered that,

> Animal guardianship may determine the mode of transport they [guardians] use, the time it takes to leave, the number of trips that are needed, and increases the overall stress of evacuation. Even with these encumbrances pet owners [sic] will still take risks to take, or go back and get, their animals. The consequences of not taking such action are too unbearable to contemplate for many. (Taylor et al., 2015, p. 22)

This why CSZ crisis/risk communicators must strive to better understand and actively include guardians and their companion animals. Messages must provide guardians with information about companion animal-friendly evacuation transport, shelters, and resources. When such information is not provided, protective actions can be compromised. This may not only be the case for evacuation failures, but also for responders' willingness to work during disasters since they too may have companion animals of their own.

Crisis responders often uproot their daily lives to serve during times of disaster. These responders include search and rescue personnel, health professionals, military, and aid workers. Their ability and obligation to serve, however, can become complicated when they are also guardians, which can cause conflicts between their personal and professional obligations during the onset of a disaster (Chaffee, 2009). For example, the bond between a guardian and their companion animal can impact hospital staffs' decisions to go to work during a disaster (Qureshi et al., 2005). Hospital staff's willingness to respond during a disaster can be hindered by concern about caring for their companion animals, especially if leaving them presents any type of risk to their health and safety (Ogedegbe, Nyirenda, Del Moro, Yamin, & Feldman, 2012). If a crisis responder does not report to work during a disaster because they are concerned about their companion animal(s), this could impact the healthcare of disaster-affected humans and put additional stress on the larger response community due to minimized staff (Chaffee, 2009). This applies to veterinarians and staff regarding care of all animals, both companion and other types, such as wildlife. Moreover, as many guardians view companion animals as family members, it is possible to see how this may complicate

crisis responders' willingness to report to work during a disaster (Davidson et al., 2009).

It is evident that guardianship is a risk factor during disasters and can influence disaster-related decisions (Heath & Linnabary, 2015). Leaving these known risks unaddressed regarding a disaster, like the CSZ, can result in poor decision-making and intensify trauma for guardians during a disaster, further straining their lives beyond the disaster's initial impact. There are numerous strategies that disaster-related organizations and governmental agencies can take in effort to prepare guardians for the CSZ disaster and its cascading effects. One way this can be supported during the crisis stage is via message tailoring.

Tailoring crisis communication during the crisis stage is an effective way to engage and reach specific populations, helping to promote protective actions. Tailored messages should be developed before the onset of a disaster and in collaboration with target populations (Baezconde-Garbanati et al., 2014; Hedman & Akagi, 2008). It is crucial to realize, however, that tailored crisis communication must be consistent and easily decoded by the target population(s). While these crisis communication messages do not have to be identical, they must be consistent, nontechnical, and convey a primary purpose that individuals can easily decode in a disaster situation (Johnson, 2016; Rundblad, Knapton, & Hunter, 2010; Sugerman et al., 2012). Even more important is that these messages should suggest specific actions that guardians can take for themselves *and* their companion animal(s) (e.g., Anthony & Sellnow, 2011; Beaudoin, 2009; Sherman-Morris, 2010; Zimmerman et al., 2010).

Messages that do not consider an individual's social and familial networks are ineffective during disasters (e.g., Johnson, 2016; Rundblad et al., 2010). As many guardians view companion animals as family members, this must be considered by disaster agencies and professionals, organizations, and government officials. It must be included in their crisis and risk communication because as Heath and Linnabary (2015) point out, "There is no other factor contributing as much to human evacuation failure in disasters that is under the control of emergency management when a threat is imminent as pet ownership" (pp. 184–185). Once a disaster's onset decreases or completely dissipates, there is a shift into the post-crisis stage, which has different communicative exigencies.

Post-Crisis Stage

Post-crisis communication serves a vital function in providing publics with information about, actionable knowledge and activities for recovery, better planning and preparedness for future disasters, and larger evaluation efforts

by authorities. However, it is often the stage that receives the least attention by professionals and the media (Sellnow & Seeger, 2013). As the CSZ disaster is expected to be catastrophic in its longitudinal impact and recovery needs, the post-crisis stage cannot be overlooked. Here, responding organizations and governmental authorities' post-crisis communication should specifically address guardians, especially surrounding health issues such as grief, depression, etc. that the CSZ disaster will evoke.

Loss of a companion animal(s) from a disaster can produce high levels of grief and psychological trauma for guardians. This is beyond what the disaster itself triggers, and, therefore, can last well beyond a disaster's initial aftermath (Hunt, Al-Awadi, & Johnson, 2008; Lowe et al., 2009; Zottarelli, 2010). As many guardians consider their companion animals to be family and have meaningful, relational bonds with them, it is comprehensible that losing them to a disaster could exacerbate anxiety, grief, and other negative health effects (Field, Orsini, Gavish, & Packman, 2009; Hunt et al., 2008). This was reported by guardians affected by the 2000 Miyake Island volcanic eruption in Japan. They experienced very high levels of posttraumatic stress disorder (PTSD) and depression as a result of losing a companion animal to the eruption (Goto, Wilson, Kahana, & Slane, 2006).

Guardians who lose a companion animal(s) during disasters are at greater risk of experiencing other types of trauma. For example, during Hurricane Katrina, guardians who lost a companion animal were more likely to be injured and/or separated from other family members (Zottarelli, 2010). Furthermore, bereaved guardians experienced equal levels of depression as nonguardians who lost close (human) friends (Hunt et al., 2008). Such experiences not only prolong the effects of disasters, but they can contribute to increased financial costs for recovery services tied to treating these illnesses. However, these effects could be mitigated with proper communication during the pre-crisis stage of planning and preparedness. This is an important function that the post-crisis stage can serve by beginning the discussion of these topics as they relate to future disasters.

All citizens, including guardians, may be at risk due to the public health consequences of abandoned or lost companion animals. This is often due to issues surrounding communicable zoonotic diseases; possible aggression due to anxiety, entrapment, fright, and hunger; and other issues concerning public health such as sanitation challenges (e.g., unmanaged urine and feces, decaying bodies; Heath & Champion, 1996). These can become most apparent during the post-crisis stage because it is the time when crisis responders as well as guardians can (typically) enter disaster sites to search and rescue any abandoned or lost companion animals. These issues were well-documented during Hurricane Katrina and manifested during the post-crisis stage. There were also documented issues pertaining to capturing,

feeding, providing medical care, transporting, sheltering, record keeping, and relocating abandoned companion animals as well as properly managing sanitation issues concerning deceased and decaying companion animals (Irvine, 2009).

Disaster response organizations and governmental authorities charged with planning for and managing the CSZ disaster should use the post-crisis stage to communicate about and reinforce the importance of companion animal-inclusive planning and preparedness for future disasters. Using lessons learned from the CSZ disaster would be a way to promote future preparedness as well as aid in the recovery and resiliency of affected publics (Sellnow & Seeger, 2013; Ulmer et al., 2015). This could include development of household planning and preparedness campaigns or interventions, or formulating coalitions to address the concerns of guardians. Crisis communication scholars stress interdisciplinary collaboration (Sellnow & Seeger, 2013) when conducting any evaluative efforts initiated by responding organizations and governmental authorities. Therefore, evaluation teams also should include communication experts, companion animal experts, companion animal organizations, and guardians. Not only could they help analyze any gaps in the CSZ response efforts, but they could also help formulate better, more companion animal-inclusive disaster plans and preparedness strategies for future disasters. Such engagement could be fulfilled via post-crisis, public meetings whether face-to-face or virtual.

Public meetings can serve a vital role for crisis communication, especially during post-crisis. Public meeting(s) with disaster affected-publics foster feelings of "being heard" through two-way communication and can help officials determine issues that need to be addressed, such as companion animal concerns and risks during disasters (McComas, 2003; McComas, Lundell, Trumbo, & Besley, 2010). Additionally, public meetings can offer resources and support for affected publics and can positively impact their risk perception of future disasters (Albright & Crow, 2015; Chen, Chen, Vertinsky, Yumagulova, & Park, 2013). Post-crisis strategies such as this were implemented during the 2009 Red River Valley floods in North Dakota. City officials facilitated televised public meetings to make decisions about the ongoing flood efforts and plans for recovery (Beck, Littlefield, & Weber, 2012). Events like public meetings can foster dialog between authorities and affected publics and showcase the local perspective, which is important in (re)evaluating future disaster plans and preparedness efforts. This would be an ideal time to provide guardians with information on preparedness actions to take for the future, health services available for them and their companion animals, and/or how to relocate any abandoned or lost companion animals. At post-crisis public meetings surrounding the CSZ disaster, officials should plan to have a companion animal expert and/or companion animal

organization present to aid in addressing questions about companion animals. These events could also be coupled with memorials and remembrances.

Post-crisis memorials or remembrances that include bereaved guardians are important options for CSZ disaster officials and organizations to consider and initiate. As previously noted, the loss of a companion animal from a disaster can result in negative, longitudinal health and wellbeing effects for guardians and their families. Thus, post-crisis memorials and remembrances can function to help bereaved guardians' recovery and coping (e.g., Yoshida et al., 2016). As guardians are emotionally and socially attached to their companion animals, they should be included in these post-crisis events (e.g., Nagasawa et al., 2015). Not only do crisis memorials pay homage to lost lives, but they also communicate renewal through the shared experience of grief (Veil, Sellnow, & Heald, 2011).

Communicating renewal is an important function in the post-crisis stage, which can be facilitated by memorials and remembrances. The discourse of renewal embedded in these post-crisis events can emphasize shared values, optimism, and provide opportunities for learning (Seeger, Ulmer, Novak, & Sellnow, 2005; Sellnow & Seeger, 2013; Veil et al., 2011). Such events would not only be supportive and useful for bereaved and/or distressed guardians, but also for crisis planning and management organizations that host the memorials or remembrances. Hosting these events can demonstrate organizational commitment to affected publics, provide opportunities for forming partnerships with the public, and gain deeper insight about the needs and risks of guardians.

Communication Activities and Messages

Disasters inherently contain varied hazards and cascading effects, and therefore present numerous challenges across the three-stages of crisis. Crisis and risk communication dramatically influence public health and safety outcomes in the event of a disaster, like the anticipated CSZ disaster. Whether through activities or messages, communication plays a constitutive role by defining who is a valued community member (identity). Additionally, who is a valued community is enacted by the engagement of said community members in disaster planning, preparedness, response, and recovery. We make the case that families often include humans *and* companion animals, thereby requiring explicit and active acknowledgment and engagement of guardians as community members. This, in turn, often requires guardians to be savvy, self-motivated information-seekers as well as volunteers in community efforts. While crisis communication in planning and preparedness initiatives are being practiced and evaluated with regard to the CSZ disaster—such as

with the Cascadia Rising 2016 Exercise—they need to make greater efforts to incorporate families with companion animals.

Failing to account for preventable risks, like companion animal guardianship, can result in threats to health and safety and increased risks and costs as extant research informs us. Therefore, we suggest relevant communication activities and messages that aim to include and prepare guardians and their companion animals for the expected CSZ disaster. Informed by Seeger's (2006) best practices for crisis communication, we suggest the following:

1. Companion animal-inclusive crisis and risk communication should be included in CSZ policy/protocol developments and decision-making processes. As Seeger (2006) stressed, this should be an ongoing, proactive rather than reactive, process. This could be accommodated by holding public meetings before policy/protocol developments to get input from local publics, such as guardians.
2. Pre-crisis planning should identify potential hazards and initial disaster responses should be preplanned (as they relate to families with companion animals). This would include companion animal-related concerns, risks, and messaging that provides guardians with protective actions. For example, organizations and/or governmental agencies could survey local guardians about what they view as potential hazards and what they would expect from responding organizations—as related to their status as guardians. Organizations and governmental agencies could also complete home inspections and interviews with local guardians willing to participate. Reviewing identified hazards and effective responses from past disasters would also be a helpful option.
3. Companion animal guardians must know the risks they face and responsible agencies should help educate them on such matters. Guardian concerns about risks need to be considered; thus, a dialogic approach should be practiced. Such an approach can foster positive relationships and goodwill before the onset of this disaster, both of which are critical for effective crisis communication and management. This could be initiated by public meetings, public preparedness campaigns that are inclusive to guardians and companion animals, and partnerships will local businesses that guardians frequent, such as veterinary offices, feed stores, etc.
4. Disaster agencies (such as those included in the Cascadia Rising 2016 Exercise) should partner with companion animal-related organizations and experts—especially those in their communities—as they can provide essential support in the dissemination of planning and preparedness information and serve as a credible informational source for guardians. Social media is also a useful tool for message dissemination and dialog with guardians (Veil, Buehner, & Palenchar, 2011).

5. Crisis responders, communicators, volunteers, and coordinators should become familiar with the exigencies of guardians in their regions. This could include trainings on communicating and interacting with guardians as well as handling, understanding, and interacting with companion animals during disasters.
6. Post-crisis memorials and remembrances should be inclusive to guardians and any deceased companion animals. Renewal discourse should be purposively incorporated by crisis planning and management organizations in these events. Renewal discourse is an opportunity to emphasize shared values, optimism, provide opportunities for learning, and support grieving disaster-affected individuals and bereaved guardians. This could be held in a public park or community center and advertised via flyers, radio, social media, and television.

CONCLUSION

Disasters and potential disasters surround us. The CSZ looms ominously. They interact (or will interact) with our porous, complex, and intersecting systems, producing threats, often unfamiliar disruptions, and uncertainty. When we consider the vast number of families with companion animals in the Pacific Northwest region in the context of the CSZ disaster, we must also consider the communicative exigencies of this population. If these exigencies are insufficiently addressed, the threats to the health and safety of this population as well as crisis responders and the entire community will be compounded. Because many guardians see their companion animals as family members and are strongly attached to them, their loss due to a disaster can result in trauma, depression, PSTD, and other negative consequences beyond those caused by the disaster event. In addition to the plethora of exigencies that leaders and organizations must account for while planning for and managing disasters like the CSZ, they must also begin to seriously include guardians and their companion animals.

We have demonstrated how companion animal guardianship illuminates many implications for crisis, health, and risk communication in relation to the CSZ disaster. Further discussion and research about communication, human-animal relationships, and disasters will enhance our planning, preparedness, response, and recovery efforts. Unfortunately, Hurricane Harvey and its devastation in Texas in August/September 2017 provides the opportunity to further examine successes, failures, and oversights that can be better addressed in future disasters. As we move forward in (re)shaping the current dogma of crisis communication and its intersection with disaster planning, preparedness, and response, and recovery, it will not only be relevant, but imperative

to ensure public health and safety for humans and *companion animals* in the CSZ disaster.

Discussion Questions

1. How do you see individuals as well as disaster professionals contributing to the reification of anthropocentrism surrounding disaster planning and preparedness for the CSZ disaster?
2. What are the repercussions of anthropocentrism in disaster planning and preparedness surrounding the CSZ disaster?
3. If you were a disaster professional charged with the CSZ disaster planning and preparedness efforts, what communication activities and messages would *you* promote for both humans (guardians and non-guardians) and companion animals?
4. How would you tailor and disseminate these communication activities and messages?
5. Our chapter has focused on companion animals; however, there are many other types of animals that will likely be affected by the CSZ disaster. What are some issues that arise in this context when we think about agricultural animals, farms, zoos and aquariums, and wildlife?
6. Keeping in mind what you discussed in the above question, how could individuals and organizations plan and prepare for the CSZ when it comes to agricultural animals, farms, zoos and aquariums, and wildlife? Try to provide specific suggestions and communication strategies.
7. Imagine you are a team member on the Cascadia Rising 2017 Exercise. Craft a constructive and informed response to the following message from another team member: "Why should we spend our energy, resources, and time worrying about any animals?"
8. Can you think of other exigencies presented by the CSZ disaster for crisis, health, and risk communication as they relate to companion animals and their guardians? Can you think of additional lessons learned from other disasters, ones more local or more recent?

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Chapter 9

What Is to Be Done?

A Preparedness Polemic

Yianni Doulis

My parents subscribe to the *New Yorker*, and pass their copies on to me as they work through them. When I visit, there is a little pile by the back door: articles clipped from the newspaper, the junk mail that still comes, and an issue or two of the magazine. A nice surprise … bedtime reading. Of course, by the time I get around to them, the must-see show at the Guggenheim has closed, and the outrage of the week has been tempered somewhat by the passage of time, so what I'm reading is more like pertinent history than freshly-minted news.

My wife and I moved our shared offices in early 2015 into a bigger space right downtown, a beautiful nineteenth century cast-iron façade building of unreinforced brick. I had a lot to do around then building desks and coordinating cable guys, so the pile by the bedside table grew for a while before I was able to catch-up on what I'd missed. Besides some great one-panel comics, what I'd missed was Kathryn Schulz's (2015a) article "The Really Big One." Bedtime reading extended into early-morning dread. I thought about all the desks I'd cleverly lined up on either side, against the 18-foot-tall brick walls held together with old mortar. I thought about Schulz's descriptions of the earth moving during the 2011 Japan earthquake, the buildings "lurching" back and forth. I thought about the people sitting at those desks I'd built. "Toast."

As an architect, I have to know something about how to protect people from buildings falling down around them. I rely on the competence of engineers of course, but my licensing exam was full of questions about the public safety goals of the structural code and practical application of its principles. I've had a residential client ask me to design their house for a higher degree of resilience than necessary, to treat it like a school or police station from a seismic code standpoint. I get it, more or less. But *this* building, falling on

these heads, well, that was not a thought experiment I'd conducted. We've since outfitted the office with emergency backpacks, two weeks of food and water, and reinforced the desks to (hopefully) resist a hail of bricks. However, the larger implications of a Cascadia Subduction Zone (CSZ) earthquake continue to reverberate throughout my professional and personal life.

SCALES OF ACTION

Though my initial reaction to reading Schulz's article (2015a) centered around me and those right around me, this personal perspective is just one of several, broader frames of reference on the enormous risk the article describes that I hope to examine in more detail. Generally speaking, these frames break down into the personal, the communal, and the social or governmental. Each of these three perspectives suggests priorities for managing the uncertainty that a particular catastrophe presents. For me, though, the galvanizing idea to come out of Schulz's piece (2015a) is that preparing for the rising waters of a fast moving tsunami might be the best chance we have of preparing for the slow but inexorably rising waters of the *other* catastrophe on our horizon. To that end, I only have a little more to say about the *personal* scale of action and have doubts as to the effectiveness or realism of action at the broad *governmental* level, at least in our present political climate. But, perhaps because it occupies a vague semantic middle ground or because it provokes the most personal anxiety or provides the most real hope for durable solutions, I will spend much of my time circling around and then delving into what a *community* scale reaction to impending disaster might look like.

There is plenty of information on personal preparedness readily available without my needing to rehearse it again here. Schulz's follow-up article, "How to Stay Safe When the Big One Comes" (2015b), is as good a place to start as any. Other sources of information come from the chain grocery store where I shop, which stocks half a dozen magazines devoted to niche survival readerships, with a totally unsurprising emphasis on weaponry, home defense, and exotic *prepper* scenarios. Oh, and there's the internet. Be informed, make a plan, build a kit.

There are limits to how far individual preparedness can take one. Learning CPR, stocking a pantry and creating a contingency plan all leave us feeling more empowered as well as concretely more resilient. But such preparation can also shade easily into an "everyman an island" mentality, which will frankly not be much use in the event of a major earthquake. The American psyche is deeply invested in the virtue of self-reliance, but the scale and unpredictability of a disaster such as an earthquake will strain the ingenuity of even the most independent and resourceful of us.

When we turn our attention to the largest frame of reference, what I've designated the social or governmental scale of thinking, there are more interesting concepts to unpack. Another way to think about this is to call it the realm of things no individual particularly wants to spend money on, but which we've more or less decided still needs doing. Except on the far edges of anarchic or libertarian economics, there's a broad consensus that we want government to build and maintain water systems, sea- and airports, schools, parks, and transportation networks. And though it's a separate issue with its own fraught politics, in the public realm we've decided taxes in one form or another are the best mechanism for doing this.

Every four years, the American Society of Civil Engineers (ASCE) assigns a grade to the state of U.S. infrastructure, the purpose of which is to inform and guide policy at the state and national level. The *2017 Infrastructure Report Card* (Diloreto et al., 2017), published in March, gives it an overall grade of D+, as the *2013 Report* had done four years earlier. This terrible score is fleshed out in plenty of detail, broken down by state and type, but the recommendations add up to a 4.59 trillion dollar investment (some%age of which would be purely private) in necessary improvements to be made over the next ten years, with a projected funding gap of just over 2 trillion dollars (Diloreto et al., 2017). The report forms the empirical basis for many of the proposals elected officials make to increase spending for infrastructure, and though the content of the report itself has largely escaped polemics, its conclusions are used for various ends across the political spectrum (Frelinghuysen, 2017).

Although it may seem an obvious point to make, it's notable that the primary focus of the ASCE report is on the capacity and condition of our current infrastructure given *current* standards and assessments of risk. Newer schools and bridges fare better under scrutiny than older ones, both because of their state of repair and because of modern structural safety codes. With the composite grade of D+ being a cumulative score, some levees and water systems are worse off than the average, and in danger of immanent failure. But though the report and its companion website refer to "preparing for the future" (Diloreto et al., 2017), what that means is a future that's more or less like the present we occupy. It doesn't reflect a *changing* landscape of risk, where rising seas levels and more frequent storms, or a clearer understanding of seismic risks, might impact the true state of physical infrastructure preparedness.

The ASCE report makes explicit as least one solution—increase investment in maintaining and developing modern infrastructure—but this rather straightforward conclusion comes up against two factors that transform the potential solution into a dilemma. First, in the private sector, investing in maintenance and upgrades doesn't necessarily lead to a return either in

share price or efficiency, and it's not always easy to pass these costs on to consumers. And in the public sector, we—and the pronoun refers both to the individual and the collective—lack the resources or often just the will to allocate available resources to pay for the level of material civilization we take for granted. This is by no means a brand-new phenomenon, and runs deeper than our tendency to simply not save enough, or rely on credit for things we cannot really afford. During the most recent financial crisis, the federal government created an infrastructure stimulus package that focused on "shovel ready" (i.e., deferred maintenance) projects that could theoretically begin immediately (Grabell, 2012). Eight years later, as reflected in our "report card" (Diloreto et al., 2017), the overall state of our country's infrastructure is no better. A lack of concrete results and failure of political will turns the issue of funding infrastructure into a squabble over resource allocation. In this context a certain collective amnesia sets in, and pitting the claims of a possibly distant calamity like an earthquake against the immediate challenges of education, rising drug addiction, or homelessness means infrastructure spending is likely to lose out.

At the regional level, the State of Oregon has independently undertaken its own analysis of infrastructure risks, specifically focused on the case of a magnitude 9.0 CSZ earthquake, which was published in 2013 as the *Oregon Resilience Plan* (Oregon Seismic Safety Policy Advisory Commission). Many of the same conclusions that are drawn in the ASCE report can be seen in this plan as well. One difference is that the ASCE calls for an implementation timeline of 10 years, versus 50 in the Oregon plan (Diloreto et al., 2017; Oregon Seismic Safety Policy Advisory Commission, 2013). A more subtle difference is that the former looks at how to sustain current systems (in other words viewing the problem through a *custodial* lens), while the latter looks at how we prepare to more quickly fix things once they break down (that is, through a *remedial* lens.) More pointedly, the ASCE assumes that the status quo will be maintained in the future, while the regional Oregon plan assumes something bad will happen sooner or later. Currently scientists are predicting that there is a about a 40% chance that a megathrust earthquake of 9.0+ magnitude in this fault zone will occur in the next 50 years and be felt throughout the Pacific Northwest (Oregon Office of Emergency Management, n.d.). The Oregon plan assesses the ways in which a catastrophic event will break both physical and social structures such as first-responder networks, coastal communities, and business continuity, and strategizes about how to prepare them to bounce back quickly, in other words: how to be resilient.

Resilience and its kissing cousin *sustainability* are both terms that have been used within progressive-minded design circles for some time, and it seems that in the natural cycle of buzzwords resilience is ascendant. I like this change of emphasis for a couple of reasons. First, the term sustainability

may have meant something clear and motivating when it first came into the designers vocabulary, but when fossil fuel and agro-pharmaceutical companies use the term to characterize their efforts it is hard to know what, exactly, it refers to. Second, the term resiliency focuses on building capacity to manage change at whatever level possible, rather than assuming a prelapsarian condition that we should nostalgically strive toward. It acknowledges that getting an "A" grade for our roads or levees won't necessarily mean we're prepared for the unknown. It acknowledges that repairing physical infrastructure is just one element of a response to the kind of threat that an earthquake poses. And, most importantly, it acknowledges that given a scarcity of means or the will to deploy them, intellectual resources and tactical thinking are needed to help compensate. Understanding what building resilience means for the Pacific Northwest means thinking about where the primary force for change to our present, ill-prepared condition comes from. I argue that this force comes from building a vibrant and self-organized civil society, one that arises from and acts on a local or regional level, and that consists of all kinds of groups, both those pertinent to disaster response and those not.

Though it is well-worn territory, looking at the failure of governmental response at every level to Hurricane Katrina offers a number of useful lessons. This cursory analysis cannot hope to relegislate who bears responsibility or owns the vocabulary. My perspective is fairly narrow, and relates mainly to the struggle to shape reconstruction in the months following August 2005. Private and charitable groups and NGOs from all over the country offered both material and volunteer labor immediately and in the longer term. Groups working on longer term reconstruction strategy included such groups as the Heritage Foundation, which convened 14 days after the levees breached, and soon after released a grab bag report of privatizing schemes including school vouchers and drilling in the Alaskan Arctic (Heritage Foundation, 2005), and Brad Pitt's "Make it Right" (n.d.) sustainable development NGO, which harnessed star power and name-brand architects to offer modern examples of flood-resistant homes. Even Mayor Ray Nagin's "Bring New Orleans Back" Commission, made up of blue ribbon local community leaders, was heavily influenced by the national conversation around ecological principles of climate resiliency and renaturalization. Once the commission's plan was unveiled in early 2006, the affected neighborhoods responded to it as an existential threat and coalesced around resistance to the ideas, which they viewed as an updated version of the "red-lining" that had disenfranchised them a generation earlier (Campanella, 2015).

Though one might—in the abstract—mourn the lost opportunity of a "greener" New Orleans as it was presented in graphic form, the fact was many residents saw it as a racially motivated land grab that removed their agency in decision making. What they insisted on in its stead was a more

piecemeal recovery that focused their resources (some of which did come from federal relief) on rebuilding-in-place rather than transformation and displacement.

New Orleans had spent decades underinvesting in the public sector and thus had little capacity to respond to the needs of its citizens; residents of the Lower Ninth Ward and Gentilly neighborhoods likewise lacked the means to implement their own *holistic* plan. In the face of opportunistic proposals from distant sources lacking a cultural context, these residents found their most proactive option to be piecemeal self-determination (Klein, 2008). It is—as of this writing—far too early to tell how the local and federal responses to Hurricane Harvey will bear the imprint of lessons learned from Katrina. The first wave of reporting from across the political spectrum has highlighted the grass-roots aspect of rescue efforts while floodwaters were still high in Houston and Port Arthur (Price, 2017). The "Cajun Navy"—those fishermen who formed ad hoc rescue patrols after Katrina and mobilized to respond immediately after Harvey struck—serve as an object lesson in what a local response to federal failure looks like, but interpreting this lesson is fraught with complication. It is easy to find a libertarian argument for the federal government retreating from its role as savior of last resort, but I consider this argument too facile and will try to unpack it in what follows.

There are important ways in which the situation we are facing in the Pacific Northwest contrasts with that of the Gulf Coast. The first is that while Texas, Louisiana and Mississippi have a recent and recurrent history of flooding, we have nothing but the geological record and scientific discovery to galvanize us. On the other hand, there has been some preliminary action at the state and local level to raise public awareness and plan for our most likely emergency. Finally, though, we have the inestimable luxury of time; time to absorb lessons of the dangers of relying on national solutions to regional problems, and thus time to cultivate the kind of robust, finely grained civil society necessary to respond meaningfully to the shock when it does come. What is becoming clear to me is that we need to look closer to home, to the people we see every day, to find strategies for resilience.

CLOSER TO HOME

Until recently the Portland Fire Department had a tag line emblazoned on the side of their supervisor's vehicles: "Your safety is your responsibility." I spent a lot of time being outraged at the cavalier attitude that this phrase represented. Why not (my internal monologue went) change "your" to "our" in both cases, which gives each one a slightly different valence and thus a nice poetic turn: "our (everybody's) safety is our (this department's)

responsibility?" The fact is, though, having a fire department doesn't eliminate risk; it just offers one layer of backstop against it. Knowing not to smoke in bed or leave candles by open windows is another kind of layer. Having a smoke alarm to let you and your neighbors know something's wrong is another. Thinking about earthquake preparedness is the same kind of nested problem, with each level of risk mitigation serving to add a level of redundancy but with none sufficient by itself. Once I recognized that the Fire Department wasn't washing its hands of me, just asking me to take some ownership of my own contingent, fraught, risky existence, it was frankly liberating.

The liberation came from realizing that doing something, at whatever level we can, to prepare for a major earthquake or tsunami leaves us better prepared for the *other* risk we're facing—that is—climate change, with its extreme weather events, long-term power outages, loss of biodiversity, disproportionate impact on marginal populations, rising and acidifying oceans. And unlike that far greater risk, nobody is arguing about the facts. There's not a straw-man debate about the reality of plate tectonics, or the lack of scientific consensus around earthquake risks, that serves as a distraction from the discussion about marshaling personal and political will. There are the mundane difficulties of honestly facing the problem and how to best make do with limited means, of course, and these are not trivial. But this is really a classic opportunity masquerading as a crisis.

The opportunity presented by an adequate response to the CSZ earthquake comes from the scale at which I believe such a response has to arise, namely the mushy middle realm of community-level organizing, and thus resilience building. The problem of a major crisis will be confronted in the moment—and in the moments after—at a local level: by a single block, or a neighborhood, by the distance that one's voice will carry, or the radius of a circle one can run in a few minutes. Where we run or to whom we call out will depend on whom we know already, who our neighbors are. Because in addition to sharing fences, roads and mail carriers, neighborhoods share a complex web of petty grievance, negotiated affinity, and mutual dependence. This delicate web of casual human relationship is what allows a community to build capacity to respond to a common problem. We have to *ask* for favors from our neighbors and be willing to help them in return. We have to pool resources, take part in a phone tree, attend meetings, and listen to everyone's concern or gripes. In short, we have to do all the sticky, awkward things that make a direct democracy aggravating but worthwhile. This doesn't let the federal government off the hook to take care of all its citizens or let us write off the possibility of large-scale collective action. It just means we have a nested problem that requires a solution approached from multiple levels.

A relevant international example comes from the recent earthquakes in Chiapas and Puebla, Mexico. In a sourly ironic twist, the latter of these fell on the 32nd anniversary of the devastating 1985 Mexico City earthquake that killed at least 10,000 people. Hours before the recent quake hit, the city had held its annual memorial, and hundreds of buildings had staged evacuation drills as a way to keep the lessons of that tragedy fresh. This meant providentially that many people—after some initial confusion—were actually more ready to respond than had it been any other day (Resnick, 2017). The fact that private ad hoc initiatives and local organizations helped neighborhoods respond quickly and start searching collapsed buildings immediately points to two interesting things. First, unsurprisingly, is that rehearsal is important: what we do *often* is likely to be what we do when something unexpected happens and our critical thinking is overwhelmed by our shock response (Ripley, 2008). The second points to an ongoing revolution within Mexican civil society that has been noted as a positive outcome of the 1985 quake (Aridjis, 2008). Given the silence of the president at the time and the systemic failures of the central government to respond, inform, or provide any real help as people suffered, the office of the president and the institution of the government lost their auras of omnipotence. What rose up from the disgust and disillusion was a sense of the power of direct democratic action and a newly forged skill in self-organization, particularly in the hardest hit central districts of the capital which had been ignored by the entrenched party. Over the long term this same empowerment has given rise to indigenous rights groups, neighborhood assemblies, a vocal opposition party, and a somewhat more diverse and transparent political landscape. In short, something that looks like democracy.

The reference above to "little D" democracy is not meant to be hyperbolic. If we take seriously the fact we have a natural disaster to confront in our future, then " … when that crisis occurs, the actions that are taken depend on the ideas that are lying around" (Friedman & Friedman, 2012). If the governing idea is that we have to make a kit, store some food and water, and keep our gas tanks full, then the outcome is likely to be an unconnected set of individuals or small tribes who manage to survive for some period of time before their contingency planning breaks down and they confront a region incapable of rebuilding through collective action. Conversely, if the idea "lying around" is that the federal government and blue ribbon panels are the best hedge against a disaster, then the outcome is likely to resemble the New Orleans Superdome in the short term and a client state dependent on external aid or susceptible to expropriation in the long term. The little "D" democracy I want to advocate for incorporates both empowered individuals and an accountable federal government, but has the crucial additional level of concrete

and organized cooperation at the community scale, with its negotiation from peer-to-peer in a continual dialogue of interdependence.

ACKNOWLEDGING OUR INTERDEPENDENCE

What does the Pacific Northwest look like in this alternative I propose? How does emphasizing preparedness at the neighborhood and community level manifest itself in our daily lives, and how does this constitute anything like democracy? My first insight into this question came from a book of photographs and essays that I've been drawn to for some time, which is a hard to find book and an incredible piece of cultural anthropology and worth looking out for (Barker et al., 1993). It is a 20-year documentation of the Yup'ik Inuits and their way of life in Southwestern Alaska. The title, *Always Getting Ready—Upterrlainarluta,* refers to the stance that this subsistence culture of fishing, hunting, and gathering is forced to adopt in its extreme environmental context. The actions that surround seal hunting, ice breakup, salmon harvest, berry picking, and potlatch all have the urgency of survival. These actions are reinforced by story-telling, ceremony, and rituals designed to place them in a historical continuity, and thus define the Yup'ik people as stewards and actors in that context. In short, they are a technology for survival, animated by meaning: a culture. The culture's survival "depend[s] on being ready at the exact moment that the conditions are right and from the fact that the right moment is unpredictable" (Barker et al., 1993, p. 20).

It's easy to admire this stance and frankly not *so* difficult to rehearse it in our more conventional lives. But it is crucial to see the cultural frame in which this stance of readiness can maintain its relevance, and not devolve into an exercise in machismo and toxic individualism. The Yup'ik culture of mutual aid and interdependence, of working *together* when necessary and celebrating together when finished, arises out of an acknowledgment that their *individual* survival depends on doing so (Barker et al., 1993). But we Americans needn't look to traditional cultures to find this lesson and bring it back; interdependence is deeply ingrained in our own foundation myth—its memory has simply been occluded.

Alexis de Toqueville noted our habit of "civil association" throughout his book *Democracy in America* and admired its ability to mediate between a tendency toward individualism or narrow tribalism and the opposite danger of a tyrannical majority:

> Americans of all ages, all conditions, and all dispositions constantly form associations. They have not only commercial and manufacturing companies, in which all take part, but associations of a thousand other kinds, religious, moral,

> serious, futile, general or restricted, enormous or diminutive" and further on ". . . as soon as they have found one another out, they combine. From that moment they are no longer isolated men, but a power seen from afar, whose actions serve as an example and whose language is listened to. (Tocqueville, 1945, pp. 106–109)

It is in this spirit—of negotiation between the individual and collective—that I find a fruitful path forward in preparing for the CSZ earthquake. This path acknowledges the role individual action and governmental investment must play, but emphasizes the importance of cultivating relationships at a human scale through reinforcing the communities we find across the corridor, cul-de-sac, or city. I am not suggesting that our national government renounce its role as the supporter of last resort, or that we look to charitable, religious, or private benevolence to fulfill this role instead. Just as I still want the fire department to answer a 911 call, I think it is crucial to our democracy that we make common cause with all our country's citizens when they are in crisis. It shouldn't matter that one part of our country is further in debt than another, or that being remote makes in harder and more expensive to send aid. To not see the myriad points of contact we have between the person in the mirror and the 300-odd million of us out there is a kind of tribal blindness. I want us to recognize that building resilience at the local level can be more relevant than doomsday prepping, more engaged than holding our noses and voting in dismay, and more rewarding in the long term than either.

I want this because waking up to the reality of living in an earthquake zone is a great way to wake up to the reality of climate change, without getting bogged down in any discussions of whether it's happening and who's to blame. An earthquake is potentially devastating, it will affect all of us whatever our class, profession or race, and it will happen here sooner or later. But in this case *it's not our fault; nobody is arguing about the facts; and we can do something about it now.* We can lobby our government to implement a resilience plan, we can learn CPR and make a family contingency plan. And we can reinforce the delicate bonds of the community that we will be dependent on for survival.

Many of the concrete actions one might take in this effort are mundane, even pedestrian: meet your neighbors, lend them a cup of sugar, ask if you can borrow a hammer, see if they want to talk about the earthquake. Depending on one's temperament this kind of thing may be difficult to do (it is for me). Nonetheless, I've started a group in our immediate neighborhood to track who has extra food and water, whose home is unreinforced or vulnerable to falling trees, who might need more help when the lights go out. It's hard to find time for this, awkward to ask others what they've done or not done to prepare, difficult to organize and delegate. But building

local resilience doesn't appear to have a shortcut; there is no foolproof kit to buy or infrastructure bond measure to pass. It's a matter of doing whatever seems possible at whatever scale and with whatever attention and resources we have to do it. Enough of these small gestures added together may—as de Toqueville suggests—become habit forming and lead us to larger scales of collaboration: a block-wide earthquake plan, some new friends, a more profound sense of belonging in this place. This habit will also prepare us better for other kinds of challenges we face, whether human caused or not. I think this sense of both resolve and belonging is a legacy worth the effort, and every tiny step I make toward it reinforces the urgency of finding it.

Discussion Questions

1. Talk about aspects of the term "resilience" that distinguish it from "sustainability." How do the terms help us understand different preparations for and responses to a crisis?
2. Discuss the "scales of action" Doulis proposes in his chapter: the personal, the community, and the governmental. What are some pitfalls of concentrating preparation efforts on any one scale?
3. What are some concrete steps one can take to improve resilience at the community level? What are some difficulties or challenges to taking these steps?
4. Do you agree with Doulis's assertion that preparing for a Cascadia Subduction Zone Earthquake will prepare the region for climate change? Why or why not?

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Conclusion

Nature, Fear, and Bewilderment: A Human (Dis)Connect

C. Vail Fletcher

Our small farm just outside downtown Portland, Oregon has a magnificent view of Mount St. Helens located just 45 miles away. The mountain's volcanic history and deep connection to the "*really big one*" is now commonly known, as its eruptions are produced by the same plates that have historically created the Cascadia Subduction Zone (CSZ) quakes and tsunamis. St. Helens most recently erupted in 1980, after 123 years of hibernation.

> That timespan is dangerous both because it is too long—long enough for us to unwittingly build an entire civilization on top of our continent's worst fault line—and because it is not long enough. (Schulz, 2015, para. 26)

Massive and highly destructive, it was deemed the most disastrous volcanic event in United States (U.S.) history, producing the world's largest known landslide and 24 megatons of thermal energy, seven of which were a direct result of the volcanic blast. An explosion 1,600 times the size of the atomic bomb dropped on Hiroshima (U.S. Geology Survey, 2009), it spewed ash across 11 U.S. states, killed approximately 57 humans, thousands of elk, deer, and small mammals, and millions of native fish (mostly in hatcheries) and had an estimated economic impact of one billion dollars (3.3 billion in 2017 dollars). Still, seismologists and economists have confirmed that the damage will pale when compared to the death and destruction that the next CSZ earthquake will cause.

Perhaps one of the most relevant and important contributions the Helens eruption makes to how we are thinking about the CSZ lies not in the calculation of economic devastation or descriptions of size or environmental impact, but rather in the exploration of the narratives of the eruption. Citizens all across the PNW have been swapping stories about "where were you

when it blew?" for the past three and a half decades. These oral histories reveal a living representation of devastation that surely informs individuals' preparations, coping strategies and decision-making in the wake of a natural disaster. The most urgent and mysterious elements that bubble to the surface of these histories can be unified through the following question: how *do* humans grapple with risk related to a natural disaster? This question forms the overarching theme that has guided the 15 contributing authors of this book. Through the research and distinct theoretical perspectives of each, we catch a glimpse of the mysteries that surround the CSZ, our representations of it and preparations for it. Though the event has not yet occurred, each chapter shows that the earthquake and resulting tsunami is already a human tale, at least in part, of reluctance, fear and disconnection.

The destruction the CSZ event will cause is not disputed (Butler, 2018; see Chapter 2). Neither is the history of the tectonic plates or the earthquake reoccurrence timeline (Butler, 2018, see Chapter 2). The science is well supported and documented, if not relatively new. So, the question becomes, why are we not more prepared? Each of our chapters reveals a spectrum of pragmatic factors that contribute to our lack of preparatory response, both predictable (e.g., cannot afford flood insurance) and somewhat surprising (e.g., unaware that they live in a hazard zone). Less obviously, our authors reveal another binding answer to this foundational question, leaving us with a second key takeaway: our current (dis)connections with nature and *the wild* are sometimes confusing, often subjective, and always evolving. Each chapter calls to our attention the myriad ways our human minds conceive of the realities of nature and natural disasters that largely contribute to us being ill-prepared, paralyzed by fear and lacking the necessary knowledge to actually get ready. Perhaps our greatest weakness and strength moving forward is our seemingly fraught (in)ability to communicate about risk, especially when it is as abstract as a megathrust earthquake.

While each chapter stands alone in its contribution to risk communication literature, when consumed as a whole the text might leave a reader pondering some of its larger theoretical and philosophical themes. Below, I work to unravel and question those emergent, omnipresent meta-themes, which I have condensed into three categories: (1) Communication with Nature: Imagination and Fear; (2) Climate Change and the Struggle to Communicate Meaning; and (3) Land and Conflict. As I highlight some of these more nuanced findings, I crisscross the original organization of the book into the sense-making threads I have deduced throughout the text. In other words, I move backward and forward from one chapter to another in my attempt to draw new linkages between the ideas each author shares. After unraveling heuristic themes and revealing how the chapters inform and/or respond to these themes, I conclude

with a few thoughts about what this edited collection contributes as a whole to our understandings of risk communication.

COMMUNICATING WITH NATURE: IMAGINATION AND FEAR

In September 2017, an enormous wildfire burned nearly 50 thousand acres just outside Portland, Oregon, in a popular recreational area for the cities' one million plus residents. My social media feeds were clogged with tributes, testaments, and photo commemorations of these wild and pure spaces and the memories made there, *in nature*. I, too, suffered the sense of great loss, but I also became saturated by the overwhelming sense that the public keeps and protects an imagined nature, a place that is pristine, wondrous, and yet full of fear. As reflected by Cronon:

> To the extent that we live in an urban-industrial civilization but at the same time pretend to ourselves that our real home is in the wilderness, to just that extent we give ourselves permission to evade responsibility for the lives we actually lead. We inhabit civilization while we hold some part of ourselves—what we imagine to be the most precious part—aloof from its entanglements. We work our nine-to-five jobs in institutions, we eat its food, we drive its cars … , we benefit from the intricate and all too invisible networks with which it shelters us, all the while pretending that these things are not an essential part of who we are. By imagining that our true home is in the wilderness, we forgive ourselves the homes we actually inhabit. (Cronon, 1981, para. 30)

Cronon calls our attention to an increasingly obvious human creation: the nature existing *out there*. This culturally constructed space has gained dominance in popular culture and in our human imaginations—as witnessed by the Eagle Creek fire, among lots of other daily examples of disasters in nature—as we continue to rhetorically construct nature as something that happens elsewhere, can be managed and/or must be controlled to be safe. The conception of nature *out there* parallels what Benedict Anderson refers to as "imagined community" (1983) when detailing the social construction of the nation-state. Humans *imagine* and interpret natural disasters through our inability to control and predict them, not as naturally occurring cycles of an evolving and living planet; we are beholden to their force, time cycles, and fallout. The fear they provoke in us exacerbates the sense of dissonance between humans and nature, even when disasters occur at our doorsteps. The *nature* in disasters is not the idyllic space humans conceive of in Cronon's telling; it is bad, unkind. Uncertain of when it will interrupt us, we fear it. It does not rejuvenate and/or "clear our minds," but threatens and harms.

Schulz recognizes the tension between humans and the *nature* we imagine as both disastrous and idyllic, both of which are located *out there*, in the prologue of this book:

> Nature is full of dramatic events, and full of humans here to turn them into disasters … even a magnitude nine earthquake isn't a catastrophe unless there's a civilization sitting on top of it. We humans are … around to make nature itself more dangerous.

Rather than dramatic and *out there*, she reminds us that nature is here. It is everywhere. It is our computers, our cars, our plastic *and* our wooden children's toys. To think otherwise is to misunderstand or misconstrue the role of human culture in our current and historical understandings.

Plec (2013) encourages humans to instead listen to nature so that we hear something different in and of it. As we begin to see "disasters" as a human construction, we decenter the role of humans in their occurrence, redefining them as naturally occurring events. In the process, we glimpse the double bind we have created for ourselves as both subject and object in nature, deeply entangled with the planet in ways that never can nor should be separated. We act and are acted upon in an emergent web of relationality comprised of the human, the nonhuman, and nature. Situated in that web, earthquakes are no more a disaster than a figment of our imaginations. Furthermore, human language both constrains and enables this complex relationship, as revealed by the terminology different scholars use to portray it. The terms "natureculture" (Haraway, 2007), "humanature" (Milstein & Krolokke, 2012), "internatural communication" (Plec, 2013), and "humanature intersubjectivity" (Cramer & Foss, 2009) all attempt to show the intertwined and inseparable character of the human-nonhuman-nature relationship. Communication scholars now recognize the deeply problematic state we have worked ourselves into as a result of such conceptions of nature. We now see that there is much work to do to undo and advance our understandings.

So how do our contributing authors contribute to and/or tease out the tension in the natures we imagine, both those we long for and fear? In Chapter 6, Kim and Madison investigate the Risk Perception Attitudes (RPAs) of a variety of differing groups (e.g., business owners, previous experience of natural disaster, homeownership, etc.), and their results seem bleak. Overall, they found that certain groups are statistically more likely to prepare, but in general their chapter suggests that many citizens (in this case, U.S. Americans) have very low literacy on risk perception and even lower for certain kinds of events (e.g., individuals prepare less for floods than for landslides), despite their more frequent occurrence and the often-equal devastation they cause). Low RPAs seem to be indicators of disconnect

from the planet's naturally occurring and evolving cycles. Severed from the earth's aliveness, its activities and movements become foreign. As a result, this sector of the population is wholly unprepared for survival. Kim and Madison show how insurance companies' policies also reflect the role of imagination in disasters: "many insurance companies often avoid covering damages caused by unnamed tropical storms and hurricanes" (original source: National Association of Insurance Commissioners, 2017). Since only severe storms are named, only severe storms are covered. In this manner, as far as insurance coverage goes, a devastating storm event can *quite literally* have existed only in our imaginations.

In Chapter 8, Novak and Day highlight the enormous holes that exist in our natural disaster preparations, particularly regarding companion animals. Oregon and Washington rank fourth and fifth in the United States for companion animal guardians (e.g., cats, dogs), and yet currently there is next to nothing in the CSZ earthquake preparedness guides beyond blanket advice to stockpile food and water for pets. Yet when we examine any recent natural disaster it is easy to notice that one of the greatest threats to human survival occurs when citizens do not evacuate when instructed to. One of the main reasons cited for not following evacuation instructions is, in effect, not being able to bring companions animals to a shelter. The lack of a plan for companion animals is nondefensible, since we have data and information about the role these animals play in families' lives.

Perhaps even more chilling are the evacuation plans—or lack thereof—for nearly all nonhuman animals under our supervision. Major zoos, aquariums, and other nonhuman animal places of captivity (e.g., research labs) have little or no plans to rescue or save these beings. Not surprising, beings that help provide economic stability and facilitate vaccine creation and scientific breakthroughs are also rarely accounted for. For evidence of the ill-intended, often-preventable devastation wreaked on animals during a natural disaster, just google any major natural disaster and the name of a local zoo or aquarium. This is just another all-too-obvious fallout of the inability of our human minds to live in fear *and* properly plan ahead for natural occurring events (i.e., disasters). As a society, we struggle to come to terms with the reality that nature is here—where we live and make homes, raise our children and play with our dogs—and not just in our imagined wilderness spaces. Learning to better cope with our fear and readjusting our imagined sense of nature would likely bolster our ability to prepare for natural disasters.

CLIMATE CHANGE AND THE STRUGGLE TO COMMUNICATE MEANING

A fascinating and frustrating—though not exactly original—observation made in the research for this book was just how *believable* CSZ science is for citizens of the PNW. Few have openly questioned what it predicts—that the CSZ earthquake is indeed going to happen again, possibly in many of our lifetimes, and it will be the worst natural disaster the United States has ever experienced. And why should this well-studied prediction be questioned? The science is sound and digestible despite the fact that there are not thousands of scientists verifying the data. Yet, climate change science, which also predicts future devastation and exists on a parallel plane, is difficult for many to accept. There are thousands and thousands of researchers across the globe confirming and supporting the claim of the earth's warming and the negative impacts it is having on ecosystems across the planet, and yet there is still large-scale denial of our human contribution to the warming. Why the difference in acceptance for these two scientific predictions?

To show that this question is part of the text's broader framework, it is addressed in the epilogue by Chris Goldfinger. Goldfinger explains that the similarities and differences between climate change and the CSZ lie in the level of abstraction of both events. The long geophysical timescale of the CSZ causes a fairly serious struggle for humans to make sense of the quake's 10,000-year dating records, as does the slow progression of climate change. Unable to grasp a timescale that exceeds our individual lifespans, we behave in ways that are counter to the disaster-predicting data. As if ignoring that both events continue to progress, we are left unprepared for both the sudden onset of the CSZ disaster and the imperceptibly slow change brought on by global warming.

To help us grasp the science of the CSZ and prepare ourselves for onset of the event, in Chapter 3 Adame and Miller stress what must be done to protect the Oregon, Washington, and Canadian coastal region from the earthquake and tsunami. Their work is part of a multipronged effort that is creating a "new normal" of better-prepared buildings, citizens, and first-responders in the PNW. In particular, they call to our attention an important constraint that heightens the disconnect between our thoughts or beliefs and our actions:

> Public surveys typically show most U.S. Americans recognize the importance of preparedness. Nevertheless, there is a great disconnect between thoughts and actions; unfortunately, very few people take effective steps to prepare for potential disasters. Some 66% of Americans feel they are personally unprepared for a disaster; and when asked why they're not prepared, 26% report they have not had enough preparation time, and 22% claim they have no idea what to do or

how to proceed (Redlener, Grant, Berman, Johnson, & Arbramson, 2006). Even though most Americans report positive attitudes about the need for disaster preparedness, those attitudes do not reliably predict their actual preparedness behaviors.

Although citizens do believe/accept the CSZ event will occur and have therefore overcome the fundamental challenge of preparation, the extended timescale of the event has given it a lack of urgency. An event that occurs as often as every 250 years or as infrequently as every 1,000 years—a timeframe too vast for human comprehension—is difficult for the human mind to plan for. Even though we know that the CSZ could happen at any moment, it remains abstract.

Given that humans are terrible at risk reduction even for situations within our control, that have consequences in our lifetimes (e.g., smoking and lung cancer, seat belts and car accidents), it is not surprising that little preparation occurs for an abstract but accepted event like the CSZ. On the other hand, climate change faces distinct complications, since opposing political messages—created when competing stakeholders redirect, refute, and challenge the science for personal gain—contest the fundamental, scientifically-supported understanding that humans cause the warming. Unlike the science of the CSZ, the science of climate change has become entangled in a political environment that refutes it. Accepting the phenomenon means humbling ourselves to admit to the shortcomings of our humanness that is destroying our species.

To take the focus off of our personal role in global climate change, in Chapters 1 and 4 Lovejoy and Homchick Crowe deemphasize the role of the individual, highlighting that of broader cultural factors. They ask: What role does communication, specifically the media, play in perpetuating the disbelief that human action causes the event? Lovejoy asks us to focus on the life-saving and hurtful potential of effective communication. He shows how the media can promote increased empathy in lieu of risk perception and fear in lieu of preparation. We also learn that media outlets might be the fastest and most effective source of information in the initial wake of a disaster, providing individuals with up-to-date information about food and water supplies, shelters, and medical care. Meanwhile, as the media unite and prepare us on some fronts, he stresses how saturated messaging from an ever-growing number of social media outlets can paralyze individuals, hindering our ability to take action, especially if those outlets offer conflicting information.

In a narrower focus, Homchick Crowe strives to understand how and why Schulz's article made the biggest splash across the PNW despite the media's previous, consistent and long-standing coverage of the CSZ. Why did this specific article—that shared little "new" information—hit so close to home for residents of the PNW when many have known about the CSZ for decades?

The question highlights the struggle media messaging can face, even when sharing the most important messages, and stresses the qualities of Schulz's article that allowed it to stand apart from previous attempts at communication. She emphasizes that the human struggle to communicate meaning has particular consequences when applied to natural disasters.

LAND AND CONFLICT

In the year proceeding the writing of this book, I was personally struck by three different land conflicts. The first occurred in Oregon in January 2016 on the Malheur Wildlife Refuge. The refuge was occupied by a group of armed militiamen over a dispute of land rights (Johnson, 2017). Later that spring, the second conflict occurred in North Dakota over the Dakota Access Pipeline (DAPL), which threatened sacred sites of the local Sioux and their access to clean water. The third occurred in Tanzania while I was traveling with a group of students. A large sect of migratory land, just north of the Serengeti—in Arusha's Loliondo area—had been leased to an Emirati hunting company called the Ortello Business Corporation (OBC). The lease displaced thousands of local Maasai peoples and large tracts of fences disrupted ancient migratory paths.

There is much to learn in studying these parallel and linked land conflicts, which overlap almost seamlessly with our discussion here when we consider the role of land in our lives. Land and land ownership is widely linked to the two previous themes (i.e., Imagination and Fear, Climate Change) in that it is deeply connected to how we identify ourselves (e.g., pioneers, homesteaders, farmers, etc.), our communities (e.g., rural, urban-dwellers), and our nation-state (e.g., borderlands, natural security, etc.). Cronon reminds us that these terms are, like the idea of the wilderness, social constructions:

> The removal of Indians to create an "uninhabited wilderness"—uninhabited as never before in the human history of the place—reminds us just how invented, just how constructed, the American wilderness really is. (Cronon, 1981)

Our negligent preparation for the CSZ earthquake and tsunami is interrelated to our conflicted relationship with our land, which is deeply political and linked to a colonial history. Part of the "human-nonhuman-nature" connection is tied to this inextricable, contested relationship (Dare & Fletcher, 2018, p. 9). Humans rarely give land agency—or personhood, in legal terms—to exist in and of itself as a means of communication. There are many theories at play to describe the ubiquitous human takeover of land, yet Alexander Reid

Ross's (2014) reasoning for the "Global Land Grab" perhaps captures five of the main reasons humans aim to own and control it: (1) Climate Change, (2) Financial Speculation, (3) The Great Recession, (4) Resource Scarcities and Extractivism, and (5) Imperialism History. Needless to say, the role of land in our human lives is problematic from a variety of differing angles, ecological and political being two examples among many.

In Chapter 7, Matsuura and Sato add a new lens to our tenuous relationship with land by analyzing "hazard maps," which can overlay standard maps to tell an alternative history—or predict a potential future—of the land they depict. While there is much to learn from mapping potential risks and/or hazards, there is something simultaneously ironic about these maps. As they shed new light and ways of thinking about land, bolstering the visibility of natural disasters by creating another dimension through which to view them, they have the potential to save lives. But, they also leave blind spots that hinder our communication. Depending on what they emphasize, they may contribute to the over-inflation of land (when deemed safer) or to its undervaluing (when deemed high-risk) and/or risk calculations being incorrect or imprecise, providing a false sense of safety. Taking this into consideration, Matsuura and Sato conclude that multi-hazard (e.g., earthquake, tsunami, and landslide)—versus single hazard (e.g., floods)—maps might be better equipped to more accurately predict land value and use. They end the chapter with a key takeaway that gets to the heart of the preparation and risk communication struggles facing the PNW and land conflicts in general: when deciding where to live, people do not generally make decisions that support known facts about natural disasters, particularly when it comes to earthquakes.

RISK COMMUNICATION AND "THE REALLY BIG ONE": TAKEAWAYS AND IMPLICATIONS

This project began because my coeditor and I, and all of our local friends and colleagues, were disturbed by the now infamous *New Yorker* article published in 2015 (Schulz). We watched firsthand as the city's residents perked up their ears and started a new dialogue about the contents of the article; the impending CSZ disaster really did capture citizens' attention for an intense, yet ultimately brief, period of time. There are a variety of reasons why it did not maintain its grip, but certainly some of the lost traction was due to the saturation of the mediascape with environmental warning messages about other phenomena: climate change, artic drilling, the sixth extinction, etc. We likely just cannot process all of the future events in any meaningful,

behavior-inducing way. Yet, our short attention spans and lack of meaningful reflection can come at a high price, as Winston Churchill foresaw in another pre-disaster era, just before the onset of World War II:

> When the situation was manageable it was neglected, and now that it is thoroughly out of hand we apply too late the remedies which then *might* have effected a cure. There is nothing new in the story … it falls into that long, dismal catalogue of the fruitlessness of experience and the confirmed unteachability of mankind. Want of foresight, unwillingness to act when action could be simple and effective, lack of clear thinking, confusion of counsel until the emergency comes, until self-preservation strikes its jarring gong—these are the features that constitute the endless repetition of history. (Winston Churchill, 1935)

While Churchill emphasizes how difficult it is to effectively communicate the necessity to take action that would prepare us for a future disaster, Corbett (2014) shows how easily the media can sway us to act in ways that are uncalled for, particularly in regard to environmental messages. To exemplify and further tease out just how complicated environmental messages can be, we can look at bottled water. Why do people drink bottled water? The answer is fairly simple, but there are lots of competing messages that, perhaps intentionally, complicate the issue. First bottled water companies tell you via advertising that their water is cleaner and purer than tap water, knowing full well that the consumer would never even try to verify that claim. Still, this message is what the consumer wants to hear and plays into consumer fear, so we purchase and drink the bottled water. So even though consumers are also told that bottled water is a wasteful, unnecessary product in the United States, where tap water is perfectly safe and as pure as any water you might get from a spring, bottled water consumption rises every year. We [U.S.] continue to be the country with the greatest consumption of bottled water *and* with some of the greatest access to clean, safe tap water (which we also overconsume). It is absurd and intensely wasteful.

Risk communication—without the resulting action or behavioral change—about the CSZ feels similarly inexplicable. In Chapter 2, Butler reiterates the puzzling fact that we remain underprepared in spite of our knowledge of the CSZ while sharing the fruits of his 40+ years of seismology research, much of which has involved intense study of the region. In spite of his research, which constitutes an enormous contribution to his field and within K–12 educational contexts, when I read his Chapter I am struck again by how little his message percolates into action and/or policy on the home front. His work reminds us that even well-supported, good science is not enough to communicate risks in tangible terms. As part of this edited, interdisciplinary book, his Chapter

is important in helping us facilitate better communication, transmitting what is known about the CSZ and what is being done to prepare it. Effective and appropriate risk communication lies at the very heart of the race to beat the tremendous fallout from a megathrust earthquake and tsunami impacting an unprepared population.

In Chapter 5, Kuang shares a "fast and frugal" approach to preparing for natural disasters, offering an encouraging framing of preparation, risk communication, and decision-making. She suggests that the preparations we make for how the brain will react to a natural disaster are not sufficient, particularly since we don't realize them. So, perhaps intense, long-term preparation is not the key after all. Rather, maybe our brains and bodies fare better when we expend less cognitive energy on detailed, preemptive action. Her more reactionary framing of natural disaster planning is a welcome, less obvious perspective that might benefit both scholars of risk communication and everyday citizens.

In Chapter 9, Doulis offers the olive branch between Butler's dogmatic science and Kuang's theoretical salve, showing us how we might do a little bit of everything. He might be our ideal risk communication subject: knowledgeable and yet not a professional, open-minded to the uncertainty of the situation and yet doing actions that will help him, his family, and his community cope with this monstrously abstract event. With heightened environmental literacy and acutely aware of the macro and micro roles of time, he begs us to organize ourselves, our homes, work places, and families. He knows that most of us will be underprepared whether the CSZ megathrust earthquake happens tomorrow or in 50 years. He is aware that when it happens, our relationships—especially with our neighbors and immediate communities—will predict our chances of survival. I think this is one of the strangest and scariest part of the whole human-animal-land relationship: that we can at once know and expect our fate and still be paralyzed or distracted by the immediate needs of our daily existence. And so, perhaps our greatest take-away of this edited collection is the saliency of resilience in our risk communication. Doulis calls it by name, but most of the chapters hint at this reality: resiliency will be king *and* queen on the days, weeks, months and years both prior to and following the next CSZ earthquake. And so, how we communicate our fears, perceptions, and behaviors as related to our sense of risk is paramount to creating a sustainable and healthy preparation model.

Discussion Questions

1. Are you environmentally literate? How would you know either way?

2. Share a story about nature. Now share a story about the environment. Compare and contrast your stories. Do humans conceive of nature and the environment similarly or differently, and how so?
3. Based on where you live, what natural disasters are you most at risk for experiencing? How have you prepared, and/or what does your communication about these disasters reveal to you?
4. Have you ever experienced a natural disaster firsthand? If so, what was it like? What surprised you the most? Disappointed you? If you have not had a firsthand experience, do you perceive that you are likely to in your lifetime? How? Why?

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Epilogue

Chris Goldfinger

When the Shuttle *Challenger* exploded, test pilot Chuck Yeager said "An airplane crashed," a counterpoint to the rest of the country and world who were shocked and gut punched by this very visible disaster. He further pointed out that "every street at Edwards (Air Force base) is named after one of my friends." To someone in a high-risk life, this was simply the cost of every error in a field with accepted risk, not a disaster of epic proportions. In a way, those of us who work in disaster related fields can relate better to Yeager than to the broader public. Giant earthquakes are the pool we swim in, every day, and when they happen, they are rarely a surprise, nor is the outcome. And yet, in a fundamental way, working toward reducing these disasters is in part why we do what we do. To a geologist, time is very different stuff. If something happens, we know it has happened thousands, maybe millions of times. In our short lives, we only get snapshot glimpses of big events that have happened again and again in "geologic" time. Our existence on Earth is so short that for the most part, it fits between these major events, the giant earthquakes, volcanic eruptions, meteor strikes and the like that to us are routine stuff on Earth. But when one of these "rare" events happens, it seems out of proportion, extreme in nature, and sometimes can be catastrophic to us.

When people react to these events, workers in these fields can sometimes feel a bit like Yeager, because it was usually predictable, and well known in advance, not always in the details of time and place, but still known. Some of these threats are long-term issues, more like smoking, that will inflict some disaster sometime in the future. This makes it difficult right from the start to communicate the risk and the need for some action to reduce it. The discovery of the coming Cascadia earthquake could simply be described as having built a part of our civilization on a very large time-bomb that nobody knew about. After all, the existence of these large plate boundaries was really only ushered

in with plate Tectonics revolution of all Earth science in the early 1960s. There is no one to blame, to villain to track, it's simply a gigantic problem that has appeared as if from nowhere. Not quite from nowhere though, Native American cultures were here and aware of it. This fact is similar to other places where the original cultures had oral histories that are long, and included these rare events and in many case what to do about them. So how is it, in the information age, that we have so much trouble communicating information that persisted in native cultures and their oral histories? Time is a big part of it. We have forgotten how long time is, and that there are many things that take a long time to learn, and long time to understand, and a long time to deal with. When it comes to what to do about it, to a geologist, the solutions are as simple as the problems. We will need to retrofit four major cities, countless smaller towns, as well as rezone land use along the coast to keep important facilities and schools out of the tsunami zone. But the reality is that this message will need to be communicated thousands of times, in a multitude of different ways, and a lot of money will have to be spent in order to reach a goal of resiliency *before* the earthquake. WE need to develop our own oral history, make this somethings that everyone knows.

The New Yorker article went viral mainly because this was big news to much of the country. There was no new information in it, it was simply brand new to most. We geologists were stunned. We thought that this was old news, after all it had been on television and in the print media many times. But the presentation of it in a prestigious venue, and in a very well written way, made Cascadia known to the World. In some ways, this was an important step toward weaving this knowledge into our own oral legend. This takes time, but once it is well known to all, the door is open to taking action to improve the outcome. Doing this will be costly, and take time, two things we struggle with. It may take 100 years or more. We got to the moon in 10 years, but can we tackle something that will take much longer and succeed? Time will tell. As geologists know, the earthquake is coming. We humans, especially those of us that live in Cascadia, are in a race. We will lose the race; we won't be prepared when it comes. But we can be in a much better place than we are today, and that's our best hope.

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C. Vail Fletcher (PhD, University of New Mexico) is an Associate Professor in the Department of Communication at the University of Portland and currently teaches courses related to Interpersonal and Intergroup Communication, Gender and International Development, and Conflict and the Environment. Her research broadly focuses on the intersections of culture, conflict, and identity. She recently completed an Imagining America grant-funded project that explored the re-creation and disruption of identity among youth in a post-genocidal Rwanda that was hosted at the United Nations Headquarters in New York, while other recent research has explored cross-cultural differences in the romantic conflict styles of individuals in Uganda and Ethiopia. After traveling and teaching a course in Tanzania on Ecology, Evolution, and Environmental Conflict, she is currently examining the role of ecotourism and the touristic gaze in the context of post/neo-colonialism in East Africa. Her most recent journal articles have been published in the *Journal of Environmental Communication*, the *Journal of International and Intercultural Communication*, the *Western Journal of Communication*, and the *Journal of Higher Education Outreach and Engagement*. Vail was awarded the 2014 Outstanding Edited Book Award from the National Communication Association for her book, *Understanding Occupy from Wall Street to Portland: Applied Studies in Communication Theory.*

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* * *

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Robert Butler (PhD, Stanford) is Professor Emeritus at the University of Portland. Since 2004, he has led the *Teachers on the Leading Edge* program of secondary Earth science teacher professional development that features EarthScope science and Cascadia active continental margin geologic hazards. Bob was also a Principal Investigator on the *Cascadia EarthScope Earthquake and Tsunami Education Program* from 2012 to 2016. With Jenda Johnson, Earth Sciences Animated, Bob has developed many animations of plate tectonics and earthquake processes. He was named the 2013 Outstanding Professor of Science and Mathematics by the Oregon Academy of Science; received the Oregon Science Teachers Association Fred Fox

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Yianni Doulis (MA, Harvard University) is an architect and part-time farmer in Oregon. He worked on international award-winning projects in the Stuttgart office of Behnisch Architekten, before returning to practice in the United States, where his focus is on site sensitive residential design as principle and lead designer of his own firm. He has over 20 years experience in all aspects of the design process: from site selection, public involvement, and master planning through design, permitting and construction management, to post-occupancy review. Since 2010, Yianni has lived with his family on a five-acre farm outside of Portland, where he grows tree and cane fruit and annual vegetables, and has been educating himself in homesteading skills.

Chris Goldfinger (PhD, Oregon State University) is a Professor of Geology and Geophysics at Oregon State University. Dr. Goldfinger is a marine geologist and geophysicist with a focus on great earthquakes and structure of plate boundary fault zones around the world. He has experience with deep submersibles, sidescan sonar, seismic reflection, and other marine geophysical tools on over 40 oceanographic cruises over the last 25 years. He is currently working on great subduction earthquakes along the Cascadia, NE Japan, the Caribbean, and Sumatran margins, as well as the Northern San Andreas Fault off northern California using the evidence for earthquakes found in deep-sea sediments. This work is developing methods for submarine paleoseismology in locales where plate boundaries are submerged. Goldfinger was the recipient of the 2016 Geological Society of America Kirk Bryan Award for Quaternary Geology. Goldfinger is a Professor of Marine Geology and received his PhD from Oregon State University in 1994. He likes to windsurf in the Columbia Gorge, flies an aerobatic airplane, and still lives in Cascadia.

Julie Homchick Crowe (PhD, University of Washington) is a Senior Lecturer in the Communication Department at Seattle University. She earned her Ph.D. from the University of Washington in 2009, where she focused on rhetorical studies and the history of science. During her time there, she

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