

# Public Attention to Environmental Hazards

by

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## EXAMINING COMMITTEE MEMBERSHIP

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The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

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## **AUTHOR'S DECLARATION**

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This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## STATEMENT OF CONTRIBUTIONS

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Exceptions to sole authorship:

**Chapter 3:** Silver A. and Matthews L. (2017). The use of Facebook for information seeking, decision support, and self-organization following a significant disaster. *Information, Communication, and Society* 20 (11): 1680-1697.

**Chapter 4:** Silver A. and Andrey J. (submitted). Public attention to extreme weather: sense-making on social media. Submitted to: *Journal of Contingencies and Crisis Management*.

I hereby declare that as lead author on all three manuscripts within this thesis, I was responsible for the conceptualization of the research, including writing the proposal for the overall dissertation and serving as principal investigator for the two empirical manuscripts.

For the manuscript published in *Information, Communication, and Society*, I conducted and transcribed the semi-structured interviews and coded and analyzed the interview transcripts. I also wrote the majority of the manuscript, submitted the manuscript to the journal, and addressed comments from the peer-reviewers. My co-author Lindsay Matthews developed the methods for the computer-assisted content analysis, downloaded and analyzed the digital data, and wrote the corresponding portion of the methods section.

For the manuscript submitted to *Journal of Contingencies and Crisis Management*, I gathered, cleaned, coded, and analyzed the Twitter data. I also drafted the entirety of the manuscript and I was responsible for formatting the manuscript for publication. My supervisor and co-author Dr. Jean Andrey provided insights into the methodological framework to be used for analysis in the article. She also offered intellectual insight, feedback, and editorial suggestions on the manuscript.

## ABSTRACT

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Although public attention has been noted as being influential within the hazard-response cycle, it has received almost no consideration within the risk and hazards literature. This is surprising, as attention is often noted in other disciplines for bridging the gap between information and action, and therefore public attention is highly relevant to the study of risk communication and response. It is prudent, therefore, to draw insights on public attention from other disciplines and bring them to bear on challenges pertaining to the human dimensions of environmental hazards. This dissertation presents original research that investigates this important issue. The first manuscript examines the use of Facebook after a significant tornado event that occurred in southern Ontario, Canada in August 2011. The results of this research underscore the usefulness of Facebook and Facebook groups for information seeking, decision support, and misinformation management. The second manuscript investigates the ways that Twitter was used by different actors groups (e.g., weather professionals, weather enthusiasts, news media, first responders, and citizens) during a second tornado-warning storm that affected southern Ontario, Canada in September 2016. The results of this research underscore the fact that Twitter is a powerful platform for the interpretation of both official and unofficial weather information. This interpretation is an iterative process that occurs both individually and collectively—a process that is often referred to as sense-making. The results of the second manuscript also highlight the fact that activity on Twitter can be indicative of professional, rather than “public”, attention to severe weather. The final manuscript draws on theoretical and empirical insights from research across numerous disciplines in order to frame the concept of public attention. Next, theoretical insights from the existing literature on public attention were taken together with empirical insights gained from the two original research projects, in order to develop a conceptual model of public attention. This model shows the process of attention creation from the initial point of exposure, to the iterative and collaborative process of sense-making, to an outcome (i.e., perception, decision, or action). The results of this dissertation emphasize the usefulness of public attention as a lens through which social scientists and other researchers can explore human behaviour when confronted with uncertainty—a topic that is of interest across the social sciences.

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## DEDICATION

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For Katherine, with all of my love.

## TABLE OF CONTENTS

---

Examining Committee Membership .....	ii
Author's Declaration .....	iii
Statement of Contributions .....	iv
Abstract .....	v
Acknowledgements .....	vi
Dedication .....	vii
Table of Contents .....	viii
List of Figures .....	xii
List of Tables .....	xiii

### CHAPTER ONE — INTRODUCTION TO THE DISSERTATION

---

<b>1.1 Problem Context .....</b>	<b>1</b>
1.2 Research methods .....	4
1.3 Research goals and objectives .....	5
1.4 Outline of dissertation .....	7

### CHAPTER TWO - RESEARCH CONTEXT AND THEORETICAL CONSIDERATIONS

---

<b>2.1 Introduction .....</b>	<b>10</b>
<b>2.2 Hazards theories .....</b>	<b>14</b>
2.2.1 Psychometric paradigm .....	14
2.2.2 The Social Amplification of Risk (SAR) Framework .....	19
2.2.3 Protective Action Decision Model .....	24
<b>2.3 Social theories outside of the hazards literature .....</b>	<b>25</b>
2.3.1 Social cognitive theory .....	25
2.3.2 Issue-attention cycle .....	28



2.3.3	Agenda-setting theory .....	29
2.3.4	Synthesis of social theories .....	31
<b>2.4</b>	<b>Influential factors in risky decision-making .....</b>	<b>32</b>
2.4.1	Risk perception .....	32
2.4.2	Socio-demographics .....	33
2.4.3	Previous disaster experience .....	34
2.4.4	The influence of culture .....	38
2.4.5	Synthesis of factors influential in risky decision-making .....	39
<b>2.5</b>	<b>Public attention .....</b>	<b>40</b>
2.5.1	What is public attention? .....	40
2.5.2	A comment on “public” attention .....	43
2.5.3	A comment on “awareness” .....	44
2.5.4	Moving towards a comprehensive definition of attention .....	46
2.5.5	Public attention, risk communication, and behavioural change .....	47
 <b>CHAPTER THREE - THE USE OF FACEBOOK FOLLOWING A DISASTER</b>		<b>52</b>
<hr/>		
<b>3.</b>	<b>Introduction .....</b>	<b>53</b>
3.1	Social Amplification of Risk (SAR) Framework .....	53
3.2	Social networking sites and crisis communications .....	55
3.3	Facebook groups .....	57
3.4	Case study: Goderich, Ontario tornado .....	59
<b>3.2</b>	<b>Methods .....</b>	<b>61</b>
3.2.1	Semi-structured interviews .....	61
3.2.2	Computer-assisted content analysis .....	62
<b>3.3</b>	<b>Results .....</b>	<b>66</b>
3.3.1	Semi-structured interviews .....	66
3.3.2	Computer assisted content analysis .....	70
<b>3.4</b>	<b>Discussion and Conclusions .....</b>	<b>75</b>

**CHAPTER FOUR — PUBLIC ATTENTION TO EXTREME WEATHER** **79**

---

<b>4.</b>	<b>Introduction</b> .....	<b>80</b>
4.1.1	Public attention .....	80
4.1.2	Public attention and social media .....	83
4.1.3	Storm event and study area .....	84
<b>4.2</b>	<b>Data collection and methods</b> .....	<b>86</b>
<b>4.3</b>	<b>Results</b> .....	<b>90</b>
4.3.1	Different actor groups .....	90
4.3.2	Key actors .....	93
4.3.3	Sense-making on social media .....	95
<b>4.4</b>	<b>Discussion and conclusions</b> .....	<b>103</b>
<b>4.5</b>	<b>Limitations and opportunities for future research</b> .....	<b>107</b>

**CHAPTER FIVE — A CONCEPTUAL MODEL OF PUBLIC ATTENTION** **109**

---

<b>5.1</b>	<b>Introduction</b> .....	<b>110</b>
5.1.2	Public attention within the risk and hazards literatures .....	112
5.1.3	A comment on “public” attention .....	114
5.1.4	A comment on “awareness” .....	116
<b>5.2</b>	<b>Public attention beyond the environmental hazards literature</b> .....	<b>118</b>
<b>5.3</b>	<b>Measuring public attention</b> .....	<b>124</b>
<b>5.4</b>	<b>Moving towards a comprehensive definition of attention</b> .....	<b>131</b>
5.4.2	Conceptual model of attention .....	132
<b>5.5</b>	<b>Conclusions</b> .....	<b>139</b>

**CHAPTER SIX — DISSERTATION SUMMARY AND CONCLUSIONS**

---

6.1	Study synopsis .....	141
6.2	The usage of Facebook following a significant disaster (Manuscript 1) .....	142
6.3	Sense-making on social media during extreme weather (Manuscript 2) .....	144
6.4	Public attention to environmental hazards (Manuscript 3) .....	146
6.5	Opportunities for future research .....	147

6.6	Implications for practitioners .....	150
6.7	Concluding remarks .....	151
	References .....	153

## LIST OF FIGURES

---

<b>Figure 2.1:</b> The two-dimensional factor space of the psychometric paradigm .....	15
<b>Figure 2.2:</b> The Social Amplification of Risk Framework (SARF) .....	20
<b>Figure 2.3:</b> The Protective Action Decision Model (PADM) .....	24
<b>Figure 3.1:</b> Number of wall posts and comments by week following the tornado event .....	63
<b>Figure 3.2:</b> Wall posts and comments containing meaningful words over time .....	73
<b>Figure 3.3:</b> Wall posts and comments containing words of importance .....	75
<b>Figure 4.1:</b> All confirmed and probable tornadoes by Fujita Scale .....	85
<b>Figure 4.2:</b> Tweets for the 10 September 2016 storm .....	89
<b>Figure 4.3:</b> Original tweets and re-tweets for the keywords #onstorm and tornado .....	92
<b>Figure 4.4:</b> All original tweets and re-tweets over time .....	93
<b>Figure 4.5:</b> Original tweets and re-tweets broken out by user category .....	94
<b>Figure 4.6:</b> Tweets containing action recommendations by actor group .....	99
<b>Figure 4.7:</b> Tweets containing personal observations by group .....	102
<b>Figure 5.1:</b> A conceptual diagram of attention creation .....	136

## LIST OF TABLES

---

<b>Table 2.1:</b> Definitions of risk .....	11
<b>Table 2.2:</b> Various characteristics that influence risk perception .....	16
<b>Table 3.1:</b> Usage statistics for the GOTVS Facebook group .....	60
<b>Table 3.2:</b> Top 70 meaningful words and their lexical roots .....	65
<b>Table 3.3:</b> Frequency of use for top 59 root words .....	71
<b>Table 3.4:</b> P-values for one-tailed paired t-test for Facebook activity .....	74
<b>Table 4.1:</b> Five actor groups included in the study .....	90
<b>Table 4.2:</b> Top 15 re-tweets .....	97
<b>Table 4.3a:</b> Ten tweets by weather experts that include a call to action .....	100
<b>Table 4.3b:</b> Ten tweets by citizens that include a call to action .....	101
<b>Table 5.1:</b> Select definitions of attention .....	123

# CHAPTER ONE

## INTRODUCTION TO THE THESIS

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### 1.1 Problem Context

The study of environmental hazards is a longstanding tradition within geographic scholarship. Beginning with Gilbert F. White's seminal thesis on human adjustment to floods, geographers have made important contributions to the discourse on the human dimensions of hazards and disasters over the last eighty years. From work on the environment as hazard (Burton et al. 1978; Burton and Kates 1964), to research on vulnerability and risk (Blaikie et al. 1994; Cutter 1996; Cutter et al. 2003; Andrey and Jones 2008; Smit and Wandel 2006), to risky landscapes (Hewitt 1997), and socio-ecological resilience (Adger 2000; Adger et al. 2005; Cutter et al. 2010), geographers have contributed greatly to the current understanding of hazards, risk, and disasters.

Yet despite this progress, the social and economic losses incurred from high-impact events continue to rise. Over the last five decades, the number of hydro-meteorological disasters has nearly quintupled from approximately 750 between 1971-1980 to approximately 3500 between 2001-2010 (World Meteorological Organization 2015). The economic losses incurred from disasters during this period has similarly risen, from US\$ 156 billion to US\$ 864 billion per decade (World Meteorological Organization 2015). The reasons for this increase are complex, and include both geophysical and socio-political factors. As a result, contemporary researchers and practitioners are faced with the same challenge as their predecessors: to effectively reduce the social, economic, and physical losses incurred from disasters.

Social scientists have addressed this challenge through a variety of different lenses. Perhaps most influentially, research on risk perception has contributed to the scholarly understanding of protective action decision-making (Vitek and Berta 1982; Slovic 1987; Wildavsky and Dake 1990; Gregory et al. 1997; Horlick-Jones et al. 2003; Sheridan 2007; Zhang et al. 2007; Silver and Conrad 2010; Burns and Slovic 2012; Eiser et al. 2012; Lindell and Perry 2012; Wachinger et al. 2013). Yet despite the abundance of research put into practice on the topic, many individuals still fail to take adequate protective measures for high-impact events. This raises several important questions: is there a disconnect between the communication and interpretation of potential risks and recommended responses? What linkages exist between the communication of information and the decision to take action? Are there other lenses that may provide a fuller or complementary understanding of why and how individuals respond to potential threats?

This dissertation proposes that research on public attention has the potential to address these and other important questions about human behaviour when confronted with uncertainty. Attention can be understood as the process of noticing, selecting, and focusing on one or more external stimuli (e.g., hazardous event or event-related information) to which people are exposed<sup>1</sup>. While attention is noted within the psychological, communications, and business management literatures for its influence in eliciting behavioural response (Downs 1972; Newig 2004; Neuman 1990; Webster and Ksiazek 2012; Neuman et al. 2014; Webster 2011; Hoffman and Ocasio 2001), it has received little consideration within the risk and hazards literature. This is surprising, as attention is often understood to mediate the relationship between information and action (e.g.,

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<sup>1</sup> The concept of public attention and its implications for risk communication and decision-making are explored in greater detail in Chapter 5: A Conceptual Model of Public Attention.

Newig 2004), and as such is of central importance for issues pertaining to risk communication and decision making.

This doctoral dissertation critically examines the concept of public attention within the context of environmental hazards. Social cognitive theory (SCT) provides the theoretical foundation for this research, while insights on public attention and risk communication are drawn from the issue-attention cycle, the agenda-setting theory, and from research on sense-making. Social cognitive theory is presented as an overarching framework for this research, as it highlights the role of attention in determining what external stimuli (i.e., social and environmental cues, information) to observe and what motivating power these stimuli will have (Bandura 2001a). The issue-attention cycle and the agenda-setting theory provide insights on communication and decision-making—albeit from a narrower perspective than that of social cognitive theory. Lastly, research on sense-making provides insights about the iterative process of information seeking, sharing, and interpretation that occurs, both individually and collectively, during severe weather events.

As a first step, insights across a broad range of disciplines were synthesized in order to frame the concept of public attention as it pertains to environmental hazards. The insights from this theoretical and empirical literature were then used to guide the development of two original research projects undertaken in southern Ontario, Canada. These projects investigate how the public attended to severe weather, as reflected by information seeking and sharing behaviours on two different social media platforms. Together, the theoretical insights from the literature on attention and the empirical insights from the two original research projects provided the basis for the development of a conceptual model of the processes of attention creation. This thesis also



provides evidence that attention is an important link between risk communication, risk perception, and decision-making.

## *1.2 Research methods*

The most common approach for measuring attention is the use of proxies to infer how the public attends to information and/or events, often through research on traditional mass media. But new media are increasingly being used as indicators of public attention (Neuman et al. 2014; Ripberger 2011; Ripberger et al. 2014; Swearingen and Ripberger 2014; Chung 2011). The assumption is that coverage intensity (e.g., the duration of televised coverage, the number of words in print, or the number of posts on a social media website) is positively associated with public attention. As noted by Ripberger et al. (2015:521) in their study on social media and severe weather:

The logic underlying such measures is rather simple—the more people talk about a particular issue, topic, or hazard (via Twitter, Facebook, Google+ and other social media sites), the more likely it is that they are paying attention to it. Thus, increased discussion of an issue, topic, or hazard is thought to indicate increased attention.

However, there are several challenges associated with the use of social media data as a proxy for public attention. Most notably, reliability of information, differences in technological access, and the lack of a well defined study population pose challenges for researchers (Chew and Eysenbach 2010; Neuman et al. 2014). Many of these potential challenges can be addressed by a well designed methodological framework. Even when ambiguity cannot be fully controlled (e.g., in the case of missing or erroneous metadata), social media data can still provide meaningful insights on the social norms, processes, and cultures that have developed on various social networking sites.

This dissertation uses an inductive study design, guided by the tenets of social cognitive theory. The first empirical manuscript used both in-person interviews and social media analysis to highlight the role that Facebook groups played in knowledge mobilization and collective sense-making after the 2011 Goderich tornado. Insights gained from the interviews underscore the usefulness of Facebook groups for information seeking and self-organization in the days following the tornado. To further investigate how Facebook was utilized for response and recovery, computer-assisted content analysis was conducted for the Goderich Ontario Tornado Victims and Support (GOTVS) Facebook group, which was the most popular Facebook group associated with the tornado. The second empirical manuscript builds on and extends findings from the first study through the examination of public attention during a severe weather outbreak, as expressed through activity on Twitter. Insights from this research highlight the roles of weather experts and enthusiasts (e.g., meteorologists, forecasters, storm chasers, storm spotters) as key actors that facilitate discourse during severe weather. The results from these two empirical pieces, taken together with insights drawn from the broader theoretical and empirical literature, allowed for the development of a conceptual model of public attention to extreme weather that is presented in the third manuscript.

### *1.3 Research goals and objectives*

The overarching goal of this dissertation is to provide a coherent conceptualization of public attention as a concept relevant to environmental hazards and risk reduction, and to clarify the role of public attention in individual's behaviour modification during severe weather. To achieve this goal, three objectives were developed, each with its own aims:

**Objective 1:** To provide a framework of public attention that is applicable both within and beyond the scope of environmental hazards.

Aim 1: Synthesize the theoretical and empirical literature on public attention in order to identify this literature's common characteristics, in order to frame the concept of public attention.

Aim 2: Develop a conceptual model that demonstrates how the public may attend to, interpret, communicate about, and respond to severe and hazardous weather.

**Objective 2:** To assess how public attention to severe weather is expressed through social media.

Aim 1: Learn about the different actors who engage on social media to better understand how these individuals influence one another.

Aim 2: Delve into the process of collective sense-making in order to examine how information seeking and sharing behaviours change over time.

Aim 3: Identify those who take on a leadership role and provide guidance and insights *via* social media to other users during severe weather.

**Objective 3:** To identify how public attention research may complement existing research on public perception, so as to achieve a fuller understanding of how the public responds to high-impact events.

Aim 1: Compare and contrast research on public attention and perception to environmental hazards, and identify similarities and differences.

Aim 2: Identify potential linkages between public attention and public perception, as it relates to decision-making.

#### 1.4 *Outline of dissertation*

This doctoral dissertation follows the manuscript style, which includes an introductory chapter, a chapter on the relevant literature, three original manuscripts, and lastly a chapter summarizing the major findings and contributions of the research. The second chapter provides a review of the literature on environmental hazards, public perception, and attention as these concepts relate to protective action decision-making. Several social theories are also introduced and discussed in this chapter for their relevance in informing issues pertaining to public attention and action.

Existing research on public attention is also synthesized in this chapter, both within and beyond the scope of the hazards literature in order to frame the concept of public attention.

Chapter 3 is the first empirical manuscript of the dissertation, which has been published in the journal *Information, Communication, and Society* (Silver and Matthews 2017). Utilizing a mixed methods approach, this chapter addresses Aim 1 and Aim 2 from Objective 2. Specifically, in-person interviews with Goderich area residents were analyzed to assess whether and how residents used Facebook for information seeking, knowledge mobilization, and collective sense-making in the days and weeks following the disaster. Based on insights gained from these interviews, a content analysis was conducted to document (1) how the number of overall posts changed over time, and (2) how the frequency of keywords and phrases changed over time.

Taken together, results from the interviews and content analysis provide insights on the ways

that users utilize Facebook for information seeking, decision support, and misinformation management.

Chapter 4 presents the findings of the second empirical manuscript, which has been submitted to the *Journal of Contingencies and Crisis Management*. This chapter further explores aims from Objective 2, and also investigates aspects of public attention in order to inform the development of the conceptual model of attention presented in Chapter 5. (Objective 1). To do so, tweets containing keywords **#onstorm** and **tornado** were gathered over a 48 hour period in September 2016 during which time a large storm system moved through southern Ontario. Analysis focused on three main areas of inquiry: (1) gaining a better understanding of the different actors who contributed to the conversation, particularly those who guided discourse during the storm; (2) understanding how information seeking and communicating behaviours played out over the study period; (3) investigating how people, both individually and collectively, engaged in the process of sense-making before, during, and after the severe storm. The results demonstrate that many of the most active users were weather professionals (e.g., meteorologists, forecasters, storm chasers, storm photographers) rather than laypersons. This calls into question the use of Twitter data as an indicator of “public” attention to severe weather.

Chapter 5 presents the major theoretical contribution of the dissertation, a manuscript which has been submitted to the *International Journal of Disaster Risk Reduction*. Focusing on the first and third objectives, this manuscript provides a critical review of the existing research on public attention, both within and beyond the hazards literature. Building on and extending this literature, a coherent definition of public attention is proposed. Next, the empirical insights on

public attention to extreme weather from the two original research projects (Chapters 3 and 4) are summarized. Based on the insights gained from the existing theoretical and empirical literature, coupled with the new empirical findings on the nature of attention from the two original manuscripts, a conceptual model of attention to environmental hazards is proposed and discussed.

**CHAPTER TWO**

**RESEARCH CONTEXT  
AND THEORETICAL CONSIDERATIONS**

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**2.1 Introduction**

Research on the human dimensions of environmental hazards began in earnest with the publication of Gilbert F. White's seminal thesis *Human Adjustment to Floods* (1945). White challenged the prevailing belief that flood hazards are best controlled with engineered structures, such as dams and levees. He suggested instead that human behaviour is an important factor that influences the type and extent of losses incurred from disasters. In his own words, White believed that "floods are 'acts of God', but flood losses are largely acts of man" (White 1945, p. 2). In the decades since White's pioneering work, social scientists across a broad range of disciplines have made progress in understanding human response to environmental hazards, as evidenced by a vast body of theoretical and empirical literature that addresses a broad range of geophysical and hydro-meteorological hazards that span spatial and temporal scales. This research has provided valuable insights on human behaviour when confronted with environmental stressors, and has highlighted the importance of public attention, perception, and communication in making protective action decisions.

One area of research that has substantially influenced scholarly understanding of human behaviour during crises is research on risk perception, interpretation, and communication. Before unpacking this literature, it is first prudent to explore the concept of risk. While multiple definitions are used within the hazards literature, risk is often described in terms of the

Author (year)	Select Definitions
Otway and Thomas (1982, p. 70)	“[For objectivists] risk is a quantifiable attribute of technologies and naturally occurring hazards; for the rest of us “risk” is a subjective experience (or a future projection of an experience), which is meaningful for, and can be thought about, judged and felt by anyone, expert or layperson.”
Rosa (1998, p. 28)	“...a situation or event in which something of human value (including humans themselves) has been put at stake and where the outcome is uncertain.”
Williams and Noyes (2007, p. 5)	“... there appears to be two general ways in which risk can be defined—statistically (objective risk), or as a synonym for danger or threat (subjective risk).”
Hansson (2010, p. 236)	"...an accurate and reasonably complete characterization of risk must refer both to the objective facts about the physical world and to (value) statements that do not refer to objective facts about the physical world."
Smith (2013, p. 11)	“Risk—the likely consequence—becomes the combination of the probability of a hazardous event and its negative consequences.”

**Table 2.1:** Definitions of risk.

probability of occurrence in relation to the magnitude of potential impacts (Kasperson et al. 1988; Stern and Fineberg 1996), a definition that appears at first glance to be entirely objective. In contrast, risk perception can be broadly understood as the subjective and intuitive evaluation of risk by laypersons (Sitkin and Pablo 1992; Slovic 1987). These two perspectives reflect the somewhat contentious nature of risk: is risk objective (mind-independent) or subjective (mind-dependent)? This epistemological debate has been ongoing for decades across a broad range of disciplines (Table 2.1). For the purposes of this dissertation, risk can be understood to have several important characteristics: (1) risk involves an event or decision where the outcome is uncertain, (2) as a result of this uncertainty, something of value (e.g., people, property, lifestyles) may be in danger, (3) the ways that different groups make sense of and respond to this uncertainty and danger vary.



Although the debate between objectivists and subjectivists is far from over (Hansson 2010), there is growing consensus within the hazards literature that it is erroneous to conceptualize risk as strictly mind-independent (Slovic 2004a; McComas 2006; Williams and Noyes 2007). As Slovic (2004a, p. 392) explains, "... risk does not exist 'out there', independent of our minds and cultures, waiting to be measured. Instead, human beings have invented the concept of *risk* to help them to understand and cope with the dangers and uncertainties of life". While the consequences from hazards are measurable, risk itself is a social construct derived from the iterative interpretation of events, things, and circumstances (Kasperson et al. 1988; Sjöberg 2000; Slovic 2004a; McComas 2006).

Research on risk perception, interpretation, and response proliferated in association with the development of chemical and nuclear technologies during the 1960s (Slovic et al. 1982). These technologies were met with considerable public opposition, in part based on public perceptions of unacceptable risks. This opposition confounded and frustrated many scientists and policy-makers who viewed these technologies in terms of their positive risk-benefit trade-offs (i.e., these individuals believed that the potential benefits of sustainable energy and national security, for example, outweighed the small chance for negative outcomes). However, this opposition highlighted several important research questions: why does society pay attention to some risks while disregarding others? How does society interpret risk and come to a (near) consensus on what is an acceptable *versus* unacceptable risk? How are risks communicated and how does this communication contribute to behavioural change?

Social scientists from a broad range of disciplines, including psychology, sociology, business management, and geography have addressed these and other questions about the human dimensions of risk. A substantial body of social science research has developed around these issues, including studies on risk perception (e.g., Slovic 1987; Sjöberg et al. 2004; Wildavsky and Dake 1990; Slovic et al. 1982; Wachinger et al. 2013), risk communication (e.g., Bostrom et al. 1994; Fischhoff 1995; Fischhoff et al. 1993; McComas 2006; Murdock et al. 2003; Steelman and McCaffrey 2012; Bostrom et al. 1994; Murdock et al. 2003; Fischhoff et al. 1993; Fischhoff 1995; McComas 2006; Morgan et al. 2002; Siegrist 2013), and behavioural response (e.g., Cox and Danford 2014; Sharma and Patt 2012; Lindell and Hwang 2008; Vitek and Berta 1982; Silver and Conrad 2010; Donner 2007; Zhang et al. 2007). Despite the substantial attention these issues have received, the resultant literature is surprisingly undertheorized—a trend reflected in the broader hazards literature, which has seen an increased emphasis on empirical research over the last 20 years (McComas 2006; Williams and Noyes 2007). This trend has motivated some researchers to advocate for greater theoretical integration within the risk literature specifically, and within the hazards literature more generally (e.g., Sitkin and Pablo 1992; McComas 2006; Rodriguez et al. 2007).

One way to ensure better theoretical integration is the use of theory to guide thinking on hazard-related problems. The following section synthesizes research guided by the three prominent theories developed within the hazards tradition over the last several decades: the psychometric paradigm; the Social Amplification of Risk (SAR) framework; and the Protective Action Decision Model. These theories were chosen over others for their prominence in the hazards literature, and for the ways they inform understanding of communication, interpretation,

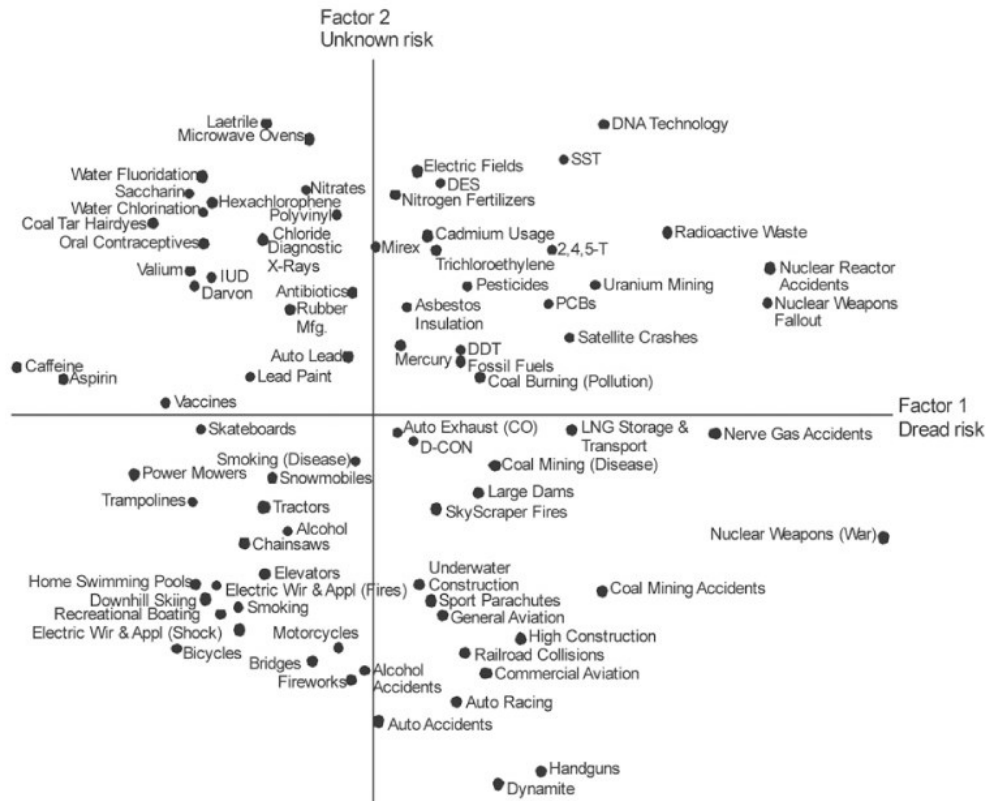
perception, and response. Next, three social theories that have guided thinking beyond the scope of the hazards literature are discussed: social cognitive theory; the issue-attention cycle; and the agenda-setting theory. These theories were chosen from a broader suite of options because they directly address public attention, and for their potential to inform research on matters of risk perception, communication, and response.

## **2.2 Hazards theories**

### *2.2.1 Psychometric paradigm*

The psychometric paradigm is arguably one of the most influential models in risk perception research, and it has had considerable influence within the broader hazards literature (Fischhoff et al. 1978). At its core, the psychometric paradigm seeks to understand the differences in risk judgements between expert analyses of risk and the interpretation of those risks by others, particularly the general public. By examining *expressed preferences*, Slovic and colleagues developed a three-dimensional factor space composed of dread risk, unknown risk, and exposure. Risk perceptions are placed within this factor space based on the interrelationships among numerous risk characteristics (Slovic et al. 1982; Slovic 1987). A two-dimensional version of this structure, with dread risk and unknown risk as the two axes, is provided (Figure 2.1).

Empirical research guided by the psychometric paradigm has provided valuable insights into the nature of risk perception. For example, this research has found that risk perception is both quantifiable and predictable (Slovic et al. 1982; Slovic 1987; Fischhoff et al. 1978; Slovic 2004a). Slovic and colleagues (1982; 1988; 2004) also have identified a number of important



**Figure 2.1:** The two-dimensional factor space with dread risk and unknown risk as the two axes. Reproduced from: Slovic (1982, p. 86, Figure 1).

characteristics that have been shown to influence risk perception, including dread risk and unknown risk, heuristics (affect and availability), trust, and stigma (Table 2.2). Research on dread risk and unknown risk in particular have become cornerstones of the psychometric tradition, and this research has provided many insights on the nature of perceived risk.

A second area of inquiry that has yielded important findings in the psychometric tradition involves the exploration of how individuals perceive risk across a spectrum of hazardous events

<b>Factor</b> <i>(related terms)</i>	<b>Definition</b>
Dread risk	Dread refers to the “terribleness” of a potential risk. As a topic of considerable emphasis within the psychometric tradition, dread risk is closely associated with feelings of uncontrollability, and it has been found to be a good predictor of perceived risk (Slovic 1987; Stein et al. 2013).
Unknown risk	Unknown risk refers to the newness of a technology. Newer technologies, particularly ones that are also perceived as dreadful, tend to be perceived as riskier than technologies that more familiar (Slovic 1987).
Affect heuristic <i>(attitude)</i>	Affect refers to a subtle form of emotion that influences the perception of an external stimuli (Slovic 2004b). Affective responses are either positive or negative, and they have been found to have a strong influence on perceived risk. Specifically, situations that are associated with positive feelings are often perceived as less risky than those situations that are associated with negative feelings (Slovic et al. 2002).
Framing effects	Framing effects can be broadly conceptualized as the ways that risks are presented (Sitkin and Pablo 1992). For example, risks that are presented as opportunities, rather than challenges, may be perceived as more acceptable. Framing effects are closely related to affective responses.
Availability heuristic	The availability heuristic refers to the tendency for individuals to assess “...the probability of an event by the ease with which instances or occurrences can be brought to mind” (Tversky and Kahneman 1974, p. 1127). A closely related concept, hazard intrusiveness, refers to the “...frequency of thoughts, discussion, and passive receipt of information from others about hazards” (Bourque et al. 2013).
Trust	Trust has become the topic of considerable interest over the last several decades. Recent research has found that trust in authority or in the source of a risk message is related to risk perception (Williams and Noyes 2007; McComas 2006; Slovic 2004a).
Stigma	Stigma is another concept that has received considerable attention in the psychometric tradition, and it is similarly related to affective responses, trust, and credibility (Slovic et al. 2002; Kasperson et al. 1988). Technologies that are associated with higher levels of stigma (e.g., nuclear technology) are often perceived as higher risk (Slovic et al. 1982).

(continued)

<b>Factor</b> <i>(related terms)</i>	<b>Definition</b>
Voluntariness	Voluntariness refers to risks that are undertaken by individual choice (free will). Research within the psychometric tradition has demonstrated that most individuals are more likely to accept voluntary risks (Slovic et al. 1982; Slovic 1987). A closely related concept is the notion of controllability (Fischhoff et al. 1978).
Optimistic bias <i>(risk denial)</i>	Optimistic bias refers to the tendency for individuals to believe that they are less at risk from hazards than their neighbours or their community (Weinstein 1989a; Sjöberg 2000).
Normalization bias	Normalization bias is an aspect of previous disaster experience, whereby individuals who are frequently exposed to objectively minor events may infer from this an ability to appropriately respond to any future events, regardless of magnitude (Paton et al. 2008; Cross 1990)
Self-efficacy	Self-efficacy refers to an individual's confidence in their own abilities to cope with or respond to a potential threat. Although high self-efficacy is often related to increased information seeking and preparedness behaviour (McComas 2006), it can also be related to maladaptive responses to threats (Schultz et al. 2010). A related concept is response-efficacy, which refers to an individual's belief "...that protective actions will in fact be effective to protect oneself or others from being harmed by a threat" (Grothmann and Reusswig 2006, p. 106).

**Table 2.2:** Various characteristics that have been identified as having an influence on the perception of risk and, subsequently, decision-making. Research on these concepts has been conducted in the psychometric tradition, the Social Amplification of Risk Framework, and others.

(Slovic et al. 1982). For example, why do most individuals place greater emphasis on preparing for certain hazards over others? In their research on hazard perception, Gregory et al. (1997) found that focus group participants were more likely to prepare for high-probability low-consequence events than low-probability high-consequence events. The results found that respondents generally felt that immediate concerns (e.g., paying bills, medical problems, and other daily challenges) took precedence over preparation for high-impact events. Research conducted by Wachinger et al. (2013) and Burningham et al. (2008) similarly concluded that individuals often prioritize daily problems above mitigation for hazards, and that individuals interpret risk in the context of other risks and benefits. For example, an individual may decide that purchasing property within a flood zone is acceptable, as the immediate benefits of such a property (e.g., scenery, recreation, retreat) outweigh any potential risks (e.g., property loss or injury due to flooding).

In addition to the important findings described above, research on heuristics is arguably one of the most substantial contributions of the psychometric paradigm (Slovic 1987). Research on the affect heuristic in particular has provided valuable insights on the ways that attitudes and beliefs can affect the perception of risk. As McComas (2006, p. 78) notes, "...people base their risk judgments not only on what they *think* about the risk but also on what they *feel* about it" (emphasis added). Thus, the interpretation of risk is composed of both reason-based analysis and the emotional response one feels about that risk (Slovic 2004a,b; Tversky and Kahneman 1974; Slovic et al. 2002). Positive feelings for a risky event or technology are associated with lower levels of perceived risk, whereas negative feelings for a risky event or technology are associated

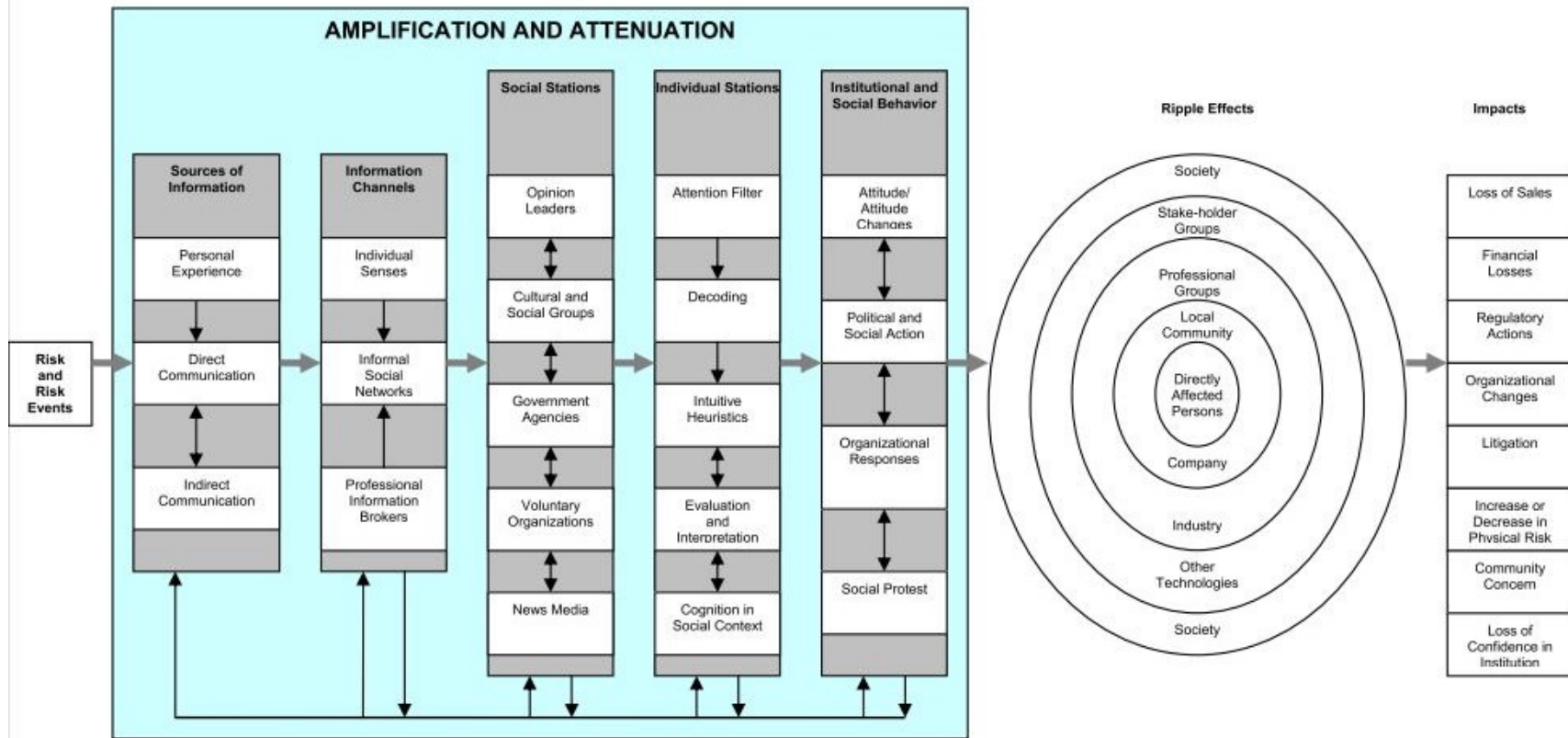
with higher levels of perceived risk (Slovic 2004a; McComas 2006; Sjöberg 2000; Slovic et al. 1982).

Research conducted within the psychometric paradigm has focused on understanding the factors that influence risk perception. The strength of the psychometric paradigm lies in its ability to identify the similarities and differences in the ways that risks are interpreted by various individuals and groups. However, it is important to note that research using psycho-physical scaling methods assess *feelings and cognitions* of participants, not actual behaviour (Slovic 2004b). Furthermore, the analysis of risk perception using this framework is highly descriptive, and subsequent research has demonstrated that psychometric techniques can only explain a modest portion of perceived risk (Sjöberg 2000). As such, this framework may not be appropriate for research questions that require a deeper understanding of societal processes.

### *2.2.2 The Social Amplification of Risk (SAR) Framework*

The Social Amplification of Risk (SAR) framework, which builds on the psychometric paradigm, was developed in response to the inability of many traditional risk assessments to account for the unanticipated public opposition to certain risks that are considered acceptable by experts. In particular, the SAR framework explains how and why certain “low risk” events (e.g., low-probability high-consequence risks, such as nuclear power, or high-probability low-consequence risks, such as genetically modified foods) often have high perception of risk among certain interest groups (Kasperson et al., 1988). In general terms, this framework examines the process of risk amplification and attenuation as signals (information) pass through different amplification “stations” (Figure 2.2, Kasperson et al., 1988). With a strong basis in





**Figure 2.2:** The Social Amplification of Risk Framework (SARF). Reproduced from: Mills (2011, p. 25, Figure 5). Original source: Kaspersen et al. (2003, p. 14, Figure 1.1).

communications theory, the SAR framework is particularly focused on understanding how a signal (i.e., risk information) travels from its source to its ultimate destination: individual end-users. This theoretical framework articulates risk as dynamic, constantly evolving, and reciprocal—in that risk information can influence perceptions, which can in turn influence the consumption and dissemination of risk information. Although the relationship between information propagation, risk perception, and behaviour is more complex than its source-receiver metaphor implies, the SAR framework compensates for this weakness by incorporating second- and third-degree impacts. For example, information about flood risk could cause concerned interest groups to increase political pressure in their municipality. This political pressure could result in a comprehensive flood assessment, which in turn could either amplify or attenuate future risk perceptions.

The SAR framework is a useful theoretical framework for hazards research for several reasons. First, it acknowledges that risk perception influences behaviours in ways that are often unexpected. Second, the SAR framework demonstrates how previous disaster experience (both direct and indirect) influences risk perception through social interactions. Finally, given its focus on both individuals as well as larger social institutions, the SAR framework allows for a critical exploration of agency *versus* structure in decision-making. Most notably, the SAR framework demonstrates that information is transferred through and interpreted by both individual and social stations, highlighting the roles that both individual agency and governance play in risk communication and perception.

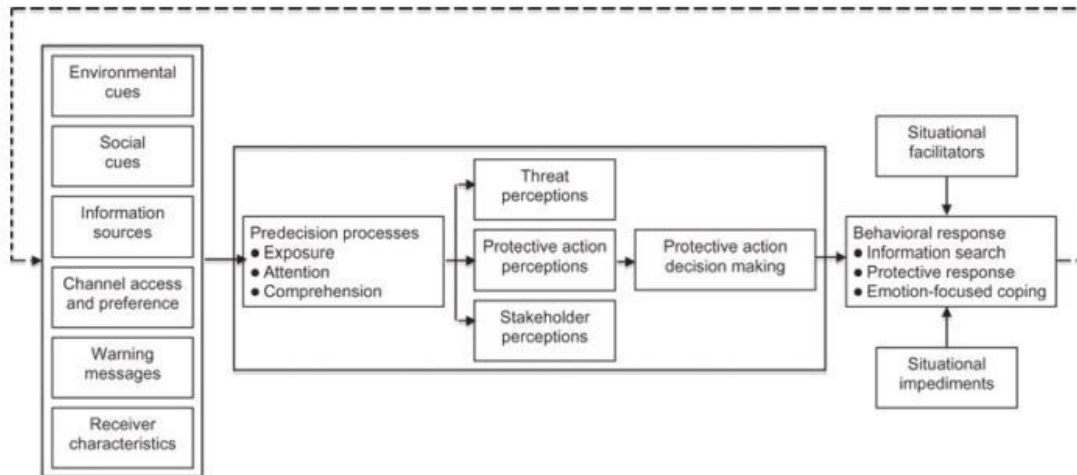
Subsequent research has criticized the original conceptual diagram for its focus on individual, rather than on community- or organizational-level variables (Rip 1988). It is suggested here that this is not a valid criticism, given the useful and thorough discussion of agency *versus* structure that appeared in the original article (Kasperson et al., 1988). Furthermore, in an analysis of research conducted in the fifteen years since the publication of the SAR framework, the authors note that many articles (indeed, perhaps the majority of subsequent articles) focus on organizational, institutional or community-level issues (Kasperson et al. 2003). This broad research base would seem to be linked to the highly adaptable and applicable nature of this framework for research on environmental hazards.

Although the SAR framework is most notable for its conceptualization of risk amplification and attenuation, it has several limitations. Firstly, the authors of the original paper indicated that the SAR framework might provide the “...theoretical base for a more comprehensive and powerful analysis of risk and risk management in modern societies” (Kasperson et al. 1988, p. 180). However, subsequent publications caution that the SAR framework is not a theory in and of itself, but rather it describes the social processes and contexts that influence risk communication, perception, and response (Kasperson et al. 2003). As such, one potential limitation of this framework is its inability to provide testable predictions; rather, the SAR framework provides a structure that allows for the descriptive analysis of events (Breakwell and Barnett 2003). Additionally, while the SAR framework is broad enough to incorporate many different aspects of the communications process, it is perhaps too all-encompassing to have any

practical policy applications (af Wählberg and Sjöberg 2000; Breakwell and Barnett 2003).

Finally, the social amplification of risk is grounded in a source-receiver metaphor drawn from classic communications theory. This metaphor suggests that information about a risk event may be amplified or attenuated as it is interpreted, filtered, and transferred—suggesting that risk is a subjective variable that is exaggerated or minimized from some ‘objective’ position (Rayner 1988; Kasperson et al. 2003). This is an issue the authors briefly addressed in their original article, and one that they critically analyzed in subsequent publications. The authors argue that the amplification metaphor is “...compatible with the view that *all* knowledge about risk entails some elements of judgement and social construction” (Kasperson et al. 2003, p. 37). Given the discussion on the nature of risk in their original article and their conclusion that risk has both objective and subjective attributes, this may be seen as a fulsome rebuttal (Kasperson et al. 1988, 2003).

Notwithstanding the criticisms of the SAR framework, the overall strength of this conceptual model lies in its highly flexible and adaptable nature that is capable of addressing a broad spectrum of risk issues. Within the environmental hazards literature in particular, the SAR framework has guided research on both contemporary and established topics, including: the relationship between risk perception and response; the role of traditional and contemporary media before, during, and after disaster; and the roles of individual agency and social structure in the disaster cycle.



**Figure 2.3:** The Protective Action Decision Model (PADM). Reproduced from: Lindell and Perry (2012, p. 617).

### 2.2.3 Protective Action Decision Model

Although the Protective Action Decision Model (PADM) is a relatively recent development in the hazards literature, it is becoming increasingly utilized within research on risk perception and response to environmental hazards and disasters (Lindell and Perry 2012; Terpstra and Lindell 2012; Lindell and Hwang 2008; Peacock 2003; Chaney et al. 2013; Lindell and Perry 2000). The PADM was originally developed to explore issues relating to short-term evacuation modeling; however, it has since been modified and expanded to encompass long-term hazard adjustments as well (Lindell and Perry 2012). According to the PADM, environmental cues, formal and informal risk messages, and the observation of others influence the perception of risk (Lindell and Perry, 2000). This increased awareness of potential threats subsequently motivates individuals to adopt the appropriate response(s) necessary to minimize negative impacts of the threat without

causing undue disruption to their daily activities (Figure 2.3, Lindell and Perry 2000, 2012). A central tenet of the PADM is the notion that risk perception has a substantial influence on behaviour, particularly for immediate disaster response and long-term hazard adjustments (Schultz et al. 2010).

As with the psychometric paradigm and the SAR framework, the PADM facilitates research on influential factors such as hazard intrusiveness, trust, expertise, affective and emotional processes, framing effects, and risk communication (Lindell and Perry 2012; Terpstra and Lindell 2012). However, unlike the psychometric paradigm, the PADM supports research on the adoption of protective actions, rather than on the interpretation and quantification of risk perception. There are also important differences between the PADM and the SAR framework. Most notably, the PADM focuses on the factors that influence decision-making in response to environmental hazards, whereas the SAR framework examines how the flow of information from source(s) to receiver (end-user) can influence the amplification of risk. Thus, although these frameworks are closely related, their different emphases facilitate the exploration of distinct research questions.

## **2.3 Social theories outside of the hazards literature**

### *2.3.1 Social cognitive theory*

One theory that is centrally relevant to the discussion on risk perception, interpretation, and response is social cognitive theory (SCT), which has substantially influenced thinking in psychology, education, and communication studies. At its core, SCT is an agentic perspective, which posits that individuals are self-reflective, purposeful, rational

agents, rather than reactive organisms controlled by external stimuli (Bandura 2001a). It is argued that cognitive factors partly determine which stimuli will be attended to, what meaning will be conferred to various stimuli, and what motivating power these stimuli will have. Thus, attention is one facet of cognition that influences what is selectively observed and what information is extracted for later use (Bandura 2001a).

Social cognitive theory, as interpreted and operationalized by Bandura (2001a,b), is particularly relevant to the study of media effects on human behaviour. SCT has four central tenets: (1) learning can occur directly, through trial-and-error, or vicariously through social modelling (i.e., observing another's actions and the benefits/consequences of those actions); (2) the symbolic environment of mass media provides a great deal of information on social norms, behavioural patterns, and social constructions of reality; (3) self-efficacy is a vital component that will transform information into action, particularly for those with little experience with the given action; and (4) mass media may influence behavioural change directly or indirectly. As noted by Bandura (2001, p. 285):

Communications systems operate through two pathways. In the direct pathway, communications media promote changes by informing, enabling, motivating, and guiding participants. In the socially mediated pathway, media influences are used to link participants to social networks and community settings. These places provide continued personalized guidance, as well as natural incentives and social supports for desired changes. The major share of behavioural changes is promoted within these social milieus.

Symbolic modelling has the potential to transmit information about events and responses across time and space (Bandura, 2001). These symbols are powerful psychosocial mechanisms that may influence the thinking, emotions, and actions of recipients

(Bandura, 2001). Empirical research guided by the theoretical framework of SCT have found that heavy media consumption shapes viewers' perceptions of reality, and that levels of media consumption are positively correlated with its social impact and attendance (e.g., Ball-Rokeach & DeFleur 1976; Hawkins and Pingree, 1982; Flerx, Fidler, & Rogers, 1976; O'Bryant & Corder-Bolz, 1978; Heath 1984; Siegel 1958). Although these findings are based on research conducted on television viewing and print media consumption before the modern telecommunications era, subsequent research has yielded similar results (Bandura 2003; LaRose and Eastin, 2004).

Accordingly, social cognitive theory may be well suited to inform research on the influence of media on risk perception, communication, and decision-making. Take for example the dissemination of warning information about an impending severe weather event. Increasingly, this information is being distributed using both traditional channels, such as television and radio, and newer information and communications technologies (ICT), such as the Internet and cell phone applications. The proliferation of new ICTs has contributed to the recent explosion of social media, a digital platform for interactive, iterative, symbolic communications that can transect time and space, as well as political, religious, and socio-economic divides. Social cognitive theory and its insights on direct and vicarious learning may help to improve understanding of how information is propagated and interpreted across these diverse digital platforms.

### *2.3.2 Issue-attention cycle*



The issue-attention cycle originally introduced by Downs (1972) theorizes that public attention to environmental issues experiences cycles of increased and decreased attention over long time scales. The central components of the issue-attention cycle are as follows: (1) attention is a scarce resource for which issues must compete for time and space within public areas (e.g., the press, academic journals); (2) each arena has a carrying capacity that limits the number of issues that can gain prominence at any one time; (3) individuals select which issues to attend to and which to ignore; (4) public attention requires a component of communication and interaction, otherwise it is merely individual attention; and (5) in order for an issue to gain traction within the public arena, operatives (i.e., individuals who are intimately familiar with the issue at hand, whether scientific experts or affected laypersons) must share their knowledge with the public (Newig 2004; Hilgartner and Bosk 1988; Hoffman and Ocasio 2001; Downs 1972). The issue-attention cycle suggests that most issues remain unattended by the general public, as public attention is a scarce resource for which competition is intense. In order for an issue to achieve traction, it must exceed some threshold of public attention (Neuman, 1990). Once an issue has gained “critical mass” (Newig 2004), it will undergo a process of heightening public attention, followed by a saturation/boredom effect, and an eventual decline of attention (Hilgartner & Bosk, 1988; Neuman, 1990).

Despite the substantial influence of the issue-attention cycle in the understanding of public attention to environmental and political issues, there are several notable limitations of this theory. Firstly, the issue-attention cycle examines the rise and fall of public attention to issues that occur over time periods on the order of weeks to decades. There is

little capacity within the model to examine short-term events, such as high-impact weather. Secondly, the issue-attention cycle focuses exclusively on public attention (i.e., the aggregate level), while excluding individual-level attentional processes. According to Webster (2011, p. 44) individual attention has “little social significance” whereas public attention “...is a more potent, and potentially, tractable manifestation of attention”. However, while the architects of the issue-attention cycle focus almost exclusively on attention at the macro-level or societal scale, it is important to note that individual attention is of central interest for researchers focusing on individual perceptions and behaviours. This is particularly true given the contemporary communications landscape, where individuals are capable of becoming “news creators” that create and disseminate content independently of mainstream news media. Thirdly, the issue-attention is largely an explanatory rather than a predictive model, and as such cannot predict why some events gain traction while others do not (Hoffman and Ocasio 2001).

### 2.3.3 *Agenda-setting theory*

The agenda-setting theory originally proposed by McCombs & Shaw (1972) portrays communication as a transactional process and focuses on the role of individuals *versus* media suppliers in elevating an issue’s prominence. The original study found a strong relationship between the frequency of news coverage and the likelihood that an audience will regard an issue as important (McCombs & Shaw, 1972). Indeed, the influence of the media on public attention has been long acknowledged. As Cohen, (1963, p. 13) observed, “The press may not be successful much of the time in telling people what to think, but it [may be] stunningly successful in telling its readers what to think about”.

However, if individuals are understood to be purposeful, rational agents, then it is also possible that public attention may evolve independently of the media (Neuman, 1990). Accordingly, attention-setting theory has come to incorporate a more agentic perspective, with recent iterations acknowledging that users are capable of filtering, amplifying, and interpreting information flows (Neuman, 1990).

The issue of causality (i.e., whether media influences public attention, or the other way around) is further explored in Giddens' (1984) theory of structuration, which also highlights the importance of attention as a scarce or finite resource in a highly competitive media marketplace. There are three central tenets of this theory: (1) individuals are rational actors who chose media channels that best serve their needs and preferences; (2) the quantity of media that individuals can consume is finite, and therefore media consumption has an upper limit, and (3) users both reproduce and alter the media environment; thus, the media environment is jointly constructed—a concept Giddens (1984) called 'duality'. As Webster (2011:48) explains, structural theory posits that "...structure and agency are mutually constituted. Individuals rely on structures to exercise their agency and, in doing so, reproduce and alter those very structures". Thus, the theory of structuration conceptualizes public attention as both an outcome and a component of the interactive process between people and the media resources they access.

Research from the perspective of structural theory has yielded important findings on the nature of public attention and media consumption (Gitlin 1998; Turow 1997; Sunstein

2007; Webster and Ksiazek 2012). For example, researchers noted that users tend to consume media from channels they prefer and to ignore media from those they do not. At its extreme, researchers cautioned that this ‘selective exposure’ could result in highly fragmented and focused audiences. However, recent research on audience fragmentation found that, while users tend to develop ‘media repertoires’ of preferred and familiar sources, there was little evidence that such preferences resulted in any notable audience bias (Webster and Ksiazek 2012).

#### *2.3.4 Synthesis of social theories*

Gilbert F. White’s pioneering dissertation marked a major change within the hazards tradition. His view that human behaviour can influence the outcome (and consequences) of hazardous events has revolutionized scholarly understanding of environmental disasters by encouraging research on human decision making (Hewitt 1997; Blaikie et al. 1994; Burton et al. 1978; Burton and Kates 1964). Building on these early insights, social theories were developed to help explain various aspects of human cognition and behaviour when confronted with risk. The psychometric paradigm, the Social Amplification of Risk (SAR) framework, and the Protective Action Decision Model (PADM) can all be traced to White’s foundational body of research. Although these three theories have been largely influential in guiding scholarly understanding of risky decision-making, their impacts have remained relatively confined to the risk and hazards literature. Indeed, the lack of theoretical integration with other disciplines is a weakness within this body of research. As such, the risk and hazards literature may benefit greatly from drawing upon and synthesizing theoretical insights from disciplines such as

psychology, sociology, business management, and information science. Social cognitive theory (SCT), the issue-attention cycle, and the agenda-setting theory are three social theories that have the potential to guide research on issues pertaining to public attention, risk perception, and action. The following section will synthesize the current state of the empirical literature on human response to environmental hazards. Most notably, this review will focus on the influence of risk perception and public attention on protective action decision-making, for both immediate disaster response and long-term disaster preparedness and recovery. This section will also highlight opportunities for cross-disciplinary theoretical integration using the social theories discussed above.

## **2.4 Influential factors in risky decision-making**

### *2.4.1 Risk perception*

One of the initial goals of risk perception research was to understand how individuals and groups interpret and respond to risk. As Slovic (1987, p. 281) explains:

If successful, [risk perception] research should aid policy-makers by improving communication between them and the public, by directing educational efforts, and by predicting public responses to new technologies, events, and new risk management strategies.

A number of fundamental questions are central to this line of inquiry: how does risk perception influence decision-making? What factors influence the nature and strength of the relationship between these variables? Perhaps most importantly, will an individual's perception of risk reasonably predict whether and how they will respond to that risk? A substantial portion of the existing empirical literature on environmental hazards has investigated these important questions. Many studies utilize some form of a

questionnaire-based instrument that is distributed within an affected community sometime after a high-consequence event (Siegrist 2013). These questionnaires typically probe issues relating to: whether and how official warnings were received; whether individuals took protective action; the social or environmental cues that motivated protective action; and respondents' previous disaster experience and/or perceived risk. In 2000, Sorensen summarized the body of empirical research that attempted to address these and other important issues about the human dimensions of natural hazards. He noted the importance of socio-demographics, previous disaster experience, and cultural factors in the formulation of risk perceptions (Sorensen 2000; Haynes et al. 2008; Pennings and Grossman 2008; Gierlach et al. 2010). The following sections will explore the influence of these three variables in the context of environmental hazards, in order to draw linkages between risk perception, attention, and response.

#### *2.4.2 Socio-demographics*

The influence of socio-demographics such as gender, age, education, and ethnicity on risk perception has a large amount of empirical support (Sorensen 2000). Gender, for example, has been the focus of considerable attention, and the majority of these studies have cited a positive relationship between gender (female) and perceived risk (e.g., Gustafson 1998; Andrade et al. 2011; Wachinger et al. 2013; Sherman-Morris 2005, 2010; de Man and Simpson-Housley 1987). Other studies have shown that the gender effect is not consistent across different ethnicities (Olofsson and Rashid 2011; Slovic 2004b), or even between different situations. For example, some tornado-related studies have found that being female has a positive influence on protective action (Sherman-

Morris 2005, 2010; de Man and Simpson-Housley 1987; Murphy et al. 2005), while other studies have shown mixed or inconclusive results (Silver and Andrey 2013; Nagele and Trainor 2012; Schmidlin et al. 2009). However, the latter studies represent the minority of published research.

As with gender, most studies have found reasonably strong evidence that education level (Sorensen 2000; Blanchard-Boehm and Cook 2004; Wachinger et al. 2013), socio-economic status (Sorensen 2000; Wong and Yan 2002), and ethnicity and culture (Wildavsky and Dake 1990; Rayner 1992; Gierlach et al. 2010; Slovic 2004a; Bourque et al. 2013) act as modifiers or amplifiers of risk perceptions (Wachinger et al. 2013). However, these relationships can be highly dynamic and context-specific.

#### *2.4.3 Previous disaster experience*

The influence of previous disaster experience has been the topic of considerable research in the hazards literature owing to its potential influence on risk perception and, in turn, decision making. The three hazard-specific theories discussed previously (the psychometric paradigm; the SAR framework; and the PADM) all incorporate previous disaster experience within their theoretical structures (either directly or indirectly, through risk perception). The SAR framework in particular recognizes the influence of previous experience in the process of risk amplification and/or attenuation. As such, it provides the opportunity to examine how experience influences risk perception through the process of social interaction.

While many studies include an “experience” variable when probing issues related to risk perception and protective-action decision making, the findings of related research are not always consistent. Many studies across a broad spectrum of hazardous events have noted that previous disaster experience positively influences risk perception and motivates protective behaviours (Comstock and Mallonee 2005; Sharma and Patt 2012; Silver and Andrey 2013; Norris et al. 1999; Blanchard-Boehm and Cook 2004; Murphy et al. 2005; Mileti and O’Brien 1992). In contrast, other studies have been inconclusive or suggest a mixed relationship between previous disaster experience and the adoption of protective measures. For example, several studies have shown no statistically significant or consistent relationship between previous disaster experience and the adoption of protective measures (e.g., de Man and Simpson-Housley 1987; Donner 2007; Schmidlin et al. 2009; Balluz et al. 2000), while other studies have actually found a negative relationship between these variables (e.g., Wachinger et al. 2013b; Weinstein 1989a; Paton et al. 2008; Drost 2013).

One potential explanation for these (seemingly) inconsistent findings may lie in the ways that previous studies have conceptualized disaster experience. This commonly used blanket term refers to a diverse range of experiences that are influenced by: the frequency and magnitude of past events; experience with false alarms; experience with a variety of hazard types (including low-probably high-risk events, and high-probability low-risk events); and the extent and type of previous impacts (injuries, deaths, financial losses) at the individual-, household-, and community-level. In many previous studies, experience



is either treated as a binary variable or it is inadequately measured (Weinstein 1989b; Sharma and Patt 2012).

Although there is a limited amount of research that attempts to systematically explore the influence of disaster experience on protective behaviours, many of these studies have found a positive (albeit complex) relationship between these variables (Norris et al. 1999; Sharma and Patt 2012; Comstock and Mallonee 2005). For example, Murphy et al. (2005) examined the influence of previous disaster experience by comparing two similar communities: (1) Pine Lake, Alberta, which had prior experience with a damaging tornado; and (2) the Township of North Dumfries, Ontario, which had no previous disaster experience. The results of this mixed-methods study found that previous disaster experience was associated with improved preparedness at both individual- and community-levels. Another recent study conducted in Ontario, Canada examined the influence of an F3 tornado that impacted the community of Goderich, Ontario on 21 August 2011. The results of this study suggested that previous disaster experience (whether direct or indirect) was a good predictor of increased protective behaviour during subsequent events (Silver and Andrey 2013).

However, not all studies that control for experience have found a positive relationship between prior experience and the adoption of either short-term protective behaviours or long-term preparedness measures. On the contrary, some studies have found that experience with disasters may promote feelings of decreased efficacy or helplessness that may discourage individuals from preparing for future events (Weinstein 1989b).

Similarly, frequent experience with low severity hazards or hazards with minimal impacts may cause individuals to develop a false sense of security (Wachinger et al. 2013). This ‘normalization bias’ refers to the tendency for people to “...infer from an ability to cope with (objectively) minor [events] a capability to deal with any future occurrence” (Paton et al. 2008, p. 181). For example, Drost (2013) hypothesized that disaster experience would be associated with an increase in perceived risk and, subsequently, the adoption of precautionary measures. However, this was not the case. Instead, most of the previous disaster experience reported by participants encompassed “relatively harmless” events, which conveyed a sense of reduced danger (Drost 2013).

Another topic that is notable for its divided empirical support is the relative influence of direct *versus* indirect experience on warning compliance and long-term disaster preparedness. On one hand, a sizable number of studies have found that direct experience, rather than indirect (or vicarious) experience, is the best predictor of perception and response (e.g., Paton et al. 2000; Blanchard-Boehm and Cook 2004). In contrast, the notion that indirect experience may have a similar influence on risk perception and response is supported by the theoretical structure of the SAR framework. For example, Kaspersen et al. (1988) hypothesized that indirect experience could influence risk perception as substantially as direct experience when information is amplified through media and social networks. Although a number of recent studies have provided empirical support for this hypothesis (Wachinger et al. 2013; Bourque et al. 2013; Silver and Andrey 2013), additional research is required to achieve a fuller understanding of the relationships between these variables.

#### *2.4.4 The influence of culture*

The assertion that culture substantially influences the formulation of risk perceptions has been supported by both the theoretical and empirical literature in many disciplinary and geographic contexts (Wildavsky and Dake 1990; Rayner 1992; Gierlach et al. 2010). Specifically, social theories on risk tend to emphasize the role of culture in shaping values, privilege, independence, and attitudes towards authority (Slovic 2004). For example, Cultural Theory asserts that individuals determine the riskiness of activities, events, and technologies based on the perceived relevance of the risk to their way of life (Wildavsky and Dake 1990).

Similarly, the psychometric tradition also provides theoretical support for the assertion that culture can have a strong influence on the interpretation of risk (Slovic 2004b). Specifically, a large body of empirical research has found that culture plays an important role in shaping issues relating to trust, risk propensity, and risk attitudes (Slovic 2004a; Gierlach et al. 2010; Gregory et al. 1997). A recent study conducted on ways that Japanese and American citizens perceive risk found that cultures that tend to be deferential to authority are more likely to support “risky” technologies (Gierlach et al. 2010). Other studies have similarly found strong connections between culture and risk perceptions (Slovic 2004b; Anagondahalli and Turner 2012; Bourque et al. 2013).

#### *2.4.5 Synthesis of factors influential in risky decision-making*

As the preceding review has noted, there is a high degree of empirical support relating risk perception to socio-demographics (particularly gender, age, socio-economic status, and education), culture, and previous disaster experience. Yet despite this voluminous literature on the factors that influence public perception and response, the social, economic, and physical losses from disasters continue to rise. As a result, contemporary researchers and practitioners are faced with the same challenge as their predecessors: how to most effectively reduce the social, economic, and physical losses incurred from disasters.

Public attention is often noted within the psychology, communications, and business management literatures for its importance in eliciting behavioural response (Downs 1972; Newig 2004; Newig and Hesselmann 2004; Neuman 1990; Webster and Ksiazek 2012; Neuman et al. 2014; Webster 2011; Hoffman and Ocasio 2001). However, despite its applicability, attention has received almost no consideration within the risk and environmental hazards literatures. This is surprising, particularly given its relevance to issues of risk communication, interpretation, and decision-making. Thus, the following section will synthesize the existing body of research on public attention, both within and beyond the environmental hazards literature. As part of this review, public attention research that may complement existing research on public perception will be identified, so as to achieve a fuller understanding of how the public responds to high-impact events.

## 2.5 Public attention

### 2.5.1 What is public attention?

At the end of the 19<sup>th</sup> century, psychologist William James (1890:381) remarked that, “everyone knows what attention is”. Yet despite this assertion, there is still considerable discussion (and disagreement) on the exact nature of attention. Over the last century, researchers from a broad range of disciplines have contributed to a literature that explores the role of attention from the micro-scale (e.g., neuropsychology of the individual) to the macro-scale (e.g., influence of attention on institutions and structures). However, despite the volume of existing research on the subject, the concept of attention remains surprisingly under-theorized, a weakness that has been previously identified within the literature (e.g., Newig, 2004; Webster, 2011). Three possible explanations for this lack of theorization are offered here:

- (1) Although the literature on attention is vast, it lacks cross-disciplinary connections. Much of the existing research has been conducted within disciplinary “silos”, which has contributed to a fragmented and narrow view of attention as a concept.
- (2) Attention is rarely defined within the literature, even when it is the explicit subject of research. The lack of a coherent conceptualization is further exacerbated by the tendency to use attention synonymously with similar terms, such as awareness, alertness, consciousness, and perception, thus confusing markedly different concepts.
- (3) Within the hazards literature specifically, the concept of attention is rarely the direct subject of research, although it is often cited as an influential factor in

many studies. This issue is further exacerbated by the lack of reliable metrics to assess cycles of public attention in both short- and long-term hazard-response cycles.

Within the hazards literature, attention has been identified as an influential variable in hazard response. For example, Schipper & Pelling (2006) note that weather disasters catch both public and political attention, and may act as catalysts for positive social change. In their research on weather salience, Stewart et al. (2012) found that people will attend to the weather to the extent that it is perceptually salient—that is, people tend to pay attention to the weather when it becomes noticeable to them. Lindell and Perry (2000) found that the salience of seismic hazards competes with other more routine demands on residents' attention, and Silver (2015) found that individuals typically do not pay attention to the weather unless it becomes inconvenient or threatening. Similarly, Morss & Hayden (2010) found that attention was variable, but people paid more attention to Hurricane Ike as it approached their area. Another study on tropical cyclones noted that the Internet can provide valuable information that may heighten public attention to hurricane forecasts (Sherman-Morris et al. 2011).

Despite the abundance of studies that have identified attention as a potentially important variable, the hazards literature suffers the same dearth of theorization as the broader literature on attention. One exception can be found in the Protective Action Decision Model, discussed previously (1992; 2004; 2012). In this model, attention is identified as one of three pre-decisional processes (in addition to exposure and comprehension) that influence when and how individuals take protective action. Lindell and Perry (2012)

highlight the role of attention, suggesting that it is influenced by an individual's expectations, competing attentional demands, and the intrusiveness of information, but they fall short of defining or operationalizing attention in specific terms.

Similarly, there are only a handful of empirical articles within the hazards literature that attempt to directly investigate the concept of attention. For example, Chung (2011) examined public attention to environmental risks from a construction project in South Korea. To do so, the author compared the number of newspaper articles, message board posts, the volume and content of readers' comments, and the number of website visits to assess the attention amplification process. The results of this research suggest that the Internet provides a social environment that may quickly amplify public attention to risk. The findings also suggest that direct measures of public attention (e.g., number of comments and website visits) may better represent public attention towards an environmental issue than indirect measures (e.g., number of newspaper articles or number of website posts). While this paper is one of the few that attempts to explore the concept of public attention directly, it neither provides a definition of public attention nor discusses which aspects of public attention the research investigates.

Two other notable articles explored the concept of public attention to hazardous events as indicated through activity on Twitter (Ripberger et al. 2014; Chew and Eysenbach 2010). The results of this research suggest that information in the form of news stories (Chew and Eysenbach 2010) and weather watches and warnings (Ripberger et al. 2014) were positively correlated with increases in tweet activity, and as such, Twitter may provide a

“real time” indicator of public attention. The Ripberger et al. (2014) article is particularly notable for several reasons: (1) it explores public attention as part of the risk communication process; (2) it proposes a metric to measure public attention in real-time; and (3) it distinguishes between public attention to severe weather watches/warnings and the severe weather event itself.

Although these papers are notable for being among the first in the hazards literature to operationalize the measurement of attention, there are several potential shortcomings of this research. Most importantly, the authors propose that Twitter activity may be a reliable indicator of public attention—a conclusion that is potentially premature. For example, the user base of social networking sites is not demographically representative of the general population. As such, drawing conclusions about public attention based on Twitter activity is problematic without first obtaining a clear understanding of the study population.

### *2.5.2 A comment of “public” attention*

The majority of existing research on attention has focused on “public” attention (e.g., Webster 2011; Newig 2004), rather than “individual” attention. This is potentially problematic, as “the public” is not a monolithic entity. Rather, there are many distinct and/or overlapping groups that comprise the “general public” behemoth. These groups vary markedly in terms of personal wealth, education level, political power, geographical location, and so forth. Accordingly, these publics may have very different vulnerabilities, priorities, capacities, opportunities, and constraints that facilitate and/or impede their



actions during severe or hazardous weather. For example, non-English speaking immigrants may find it difficult to obtain official warning information, which is typically posted only in official languages (e.g., English and French for Canada). Similarly, individuals with poor financial credit and substantial household debt would find it difficult to afford hazards insurance and/or to adequately prepare for potential threats. Individuals below the poverty line may also be forced to live in structures or locations that are particularly vulnerable to severe weather, such as mobile homes (Schmidlin et al. 2009; Sutter and Simmons 2010) or in flood plains (Lindell and Hwang 2008; Moore et al. 2004). Taken together, this emphasizes the need to use caution when referring to “public” attention to severe weather, as the public consists of many groups that may obtain, interpret, and respond to extreme weather in distinct ways.

### 2.5.3 *A comment on “awareness”*

As with attention, awareness has only occasionally been the subject of focused theoretical and empirical research within the hazards literature. However, even when awareness is the direct focus of research, it is rarely defined or conceptualized in a way that clearly differentiates it from similar concepts. As a result, some studies that explore awareness may actually provide insights on attention or perception instead. For example, in an early study on storm spotting and “public awareness”, Doswell III, Moller, & Brooks (1999, p. 544) note that:

The users of weather forecasting information must *hear* the forecasts, must *interpret* them in their own terms in order to make decisions, and must *know* what to do in order to achieve some desired result, if the forecasts are to be successful in having a positive societal impact.

However, research within psychology, organizational science, and communications studies have conceptualized attention as: the noticing and focusing of time and effort (Hoffman and Ocasio 2001); the selection and interpretation of one (or more) of a plethora of available stimuli to which people are exposed (Kentridge 2011; Webster 2011); and/or the use of information gained from the acts of noticing, selection, and interpretation (Kentridge 2011). As such, it would seem that Doswell III, Moller, & Brooks (1999) might have uncovered insights on the nature of attention, rather than awareness. Indeed, the results of the study suggest that improved communications technologies of the 1920s and 1930s, as well as the occurrence of the Tri-State tornado in 1925, "...initiated a trend toward public awareness that . . . encouraged preparation for potentially disastrous tornadoes that continues to this very day" (Doswell III et al. 1999, p. 545). Although this is potentially true, it would seem that the results of this research shed light on the role of traditional media in exciting and focusing public attention that has been previously noted within the broader communications literature.

Other studies explore awareness in a more direct and coherent manner. For example, in their study on flood awareness in the United Kingdom, Burningham et al. (2008) note that flood risk awareness has three components: (1) awareness of living in an at-risk area; (2) awareness of flood warning systems and methods of dissemination; and (3) awareness of appropriate actions to take during a flood or flood warning. Recent research on microblogging during hazardous events provides similar insights on the nature of awareness. In this research, the authors provide a definition of situational awareness as "...an individually as well as socially cognitive state of understanding 'the big picture'

during critical situations” (Vieweg et al. 2010, p. 1079). Earlier research on aviation psychology provided a similar definition of situational awareness as “All knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation” (Sarter and Woods 1991, p. 55). This definition aligns closely with the notion of conscious awareness, a concept related closely to perception and supported by laboratory research within cognitive psychology (e.g., Hsieh et al., 2011; Hsieh & Colas, 2012). Together, this research underscores awareness as a constantly adjusting state of inherent understanding that is affected by many factors, including experiences, biases, knowledge, communications, and external cues.

#### *2.5.4 Moving towards a comprehensive concept of attention*

The existing literature on attention within the hazards literature underscores two critical points: (1) attention is a concept in the hazard-response cycle that may influence how individuals obtain, interpret, and respond to warning information and environmental and social cues, and (2) attention is under-theorized and often conflated with similar concepts, thus contributing to a literature that is not as clear or consistent as might be desired. To focus and guide any future discussions on attention as it relates to the field of hazards research, it is therefore necessary to first clearly articulate what is attention, and to differentiate it from other similar concepts. Thus, the following definition of attention is proposed, drawing on and synthesizing the existing body of theoretical and empirical research outlined above:

Attention is the process of noticing, selecting, and focusing on one or more external stimuli (e.g., hazardous event or event-related information) to which people are exposed.

By clearly distinguishing between attention and related concepts, it may be possible to achieve greater theoretical integration within the risk communications literature specifically, and within the hazards literature more generally (e.g., McComas, 2006; Rodriguez, Diaz, Santos, & Aguirre, 2007; Sitkin & Pablo, 1992). At present, a substantial portion of the existing research on high-risk decision-making has focused on the influence of perception, a component of awareness, rather than attention. This literature has provided highly valuable insights into the nature of the warning-response process. However, if theoretical insights from psychology and organizational science are found to extend to the context of hazards, attention may well be as influential as perception in motivating protective action. As such, additional research is needed within the scope of the hazards literature to assess the linkages between attention and decision-making across a broad range of event lead-times, from high risk short-notice disasters to longer term preparedness and planning decisions.

#### *2.5.5 Public attention, risk communication, and behavioural change*

The vast majority of the existing literature on protective action decision-making has focused on the role of public perception in behavioural response. As noted above, very little research has been published on the role of public attention to risk information or hazardous events. This is highly surprising, given the often-stated importance of public attention in the decision-making process (e.g., Ripberger et al. 2014; Lindell and Perry 2012). Accordingly, the relationship between mass media, public attention, perception, and decision-making is one area that would greatly benefit from theory-driven research, as the empirical findings are not as consistent or comprehensive as might be desired.

Specifically, the influence of mass media on public attention, perception and, subsequently, decision-making is currently a topic of considerable debate (Sorensen 2000). On one hand, the notion that mass media has a powerful influence on risk perception is supported by the widely-regarded prospect theory, which purports that the “availability” and dissemination of risk images can contribute to the misinterpretation of risks (Tversky and Kahneman 1974). Others have suggested that sensationalism in mass media can lead to the amplification of risk, particularly when direct experience with the risk is lacking (Kasperson et al. 1988). While some researchers have identified a “...practically totally determinant effect of the media in risk perception” (Koné and Mullet 1994), research conducted within the psychometric paradigm (Slovic 1987; Slovic et al. 1982) and the Social Amplification of Risk framework (Kasperson et al. 1988, 2003) supports the general conclusion that sensationalism in the media has the potential to substantially influence risk perceptions.

In addition to the influence of sensationalism, there are also studies that link bias in news media reports with distorted perceptions of risk. For example, a recent review of the communications literature has suggested that the media may emphasize certain risks over others (McComas 2006). It has also been demonstrated that news media tend to report on hazards without providing important contextual information for the consumer, such as whether and how the risk applies to *them* (af Wåhlberg and Sjöberg 2000). Thus, it falls to the end-user to interpret these risks based on their own knowledge and life experiences, which may lead to the development of variable conclusions about their exposure and/or sensitivity to risk.

However, recent research has raised questions about the validity of the widely-held belief that sensationalism and bias in the media irrevocably shape risk perceptions. This research has demonstrated that the media provides a more moderate accounting of risks and is less prone to sensationalism than was previously believed (af Wählberg and Sjöberg 2000; McComas 2006; Renn 1990). For example, in their study on the media coverage of 128 hazardous events, Freudenburg et al. (1996) found that the amount of media coverage was predicted only by the objective characteristics of the event (e.g., number of deaths and injuries, economic losses). Their results found no correlation between the dreadfulness of a hazard and the amount of media coverage it received, and they concluded that emotional sensationalism in the media is the exception and not the rule (Freudenburg et al. 1996).

Furthermore, while the media is often attributed with having a substantial role in shaping risk perceptions, the empirical support for this claim is largely inconclusive (Freudenburg et al. 1996; af Wählberg and Sjöberg 2000; McComas 2006). For example, few studies in the empirical literature fully explore the distinctions between different *types* of media on warning communication. Although communications channels are often referred to with the general term “mass media”, this concept actually encompasses a diverse spectrum of channels with different dissemination capabilities, content, accessibility, customisability, and potential effects (af Wählberg and Sjöberg 2000; Snyder and Rouse 1985; Williams and Noyes 2007; McComas 2006). Although some empirical research touches on the differing influence of various media sources, this is rarely an explicit

focus of research (af Wåhlberg and Sjöberg 2000). Similarly, although numerous studies have identified the important role of mass media in communicating weather warnings, few of these studies systematically unpack the relationship between mass media and the perception of risk (af Wåhlberg and Sjöberg 2000).

A notable exception involves the research on the influence of media on individual- *versus* community-level risk perception. Although this research topic extends back to the early 1980s, it has become increasingly prominent over the last fifteen years (af Wåhlberg and Sjöberg 2000; McComas 2006). The findings of this research highlight the complex relationship between the interpretation of risk by individuals, and the development of societal-level risk judgments. For example, the “Impersonal Impact Hypothesis” suggests that media coverage may influence societal level, not individual-level, judgments of risk (McComas 2006; af Wåhlberg and Sjöberg 2000; Tyler and Cook 1984). While these societal-level risk judgments may subsequently influence individual-level perceptions of risk (af Wåhlberg and Sjöberg 2000), a recent review on risk communication research has found that interpersonal communication is substantially more influential on the formation of personal-level risk perceptions (McComas 2006).

A similar line of inquiry has suggested that mass media consumption may influence an individual’s general risk perceptions, but this does not necessary translate to an increase in personal-level risk judgments (af Wåhlberg and Sjöberg 2000). This tendency for an individual to believe that they are less likely to be affected by a hazard than their peers is referred to as an optimism bias (Weinstein 1989a). There has been extensive research

conducted on the topic of optimism biases for the last 25 years (e.g., Weinstein 1989a; Sjöberg 2000; Gierlach et al. 2010). As a result of this research, a robust understanding of risk denial has been developed on a wide variety of topics, including general risk perceptions (Gierlach et al. 2010; Silver and Conrad 2010; Weinstein 1989a) and specific risk events (Paton et al. 2008; Hanson 2003).

One area of research that is necessary to improve the clarity of the existing literature, particularly as it relates to social media studies, involves the distinction between “public” versus “professional” attention. A few early studies have demonstrated that the ratio between public and professional user activity can vary dramatically for different issues. It is therefore necessary to explore when and how different groups access and share information, before it is possible to draw conclusions about the suitability of using social media as an indicator of public attention. Accordingly, empirical research that explores how different actors groups engage with and influence one another on social networking sites could improve understanding of how these platforms facilitate decision-making before, during, and after hazardous events.



## CHAPTER THREE

### **Manuscript #1:** The Use of Facebook for Information Seeking, Decision Support, and Self-Organization Following a Significant Disaster

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The widespread proliferation of the Internet has revolutionized the ways that individuals obtain, interpret, and respond to information in the aftermath of disaster. An F3 tornado that impacted the community of Goderich, Ontario on 21 August 2011 provided the opportunity to examine how people utilized Facebook and Facebook groups to seek out information, self-organize, and provide support. This mixed methods project was conducted in two phases. First, semi-structured interviews (n=35) were completed with Goderich area residents on their experiences using social media after the tornado. Next, all of the publicly available posts and replies on the Goderich Ontario Tornado Victims and Support (GOTvs) Facebook group were gathered and analyzed using computer-assisted content analysis. The results demonstrate that Facebook was a highly influential source of information and support, particularly in the immediate aftermath of the disaster. Although misinformation and gossip occurred, the tendency was for the group to self-moderate inaccurate information. The results also suggest that engagement by public officials may further reduce misinformation and encourage public confidence. Finally, this research underscores the vast potential for analyzing public information shared on Facebook using computer-assisted content analysis, a method which may be of broad interest across the social sciences.

### **3. Introduction**

#### *3.1 Social Amplification of Risk (SAR) Framework*

Early research on risk communication often conceptualized risk communication as a linear process of transferring information from a source (expert) to a receiver (layperson) (Krimsky 2007; Kaspersen et al. 1988). There has since been substantial progress achieved in understanding the complex nature of risk communication as a non-linear, iterative, dynamic process (Krimsky 2007; Fischhoff 1995). Although a specific definition of risk communication is still lacking in the hazards literature, McComas (2006, p. 76) provides a serviceable definition as the ‘...iterative exchange of information among individuals, groups, and institutions related to the assessment, characterization, and management of risk’. This definition is reflective of the general shift towards an understanding of risk communication as an interactive process of sharing and interpreting risk information among experts, citizens, and interest groups (McComas, 2006).

A substantial portion of the existing literature on risk communication pertains to the role of traditional media; however, there is an emergent literature that examines the usefulness of ‘new media’ (i.e., on-demand content available on the Internet) as a source of information during and after disaster. Within this literature specifically, the vast majority of the existing research has explored the roles of various social networking sites, such as Twitter and Facebook, as platforms for crisis communication (e.g., Sutton, Palen, & Shklovski, 2008; Mendoza, Poblete, & Castillo, 2010; Muralidharan, Rasmussen, Patterson, & Shin, 2011; Chew & Eysenbach, 2010; Chatfield & Brajawidagda, 2014;

Acar & Muraki, 2011; Murthy & Longwell, 2013; Schmierbach & Oeldorf-Hirsch, 2012).

Although there has been a substantial increase in the amount of empirical research investigating social networking sites as platforms for risk communication, much of this literature is notable for its lack of theoretical grounding. One opportunity for improved integration (and comprehension) within the crisis communications literature may be the use of theoretical frameworks to support inductive research on topics that have yielded inconsistent or limited findings. The Social Amplification of Risk (SAR) framework is one such theoretical framework that has the potential to guide empirical research on the topic of social media and disaster. In general terms, this framework examines the process of risk amplification and attenuation as signals (information) pass through different amplification ‘stations’ (Kasperson et al., 1988). These stations, which include individuals, cultural and social groups, government agencies, and news media, process, filter, and/or interpret information before disseminating it further. Accordingly, the SAR framework conceptualizes the process of risk communication as dynamic, constantly evolving, and reciprocal—in that end-users both influence and are influenced by the information they receive (Kasperson, Kasperson, Pidgeon, & Slovic, 2003; Kasperson et al., 1988).

While the SAR framework has several potential limitations, the overall strength of this conceptual model lies in its highly flexible and adaptable nature that is capable of addressing a broad spectrum of risk issues. Within the environmental hazards literature in

particular, the SAR framework has the potential to guide research on both contemporary and established topics, including: the relationship between risk perception and response; the roles of individual agency and social structure in the disaster-response cycle; and the interpretation and validation of information. Accordingly, the SAR framework is well suited to provide insights on the interpretation and communication of crisis information on social networking sites, which may contribute to improved theoretical integration within the hazards literature specifically and the communications literature more generally.

### *3.2 Social networking sites and crisis communications*

Social media has several advantages over traditional media as a crisis communications tool. Social networking sites have been noted for their ability to be rapidly and continuously updated by numerous end-users throughout a severe weather event. These updates can provide critical information that would otherwise be unavailable to weather forecasters and first responders located outside of the impact area. Second, information can propagate rapidly on the Internet, reaching thousands (sometimes millions) of users within a relatively short timeframe. This content can then be utilized to assist in decision-making, both for short-term disaster response (e.g., protective action decision-making) and for the purposes of disaster recovery (e.g., self-organization, volunteerism). Thirdly, social networking sites can provide a platform for emotional support and expression that can be utilized to the benefit of survivors (Liu & Jin, 2011; Vieweg, Hughes, Starbird, & Palen, 2010).

However, the usage of social networking sites for crisis communications is not without its limitations. For example, a common and legitimate criticism is that it can be difficult to evaluate the credibility and validity of user-generated content (Jefferson, 2006; Kaplan & Haenlein, 2010). Gossip and misinformation (whether intentional or unintentional) may be common on these websites, and it can be a challenge for end-users to differentiate between this content and more credible information (Hyvärinen & Saltikoff, 2010).

However, recent research has suggested that misinformation may not be as prevalent on social networking sites as previously assumed (Chew & Eysenbach, 2010). Furthermore, research on tsunami (Sutton, Hansard, & Hewett, 2011) and forest fire (Sutton et al. 2008) crisis communications suggest that the harmful effects of false rumors may be partially or wholly mediated by the engagement of local officials through social media. Specifically, it has been suggested that public engagement by local officials may minimize or counteract misinformation spread through social media and/or may encourage public confidence in crisis communications (e.g., St. Denis, Palen, & Anderson, 2014). However, the crisis communications literature on public engagement through social media is sparse, and would benefit from additional deductive research.

Given the strengths and weaknesses of new media as a crisis communication and response tool, it is prudent to explore how various platforms are being utilized by end-users. The vast majority of the existing research on social media and disasters has been conducted on information shared through Twitter (e.g., Acar & Muraki, 2011; Doan, Vo, & Collier, 2012; Murthy & Longwell, 2013; Palen, Starbird, Vieweg, & Hughes, 2010; Schultz, Utz, & Göritz, 2011; Vieweg et al., 2010). However, there is very little existing

research that examines how Facebook is utilized during and after a disaster. Although Facebook and Twitter share many attributes, the form and delivery of information varies markedly between these two platforms. Accordingly, exploring how Facebook is utilized as a crisis response tool may contribute to a deeper understanding of how individuals seek out, interpret, and share information during and after disaster.

### *3.3 Facebook groups*

Facebook is a social networking website with over 1.3 billion active users worldwide (Facebook, 2014). As a highly popular social networking service, Facebook may be accessed through the Internet and mobile phone applications. While the vast majority of activity on Facebook takes place on personal profiles, groups provide over 500 million people with a private space in which they can communicate (Facebook, 2014). Facebook groups are used to share content and information with small groups of people like family, classmates, or team members. Facebook groups can also be a much larger platform for community causes and special interest groups. Each group is run by at least one administrator who can control the customized privacy settings and can admit users that choose to become a group member. Within the group, group members can post to the group wall, upload videos and pictures, share links and news stories, or organize events (Facebook, 2014). Furthermore, group members can comment on, share, or 'like' any of the content that has been shared with the group. All of these contributions are referred to as user-generated contributions.

While there has been an increasing interest in assessing the number, types, and locations of Facebook groups for a variety of business or social causes, to date there have not been any studies that have conducted a comprehensive content analysis of the user-generated contributions to these Facebook groups. A study by Bender, Jimenez-Marroquin, and Jadad (2011) sought to complete a content analysis of 620 breast cancer related Facebook groups. Their research endeavoured to analyze the user-generated contributions on each of these groups, but was limited in that they only looked at the first page of posts on the group wall. The first page of any Facebook group will generally show the most recent 10-30 wall posts for a group that could possibly have hundreds or thousands of posts in total. Furthermore, the analysis completed did not look at any of the group member comments on posts. McCorkindale (2010) also conducted a content analysis of Facebook groups and pages, with a focus on investigating how Fortune 50 companies used Facebook to engage with customers. McCorkindale (2010) concentrated on quantifying aspects of the Fortune 50 companies' Facebook pages such as: the number of members or followers, the number of discussion board topics, and whether or not the page had videos and photos. This research was completed on 50 company Facebook pages, but was again limited in that there was no investigation of the user-generated contributions.

While these illustrative examples are by no means the only research that has been completed, they are representative of the research that has been conducted to date on content analysis of Facebook data. Similar research has been undertaken in health studies (De la Torre-Díez, Díaz-Pernas, & Antón-Rodríguez, 2012), geography (Papacharissi, 2009), marketing and media (Bortree & Seltzer, 2009), and politics (Fernandes,

Giurcanu, Bowers, & Neely, 2010). All of these studies, however, fail to investigate the user-generated contributions to the group. There are two main reasons why these studies have not looked at the user-generated contributions. Firstly, the purposes of most of the aforementioned studies were to look at differences and similarities between Facebook groups, and not on the intricacies within a single group. Secondly, accessing and downloading all user-generated contributions for a Facebook group over any period of time can be a prohibitively time-consuming and computationally difficult feat, especially for large groups that have upwards of hundreds of thousands of posts and comments. Computer assisted content analysis is an ideal solution for tackling large volumes of data such as that found on social media sites.

#### *3.4 Case study: Goderich, Ontario tornado*

Goderich is a small community of approximately 7500 residents located on the shores of Lake Huron in southwestern Ontario, Canada. As the largest settlement in Huron County, Goderich provides important economic, cultural, and municipal service functions for both local residents and for surrounding rural communities. On 21 August 2011, Goderich was impacted by an F3 tornado with sustained wind speeds of  $280 \text{ km h}^{-1}$ . This storm was the strongest to affect Ontario in fifteen years, and the damage sustained to the downtown core of Goderich was extensive. Shortly after the disaster, town officials declared a state of emergency and the Ontario Provincial Police closed all roads into the affected sections of town. Due to damaged lines in the area, natural gas service was cut off to approximately 3300 customers that evening. As a result of the tornado, one



<b>Date</b>	<b>Daily Active Users</b>	<b>Daily Logged-in Page Views</b>	<b>Daily News Feed Impressions</b>	<b>Daily Comments</b>
	The number of people who have interactive with or viewed Page or its posts (Unique users)	Daily page views from users logged in to Facebook (Unique users)	The number of times people have viewed a News Feed story posted by Page (Total count)	Daily comments created on Page's content (Total count)
Week 1	47,110	26,723	2,931,449	4048
Week 2	32,971	4642	1,678,036	1218
Week 3	21,562	1700	476,028	440
Week 4	22,680	1425	314,642	307
Week 5	17,085	940	129,044	170
Week 6	10,234	643	77,879	135
<b>Total</b>	<b>151,642</b>	<b>36,073</b>	<b>5,607,078</b>	<b>6318</b>

**Table 3.1:** Usage statistics for the *Goderich Ontario tornado victims and support* Facebook group from 20 August 2011 to 30 September 2011 (Source: United Way, 2012).

individual was killed and 39 others were injured, and the economic costs have exceeded \$75 million CAD (IBC, 2011).

Facebook was utilized extensively in the days and weeks following the tornado to provide information on impacts and recovery; to organize volunteer efforts; to solicit and direct food and monetary donations; and to share personal experiences and media content. Within only 12 hours of the tornado's impact, a Facebook community group called *Goderich Ontario Tornado victims and support* (hereafter referred to as GOTvs) was created and had over 7000 followers. This page was arguably the most influential of all of the tornado-themed social networking groups, with its content being viewed by tens of thousands of unique users in a short timeframe (Table 3.1).

This research paper will explore how the GOTvs Facebook group was utilized in the days and weeks following the tornado. Using a mixed methods approach, semi-structured interviews were conducted to assess members' perceptions of value and trust in the information they received, and the digital content of the group was analyzed. The specific research questions for this paper are as follows:

1. What information was most commonly shared and solicited using the GOTvs Facebook group? How was misinformation moderated among members?
2. How was the GOTvs Facebook group used to facilitate self-organization, particularly as it relates to food and monetary donations and volunteerism?
3. How did members value and utilize the information they received through the GOTvs Facebook group?

## **3.2 Methods**

### *3.2.1 Semi-structured interviews*

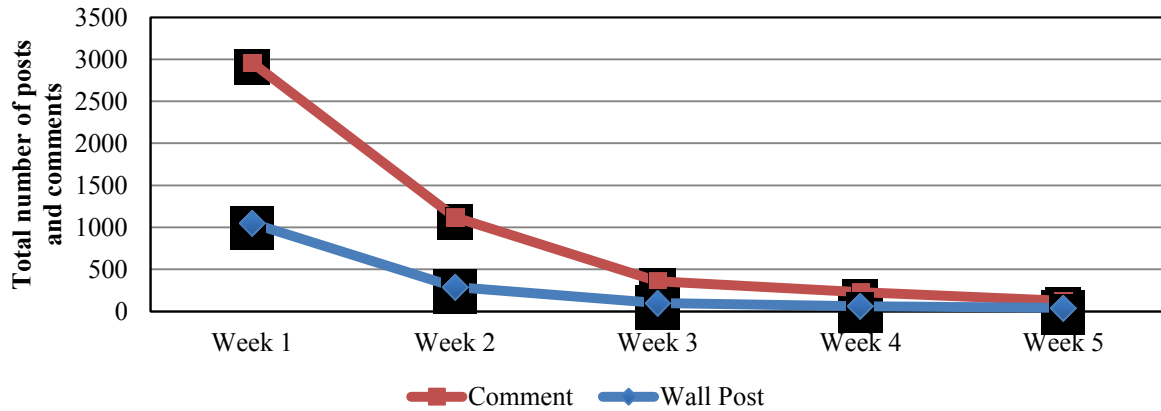
Semi-structured interviews were conducted with Goderich area residents during October and November 2011 as part of a larger research project. The interview script contained questions regarding residents' experiences before, during and after the tornadic storm; their protective action decisions; and their usage of cell phones and social media to obtain, interpret, and share information. The call for participation was shared widely across both traditional (e.g., local print newspaper and local radio channel) and contemporary (e.g., GOTvs Facebook group, Huron County on-line bulletin) media channels. A total of 35 individuals were interviewed for this project. The interviews

lasted between 25 and 80 minutes in length, with most interviews lasting approximately 45 minutes.

The interviews were audio recorded and transcribed verbatim by undergraduate student researchers, including pauses, colloquialisms, and non-verbal expressions. Random transcripts were chosen and fully reviewed for accuracy and completeness, and then analyzed by coding various themes relevant to the research topic. These themes relevant to this study included: information seeking behaviour; misinformation/gossip; self-organization; and perceptions of trustworthiness/value. Once the transcripts had been broken out into these themes, the information was analyzed using methods outlined in McCormack (2000), whereby the transcripts were reviewed multiple times to pick up patterns from different ‘lenses’, such as narration, language and context.

### *3.2.2 Computer-assisted content analysis*

Insights gained from the interviews underscored the usefulness of Facebook groups for information seeking and self-organization in the days following the tornado. To further investigate how Facebook was utilized by over 7000 group members, a content analysis was conducted for the GOTvs Facebook group, which was the most popular Facebook group associated with the tornado. Computer-assisted content analysis is an ideal solution for tackling large volumes of data such as that found on social media sites. All posts and comments were extracted into Microsoft *Excel* using free online software called *Power Query*. Wall posts are a place on the group wall where individuals or administrators can write their thoughts, views, or share news articles or videos for



**Figure 3.1:** Number of wall posts and comments by week following the tornado event.

everyone else in the group to see. Individual members are then able to comment on these walls and share their own feedback, thoughts, or information links connected to the original wall post. All wall posts and subsequent comments were downloaded from the GOTvs Facebook group for the study period of 22 August 2011 to 31 December 2011. This dataset contained 1744 wall posts and 5348 comments that were used in the content analysis. Figure 3.1 illustrates the temporal trend in user-generated activity on the GOTvs Facebook group. The wall posts and comments included in this study are only those with unique user-generated content and did not include photos, links, or videos. There were an additional 987 wall posts and comments that included photos, links, or videos but contained no unique text to analyze.

Using *VBA* macros in *Microsoft Excel*, every wall post and comment was parsed into individual words, series of letters, or series of numbers. The *VBA* code was used to remove all punctuation, including hashtags, as hashtags were not a part of Facebook

during the study period. Individual words and number combinations were then summarized and sorted by the frequency with which they occurred. The dataset contained a total of 195,319 words or number combinations with 11,649 unique words or number combinations found.

Once the words were summarized and sorted by the frequency of occurrence, the data were cleaned for two main attributes, 1) to identify and remove all stop words. The vast majority of the words used are considered to be stop words or common words (e.g., ‘the’, ‘an’, ‘I’, ‘that’), as defined by Lewis, Yang, Rose, & Li (2004). These stop words contribute little to the content of the information being conveyed. 2) The researchers sought to identify and isolate words of importance and particular meaning to this study. Meaningful words were also identified based on their frequency. This is an inductive approach where words were only considered meaningful if they were used more than 80 times. There were 337 words that were used more than 80 times, 70 of these were considered to be meaningful and 267 were identified as stop words (Table 2). A new variable was then created in *Microsoft Excel* in which the researchers coded the 337 most commonly used words as either stop words or meaningful words. The words of meaning were coded based on their lexical roots.

A lemmatization process was then conducted for the 70 words that were deemed to be particularly meaningful for this research (Table 3.2). Lemmatization is used in linguistics to group together words that have a similar root or meaning so that they can be analyzed as a single item. All words that have a similar root (e.g., ‘**helped**’, ‘**helping**’, ‘**helps**’,

RANK	WORD	n	ROOT	RANK	WORD	n	ROOT
14	GODERICH	1767	GODERICH	157	LIVE	180	LIVE
28	HELP	1028	HELP	159	DISASTER	176	DISASTER
42	PEOPLE	819	PEOPLE	165	ONTARIO	169	ONTARIO
47	CALL	669	CALL	175	DONATION	156	DONAT
49	TOWN	639	TOWN	177	LOOKING	155	LOOK
52	PLEASE	558	PLEASE	178	NEWS	155	NEW
53	211	553	211	179	NEEDS	154	NEED
55	NEED	521	NEED	181	VOLUNTEER	152	VOLUNTEER
64	TORNADO	442	TORNAD	185	PRAYERS	150	PRAY
66	THANKS	418	THANK	197	THOUGHTS	145	THOUGHTS
76	DONATIONS	359	DONAT	200	TREES	141	TREE
79	THANK	341	THANK	205	FREE	138	FREE
85	TIME	324	TIME	206	MONEY	138	MONEY
91	EVERYONE	307	PEOPLE	210	HEART	135	HEART
94	FOOD	299	FOOD	213	ARMY	133	ARMY
97	INFORMATION	290	INFO	225	UNITED	125	UNITED
102	SUPPORT	281	SUPPORT	229	LOCAL	123	LOCAL
109	POST	262	POST	232	HELPING	120	HELP
110	FAMILY	261	FAMIL	233	SERVICES	118	SERVICE
111	COMMUNITY	258	COMMUNIT	241	LOST	114	LOST
112	HOME	255	HOME	243	CALLED	112	CALL
114	NEEDED	253	NEED	244	PHONE	112	CALL
116	HURON	251	HURON	249	POSTED	111	POST
128	RELIEF	223	RELIEF	250	LONDON	110	LONDON
129	PAGE	221	PAGE	251	CHURCH	109	CHURCH
131	CONTACT	218	CONTACT	257	MESSAGE	107	MESSAGE
133	INFO	217	INFO	258	SAFE	106	SAFE
134	HOPE	215	HOPE	261	DONATED	105	DONAT
135	FIND	213	FIND	280	DAMAGE	99	DAMAGE
141	ITEMS	208	ITEM	282	STORM	99	STORM
148	FACEBOOK	193	FACEBOOK	287	INSURANCE	97	INSUR
149	FUND	193	FUND	290	CLOTHING	96	CLOTH
151	LOVE	191	LOVE	305	LOOK	90	LOOK
152	FRIENDS	188	FRIEND	318	BANK	86	BANK
156	VOLUNTEERS	181	VOLUNTEER	319	EMERGENCY	86	EMERGENC

**Table 3.2:** Top 70 meaningful words and their lexical roots

‘helpers’) are then replaced but the root word (e.g., ‘help’) as to facilitate further data analysis. The lemmatization process was completed through the following steps: 1) all 11649 words were sorted in alphabetical order; 2) the researchers found each of the 70 words that had been previously identified as meaningful and coded these words according to their lexical roots; 3) other words with the same lexical roots were coded as well by looking up the root word in the dictionary and finding similar words (aid = help); 4) this process was also useful for finding common misspellings, any word that was misspelled was coded based on its intended root; 5) the find and replace function was employed to convert all words with the same meaning to their lexical roots to facilitate further data analysis. After the lemmatization process was completed, a pivot table was used to determine the frequency with which each root word was used. This was then followed by a temporal analysis to see when each of these terms was used.

### **3.3 Results**

#### *3.3.1 Semi-structured interviews*

Thirty-two of the 35 interview participants used Facebook in some capacity to obtain information following the tornado. Of these individuals, 28 participants indicated that they used Facebook as a primary source of information. Many respondents agreed that the information they received through Facebook was rapidly and continuously updated by numerous end-users in the days following the tornado:

The internet was far more updated than the information that was coming across the TV as far through news channels and so forth. The news was way, way, way behind . . . . So the internet was how everybody communicated. Everything was through Facebook. (*Female, 45-50 years old*)

I would say [I got information] probably through social media and through word of mouth . . . For Facebook, just keeping updated on my news feed cause there was a lot of people posting what they thought was practical information. (*Male, 20-25 years old*)

I joined [GOTvs] only because that's who I had registered with to assist and you really had to be on that page to know what was going on with that group and like where volunteers were supposed to go and so forth. So that's—that was why I joined that group. And they gave really good information, I mean [the moderator] deserves a lot of credit because she gave a lot of really, really good information to people and was able to get information out to people faster. So, yeah they did a good job. (*Female, 40-45 years old*)

While the GOTvs Facebook group was often mentioned as a primary source of information, participants also noted that they used their personal Facebook pages to seek and provide information about the tornado. This trend was especially true on 24 August 2011 when a second storm system resulted in wide-spread tornado watches and warnings across southern Ontario. The results of the content analysis suggest that information about the 24 August 2011 storm system was relatively sparse on the GOTvs Facebook group. However, insights obtained from the interviews suggest that individuals relied more on their personal Facebook pages and other channels of communication to obtain details about this successive storm system.

Not only was Facebook useful for obtaining information in the hours and days following the storm, but it was also a valuable coping mechanism for many respondents. Facebook provided a public platform to share personal experiences with other survivors that fostered a sense of community and wellbeing for many participants:

I was getting emailed messages or texts or Facebooks from people, well-wishers, family all over Canada. So I would sit down at the end of the day and I'd say, 'I need an hour. And I need to respond to these people' . . . it was something I felt I needed to do. (*Female, 40-45 years old*)



Uh, there was a number of Facebook groups that were established to bring people up to date and, uh, I guess, tell people's stories, and, you know, talk about where, where help is needed, and things like that. So we did, uh, frequent those sites in the days following. *(Male, 40-45 years old)*

Although Facebook was frequently cited as a valuable source of information, many respondents also indicated that misinformation and gossip were common, particularly in the immediate aftermath of the tornado:

There was a lot of, you know, hearsay, and you know, rumours, different sort of thing. And, uh, I'd like to add that most of the stuff that I heard, um, you know, via word of mouth was either wrong or just not entirely factual. . . Um, everything from, you know, the amount of people that died, um, to, um, you know, areas that were hit. People saying, like, 'Oh, the mall in Goderich is completely destroyed' and, you know, different things like that *(Male, 20-25 years old)*

All the information was hugely out of date all the time. Um, there were lots of social media—especially Facebook—um, postings that could have happened. There were lots of questions and, and wrong information coming out on Facebook through the, the—through the, uh, those groups. *(Female, 55-60 years old)*

You know, they just stayed in contact with their friends through Facebook and Internet. And I mean Facebook was wild that night. Just wild that night. Kids were scared. Um...like anything else, Facebook, you know, it's kind of like playing the telephone game, you know? 'I heard that...' and then it gets exaggerated along the line. So there was exaggerated stories. *(Female, 45-50 years old)*

The difficulty in moderating user-generated content is a commonly cited challenge with the use of social media for crisis communication. Misinformation (whether deliberate or unintentional) represents a significant challenge on social media, and managing misinformation can be time consuming and difficult during crises. However, respondents in the present study indicated that, although misinformation and gossip were common in the immediate aftermath of the tornado, members tended to self-moderate and verify Facebook content rather than automatically accepting it:

There was so much misinformation and there was so much miscommunication in the community that [utilizing social media allowed] you to get real-time feedback, uh, on your plans and on the information that you're distributing to the community. But also when you would actually start distributing information to the community, there would be more transparency. *(Male, 20-25 years old)*

I think that was a good way of getting information. Although you could, not always, uh, you'd realize it wasn't always good, reliable information. Whenever something like this happens, there's a lot of gossip out there . . . But, uh, you know, you take it with a grain of salt. There's people that you know in the community who are, um, usually pretty accurate sources of information, and you wind up talking to those people and focusing on what they have to say. *(Male, 40-45 years old)*

If there's misinformation, I'll use [Facebook] to clarify . . . So often I'll just wait, when I see something, and then somebody else will then thankfully clarify the misinformation *(Male, 30-35 years old)*

Several respondents also indicated that misinformation largely occurred due to the lack of public engagement through social media on the part of town officials:

I think there was a lot of different things that, uh, that could have been done better [to] streamline the flow of information . . . I felt like, uh, you know, if there had been some sort of plan beforehand, uh, to utilize social media, that it could have done a world more good than it did. *(Male, 20-25 years old)*

There were lots of questions and, and wrong information coming out on Facebook through the, the—through the, uh, those groups. And if they'd had somebody official from the town, um, who could post to it. You know, so there's still a lot of panicking going on, or, or rumours or whatever. . . Somebody from the Town Hall, whether it was the Emergency Management Coordinator or, you know. Somebody should have been active and responding on behalf of the town. Because that's how people were trying to get their information. *(Male, 60-65 years old)*

Um, but there's—and there's so much information out there, and a lot of it's right, and a lot of it's wrong. What little you could see from, say leaders in town, or the folks who should have been leading were—wa—was fragmented passive. . . that wasn't really a leadership position of how to mobilize information or communicate effectively *(Male, 30-35 years old)*

In addition to the value placed on the information propagated through Facebook, many respondents spoke at length about utilizing Facebook groups to rapidly self-organize, particularly in the immediate aftermath of the tornado:

Facebook has been instrumental to coordinating the volunteers and just getting the information out, uh, to that demographic in my community that uses Facebook. And it's, uh, honestly, if, if we didn't have this form of medium, everything we've done, we wouldn't have been able to do with such efficiency and coordination. It just wouldn't be possible. *(Male, 20-25 years old)*

The first site was always the, um, GOTVS site. And it was, you know, people asking, 'Where can I donate, where can I go, does anybody know about so and so?' . . . And [the moderators of GOTVs] were fantastic. They had connections through 211 so, um, the one day [someone] said they needed margarine and eggs. GOTVs posted that, I think within four hours they said, 'Please don't bring any more margarine and eggs!' *(Female, 45-50 years old)*

I think we have so many good helpers in the community. People weren't really waiting either. They were feeling like it needs to be done now. If we had just waited for someone to call us, sat in our house and waited to be called off the list, we would've still been sitting in our house. *(Female, 50-55 years old)*

### 3.3.2 *Computer assisted content analysis*

In addressing the first research question of this paper, computer assisted content analysis was used to determine what information was most commonly shared and solicited using the GOTVs Facebook group. There were 59 roots of significance and they were used 19,917 times (Table 3.3). The most common significant word that appeared in the GOTVs Facebook group was *Goderich* (n=1767). Root words for offering or soliciting aid (e.g., *Help*; *Need*; *Donat*; *Volunteer*; *Support*) were among the most frequently appearing phrases. Root words for information-seeking (e.g., *Call*; *Info*; *Contact*) were slightly less common, but still featured prominently.

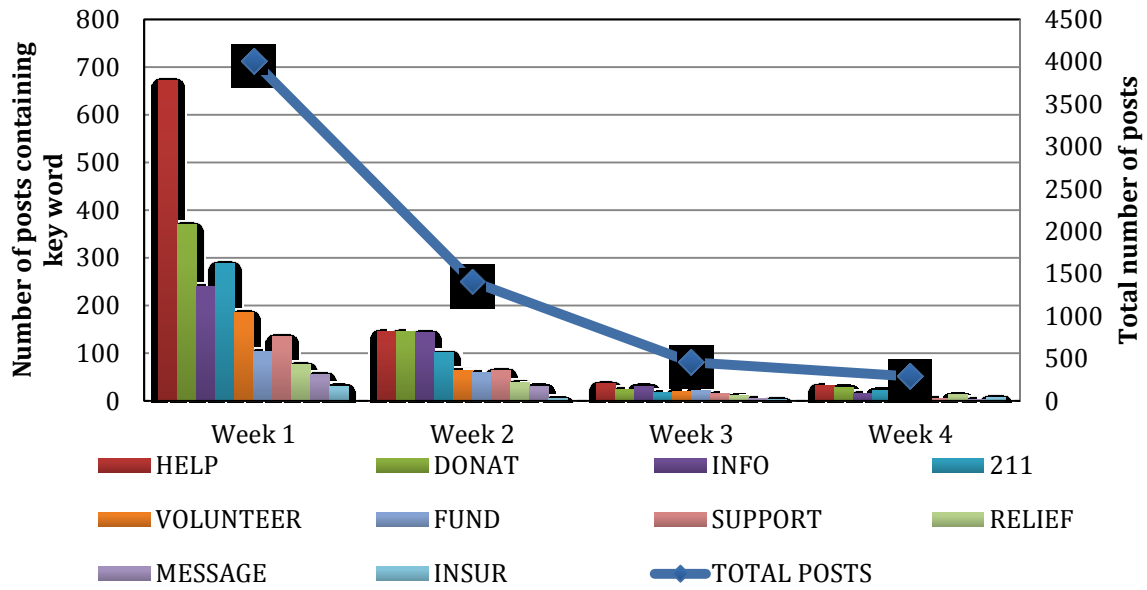
ROOT	n	ROOT	n
GODERICH	1767	ITEM	234
HELP	1245	RELIEF	223
PEOPLE	1138	PRAY	216
CALL	1012	HOPE	215
NEED	950	FACEBOOK	195
THANK	780	SERVICE	190
DONAT	677	ONTARIO	189
TOWN	639	DISASTER	187
INFO	566	NEW	165
PLEASE	558	MONEY	152
211	553	SAFE	147
POST	472	THOUGHTS	145
TORNADO	469	TREE	141
TIME	383	BANK	140
VOLUNTEER	378	FREE	138
FUND	376	DAMAGE	137
SUPPORT	338	ARMY	135
FAMIL	335	HEART	135
LOOK	308	CLOTH	134
HURON	306	LOCAL	130
LIVE	304	UNITED	125
FOOD	299	MESSAGE	120
COMMUNIT	284	LOST	114
PAGE	263	CHURCH	113
HOME	255	LONDON	110
LOVE	250	INSUR	105
CONTACT	249	STORM	101
FRIEND	245	EMERGENC	90
FIND	237	COUNTY	55
		<b>GRAND TOTAL</b>	<b>19917</b>

**Table 3.3:** Frequency of use for top 59 root words

Interestingly, the phrase 211 was the 11<sup>th</sup> most popular root word (n=553) that appeared in the Facebook group. 211 is a special telephone number meant to provide information to members of the Canadian public, which was approved by Canadian Radio-television and Telecommunications Commission (CRTC) for use in Huron County in June 2010.

Although the service was relatively new in Huron County at the time of the Goderich tornado, the results here suggest that it was widely utilized as a supplementary source of information. This tendency for end-users to confirm information through multiple channels is a trend that has been previously identified in the literature (e.g., Durage Kattan, Wirasinghe, & Ruwanpura, 2014; Lindell & Perry, 2012; Mileti & Sorensen, 1990; Schmidlin, Hammer, Ono, & King, 2009). Finally, words of support and consolation also appeared often in the list (e.g., Thank; Support; Famil; Communit; Home; Love; Pray; Hope).

After the initial analysis was completed, and the individual meaningful words, their synonyms, and misspelled counterparts were all recoded to their lexical roots, it was then possible to begin the temporal analysis. While the unit of analysis in the data preparation phase was the 'word', for the temporal analysis the unit of analysis moves to the number of posts or number of comments in which the meaningful words are used. This means that regardless of how many times a particular word is used in a single post, it was only counted once. When broken out over time, several patterns become apparent (Figure 3.2). First, the total number of posts dropped dramatically between week one (n=4006) and week two (n=1409). By the one-month mark, total activity in the group had declined to only 61 posts and 229 comments in the fourth week. This finding is consistent with previous research that found that individuals turn to social media to fill the information gap that is common during the immediate disaster response phase (e.g., Sutton et al., 2008).



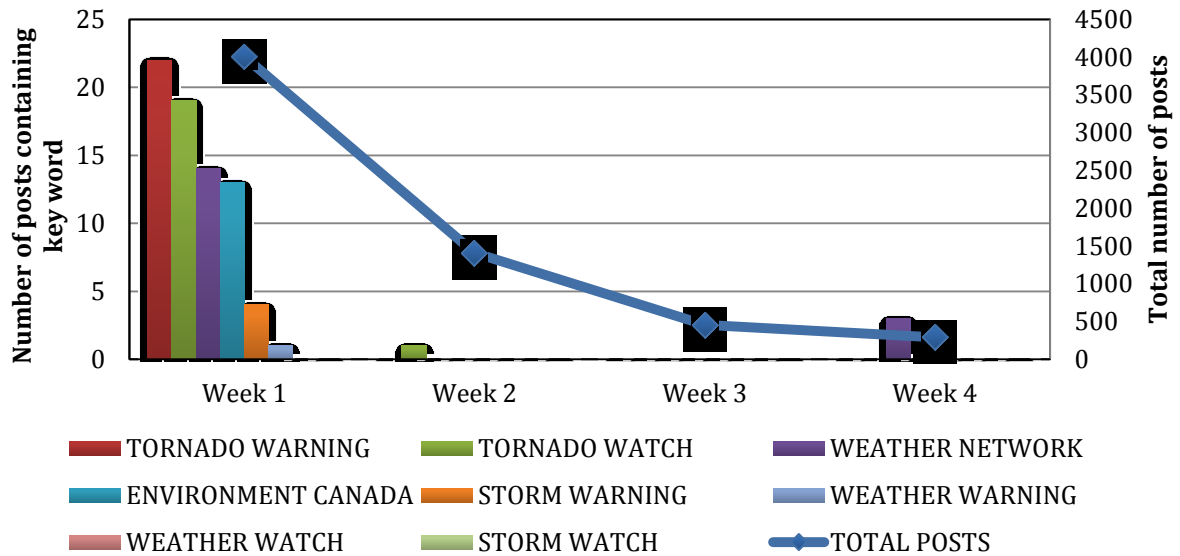
**Figure 3.2:** Wall posts and comments containing meaningful words over time

It is expected that activity on a site such as GOTvs would decrease over time. However, the point at which activity significantly drops off may be of particular importance for professionals involved in disaster response and recovery. A series of one-tailed t-tests were conducted to assess the point at which activity on the GOTvs page had a statistically significant decline. The results of the t-tests (Table 3.4) indicate that the difference in weekly mean Facebook activity in week1 and week2 are statistically significantly different from all following weeks. However, weekly mean Facebook activity in week3 is not statistically different from any of the following weeks. As such, it is determined that first two weeks after the Goderich tornado were the most important for the GOTvs site.

Week	1	2	3	4	5	6
1	NA	0.000	0.000	0.000	0.000	0.000
2			0.004	0.004	0.002	0.001
3				<b>0.045</b>	0.008	0.002
4					<b>0.012</b>	0.008
5						<b>0.450</b>

**Table 3.4:** P-values for one-tailed paired t-test comparing weekly means in Facebook activity (wall posts and comments combined)

As seen in Figure 3.3, the first two weeks after the event display a very strong negative linear relationship ( $R^2=0.87$ ,  $m=-62.2$ ), however, in the following 17 weeks, activity plateaus and the slope of the line is virtually zero ( $R^2=0.45$ ,  $m=-0.4$ ). A second component of the temporal analysis was to search for terms that were of particular importance for risk communication. This component of the analysis moves away from the inductive approach previously described and looks at specific terms of importance. On 24 August 2011 there was another storm system that moved through Huron and Perth Counties, which resulted in a tornado watch and then a tornado warning being posted for Goderich and surrounding communities that day. Interestingly, phrases related to this event (e.g., tornado watch, tornado warning, storm watch, storm warning) were only mentioned sparingly in the GOTvs Facebook group. There is a small peak in the use of the term ‘weather network’ in week four, which can be attributed to a television segment that was being aired on the Weather Network pertaining to the Goderich tornado. This result was surprising, given the established literature on the social amplification of risk among sensitive social groups (Kasperson et al., 1988).



**Figure 3.3:** Wall posts and comments containing words of importance for risk communication

### 3.4 Discussion and Conclusions

The 21 August 2011 tornado that impacted the community of Goderich, Ontario spurred substantial discussion through various social networking sites. Arguably the most popular and the most influential of these various websites was the *Goderich Ontario Tornado victims and support* Facebook group. The information exchange that occurred through this public group provided the opportunity to explore how end-users utilize unofficial channels to respond to information dearth, to self-organize, and to share their experiences of the traumatic event.

The results of this study suggest that Facebook was a highly popular and influential communications channel, particularly during the immediate aftermath of the disaster when information was scarce. Individuals accessed and shared information on both their



personal Facebook pages and on unofficial Facebook groups, such as the GOTvs group, to address this dearth of information. The most common posts on the GOTvs Facebook group were those that offered or solicited aid, requested information, or organized volunteer efforts. Accordingly, the greatest amount of information seeking and sharing occurred in the first two weeks after the tornado impacted the community, after which the activity within the group sharply declined.

Although social media is commonly criticized for the difficulty in evaluating the credibility of user-generated content, participants in the present study felt that the information they received was both practical and updated more rapidly than traditional media channels. While misinformation and gossip occurred during the immediate response phase, many participants noted that the group generally self-moderated inaccurate information. Indeed, several participants noted that the dynamic nature of Facebook contributed to information transparency, whereby members were able to engage in the interactive process of sharing and interpreting information as a that acted as a form of ‘collective error correction’ (Sutton et al. 2008). This finding supports the Social Amplification of Risk (SAR) framework, which posits that social media may provide a platform for the iterative, two-way interpretation of risk information. However, many participants in the present study also commented on the lack of consistent public engagement through social media by town officials, which contributed to diminished situational awareness and uncertainty among end-users.

Interestingly, the GOTvs Facebook group contained relatively few posts on a subsequent storm system that affected the region on 24 August 2011. This result was surprising, as the empirical and theoretical literature on the social amplification of risk suggests that such an event occurring so soon after a serious disaster would ignite a flurry of discussion as heightened risk perception contributed to increased interaction through social networks. However, insights from the qualitative interviews suggest that individuals tended to rely on other sources of information, especially in-person communication and personal Facebook pages, to obtain, interpret, and respond to information on the subsequent storm, while the GOTvs Facebook group remained focused on providing information on disaster recovery and support. This finding supports previous research that demonstrates that individuals rely on multimodal communication systems to find and confirm information during high-risk events (Durage et al. 2014).

The quick and interactive nature of information sharing on Facebook also allowed for the rapid self-organization of unofficial volunteer groups in the community. As a result of the connections made through the GOTvs Facebook page, several grassroots community groups were established and remain operational to this day. The GOTvs Facebook group also provided a public platform for members to share media content and personal stories of their experiences during and after the tornado. Being able to virtually connect with friends, neighbours, and family also contributed to a sense of belonging and connectedness that was particularly therapeutic for community members who had either temporarily or permanently relocated (Silver and Grek-Martin 2015). That social media can provide emotional support after crises has been noted in previous research (e.g., Liu

& Jin, 2011; Vieweg et al. 2010; Stephens & Malone, 2009), however, few studies adequately explore the applicability and operationalization of this virtual community space. As such, this is one area of research that would certainly benefit from additional investigation.

Taken together, the results of the present study underscore the flexibility and usefulness of Facebook groups for crisis communication during the immediate aftermath of a disaster when information is otherwise scarce and difficult to validate. Although public officials may be hesitant to engage with the public through social media for a variety of legitimate reasons, the findings of the present study support previous research that suggests engagement by public officials through social media may moderate misinformation and/or encourage trust among end-users (e.g., Sutton et al., 2008).

However, the window for engagement by public officials is very narrow, with most of the activity occurring on social networking sites within the first week of a disaster. As such, it is critical that emergency managers, public officials, and other point-of-contact individuals have a social media plan in place so that they may immediately engage with the public during the critical response phase.

## CHAPTER FOUR

### **Manuscript #2:** Public Attention to Extreme Weather: Sense-making on Social Media

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Recent advancements in the development of information and communications technologies over the last several decades have revolutionized the ways that individuals and groups access and interpret information. Perhaps most notably, the invention of the Internet represents a major technological and ideological shift in communications of all kinds, including risk communication. Social networking sites act as digital social environments that allow citizens to engage in information seeking, interpretation, and dissemination activities. The purpose of this research is to explore how social media facilitates the collaborative and iterative interpretation of an extreme weather event. Using Twitter data collected during a tornado-warned storm that affected southern Ontario in September 2016, this study utilizes computer assisted content analysis and thematic coding to explore how users, both individually and collectively, made sense of official and unofficial warning information. The results show that weather professionals (e.g., meteorologists and forecasters) and weather enthusiasts (e.g., storm chasers and storm spotters) are key actors who facilitate discussion during the event. These individuals dominated discourse before and during the severe weather outbreak, while citizens picked up the discussion shortly thereafter. Citizens engaged in the process of sense-making by re-tweeting, which allowed for the propagation of information across social networks, and by sharing personal observations of the storm. The results of this study highlight the usefulness of Twitter as a platform for sense-making, owing largely to the flexible, interactive, and rapid nature of communication through this medium. This study also underscores the fact that individuals are adept interpreters of information, even when obvious social and emotional cues are absent.

## **4. Introduction**

### *4.1.1 Public attention*

Given the increasing frequency with which societies are confronting severe weather, weather products have become essential forms of communication between official forecasting agencies and populations at risk. Previous research suggests that the effectiveness of these products depends on exposure, attention, and comprehension (Lindell and Perry, 2012). As noted by Ripberger et al. (2014), much of the existing research on public response to severe weather has focused on factors that influence message exposure and comprehension. For example, within the literature on high-impact weather events, such as tornadoes, tropical cyclones, and flash floods, many studies examine whether and when individuals receive warning products (Palen et al. 2010; Morss et al. 2015; Morss and Hayden 2010; Murthy and Longwell 2013; Hayden et al. 2007; Sharma and Patt 2012). Within the tornado literature more specifically, it has been found that time of day (Ashley et al. 2008; Sutter and Simmons 2010), warning lead time (Hoekstra et al. 2011; Simmons and Sutter 2008; Zahran et al. 2013; Comstock and Mallonee 2005), and socio-demographics (Silver and Andrey 2014; Sherman-Morris 2010, 2013; Sorensen 2000) all influence exposure to and/or comprehension of warning messages.

While the growing body of literature on the exposure to and comprehension of warning messages is contributing to a deeper understanding of effective risk communication, there is a paucity of theoretical and empirical research on the influence of public attention throughout the warning/response phases. This is despite the fact that attention is often identified within the hazards literature as an influential variable in the hazard-response cycle (e.g., Schipper and Pelling 2006; Lindell and Perry 2000; Silver 2015; Morss and Hayden 2010). One notable

exception can be found in the Protective Action Decision Model proposed by Lindell & Perry (1992; 2004; 2012). In this theoretical model, attention is identified as one of three pre-decisional processes, in addition to exposure and comprehension, that influence whether and how individuals take protective action. Lindell and Perry (2012) further note that attention is influenced by an individual's expectations, competing attentional demands, and the intrusiveness of information. While this model underscores the importance of attention for decision-making, it does not explicitly explore the relationship between these variables.

As with the theoretical literature, only a few empirical studies explore public attention in the context of people's responses to extreme events. Chung (2011) examined public attention to environmental risks from a construction project in South Korea. The results of this research suggest that the Internet provides a social environment that may quickly amplify public attention to risk. The findings also suggest that more direct measures of public attention (e.g., number of comments and website visits) may better represent public attention towards an environmental issue than less direct measures (e.g., number of newspaper articles or number of website posts). Two other notable articles also explore the concept of public attention to hazardous events as indicated by activity on social networking sites (Ripberger et al. 2014; Chew and Eysenbach 2010). These papers suggest that external information in the form of news stories (Chew and Eysenbach 2010) and weather watches and warnings (Ripberger et al. 2014) are positively correlated with increases in tweet activity, and as such, Twitter may provide a "real time" indicator of public attention.

Although the articles described above examine public attention to environmental hazards, they represent the bulk of research conducted to date. Otherwise, there exists a paucity of theoretical and empirical research on public attention within the hazards literature. However, insights on this concept can be drawn from research in philosophy, sociology, social psychology, and organizational science. This literature suggests that public attention is a process that involves exposure, selection, noticing, and focusing—the latter of which involves an iterative process of information seeking and communication as people, both individually and collectively, make sense of events and issues (Hoffman and Ocasio 2001; Neuman 1990; Newig 2004; Newig and Hesselmann 2004; Webster 2011).

The iterative process of information seeking and communicating when confronted with uncertainty is most commonly referred to as sense-making (e.g., Dervin, 1983, 1998; Weick 2010, 1988; Lee 1999), although it also has been referred to as knowledge acquisition (Olsson et al. 2004), risk interpretation (Lindell and Perry 2012; Eiser et al. 2012), and milling (Sutton et al. 2013, 2011). The insights gained from research on sense-making may inform scholarly understanding of attention creation, particularly as it relates to decision-making. Most notably, it is argued that: (1) individuals and groups seek information as a coping strategy when confronted with uncertainty (Dervin, 1983; Eiser et al. 2012; Lindell and Perry 2012); (2) sense-making is a collective learning process that requires collaboration; (3) this collaboration commonly occurs in social arenas where key actors (sometimes called “key stewards”) provide insights and guidance (Olsson et al. 2004); and (4) sense-making provides a critical link between information and action (Dervin, 1983; Olsson et al. 2004; Sutton et al. 2013; Eiser et al. 2012; Lindell and Perry 2012). It is important to note, however, that public attention towards an event or issue is not

synonymous with comprehension. The public may carefully attend to information without fully understanding it or they may actually *misunderstand* it instead. For example, paying attention to a hail storm does not necessarily mean that individuals and groups will understand what hail represents in terms of other potential hazards (e.g., high winds, lightning, torrential rains) or how to respond to the hail event itself. This potential disconnect between information, comprehension, and action is why sense-making is a critical component of attention creation. Sense-making involves the iterative, collaborative acts of information seeking and communication in an attempt to reduce uncertainty, and thereby acts as an important link between information and action. How an individual comprehends information and whether they decide to take action depends on how they, both individually and as part of a collective, make sense of an event or issue.

#### *4.1.2 Public attention and social media*

The vast majority of the existing research on public attention to events and issues focuses on traditional one-way communications media, such as television, radio, and print media. However, rapid advances in the development and proliferation of information and communications technologies over the last several decades are re-shaping the ways that individuals and groups access and interpret information. Perhaps most notably, the invention of the Internet represents a major technological and ideological shift in communications of all kinds, including risk communication. Individuals are no longer predominantly recipients of information; now, information is continually and collaboratively created and disseminated by multiple users across time and space. Social networking websites allow citizens to engage in news making, through information seeking, communication and sense-making.



The purpose of this paper is to explore how individuals and groups attend to extreme weather events through social media. The manuscript has two primary research questions:

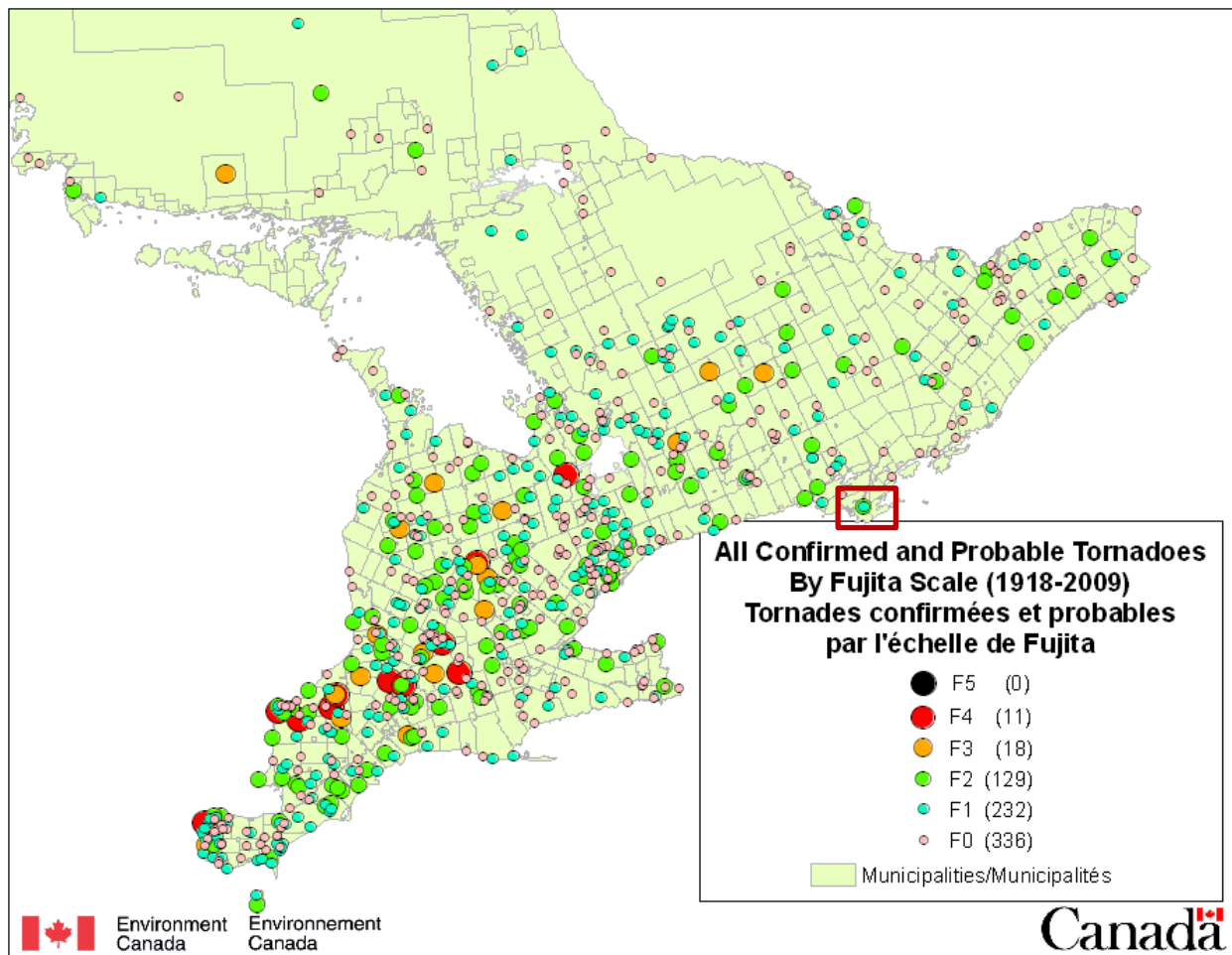
**#1:** How does the activity of different actors on social media during extreme weather events compare to and influence one another? Who are the key actors providing insights and guidance during extreme events?

**#2:** How does society make sense of extreme events and how does this sense-making relate to protective action decision-making?

To answer these questions, social media data were gathered for a severe storm that affected southern Ontario, Canada on 10 September 2016. In the next section, the storm event is introduced and the social networking platform discussed. Then, the methods and the results are presented. Finally, the discussion section returns to the research questions outlined above to consider the role of social media as a digital environment through which citizens engage in sense-making activities during severe weather.

#### *4.1.3 Storm event and study area*

On 10 September 2016, the atmospheric conditions across much of central Canada and the upper-Midwest of the United States were primed for an outbreak of severe weather. Both Environment Canada and the National Weather Service in the United States closely monitored conditions in the days leading up to the event. Major media outlets, including The Weather Network, the Weather Channel, and Accuweather also cautioned of the potential for severe weather well in advance of the storms. The first severe thunderstorm watch for Ontario was



**Figure 4.1:** A map of all confirmed and probable tornadoes by Fujita Scale to have occurred in southern Ontario. Prince Edward County is indicated by the red box. (Source: Environment Canada, 2011).

issued by Environment Canada at 12:27 PM EDT on September 10<sup>th</sup> for a large swath of the province from Windsor to Ottawa-Gatineau. Appropriately four hours later, severe thunderstorm warnings were issued for counties in extreme southwestern Ontario and continued to be issued as the storm tracked eastward. The first tornado warning was posted at 6:22 PM EDT for Prince Edward County, Ontario and shortly thereafter, a waterspout came ashore as an EF0 tornado (Figure 4.1). The tornado tracked approximately 3.5 km (2.2 miles) inland before it dissipated.

Although minor property damage was reported from this and the other severe storms that occurred across southern and central Ontario that day, no injuries or deaths were reported.

## 4.2 Data collection and methods

Founded in 2006, Twitter is a social networking site with over 328 million active monthly users (Twitter, 2017). Twitter's design allows users to create only short messages up to 140 characters in length, called *tweets*, and disseminate these messages to their followers. In addition to text, tweets can contain hyperlinks, pictures, videos, and hashtags. Hashtags are words or phrases that can be used as search terms by Twitter users; for example, a user might include the hashtag #cdnpoli in a tweet about Canadian politics. Searching for the #cdnpoli hashtag using the Twitter API returns all tweets containing this search term, as well as Twitter accounts that commonly use this hashtag (e.g., Canadian Prime Ministers Justin Trudeau, Stephen Harper). In addition to creating original tweets, users can also "re-tweet" others' tweets to their own followers, further disseminating information across social networks. Re-tweeting is an important component of sense-making, as it increases exposure and implies a sense of confidence about the information. As Sutton et al. (2014: 782-783) explain:

Serial message transmission, via retweeting following the initial receipt of a warning message, is characterized here as a form of online milling where individuals employ sense-making activities before taking protective action . . . Retweeting is a visible sign of this online milling activity, demonstrating public exposure to messages, resulting in a decision to transmit information to a broader online network.

Although research on Twitter in particular (and social media in general) is still in its infancy, early research has shown Twitter to be influential in the discussion of significant events, including tornadoes (Stokes and Senkbeil 2016; Chatfield and Brajawidagda 2014; Ripberger et al. 2014), organizational crises (Schultz et al. 2011), earthquakes and tsunamis (Acar and Muraki 2011; Doan et al. 2012; Mendoza et al. 2010; Muralidharan et al. 2011), and floods (Palen et al.

2010; Vieweg et al. 2010). The influential nature of Twitter has been attributed to its ability to provide a platform for the rapid, iterative, and collaborative interpretation of events and issues by people and groups (e.g., see Chung 2011).

In regards to the 10 September 2016 storm, discussion of the potential severe weather outbreak began several days in advance on social media, sometimes using location-specific weather hashtags (e.g., #onstorm, #onwx, #ILwx). For this study, all tweets containing the keywords **#onstorm** and/or **tornado** were gathered for a period of 48 hours, beginning approximately five hours before the first severe thunderstorm warning was issued in southern Ontario. This time frame was chosen to capture the entire warning-response cycle, from pre-warning through to the onset of recovery. Although the origins of the keyword #onstorm are uncertain, this hashtag has been in use on Twitter for several years and only recently became incorporated into the text of Environment Canada's official watches and warnings. #Onstorm was chosen for this project because Environment Canada and the Weather Network encourage Ontario residents to share personal observations of severe weather and its impacts using this hashtag. The keyword "tornado" was chosen to capture discussion of the event that did not include the provincially specific hashtag.

The tweets were gathered using the Zapier, a web-based application automation service that pulled the tweets using Twitter API along with associated metadata, including the date and time of tweets, usernames, and user-entered locations. Although the signal-to-noise ratio (i.e., ratio of on-topic tweets to off topic tweets) within the #onstorm hashtag was high, with almost all tweets

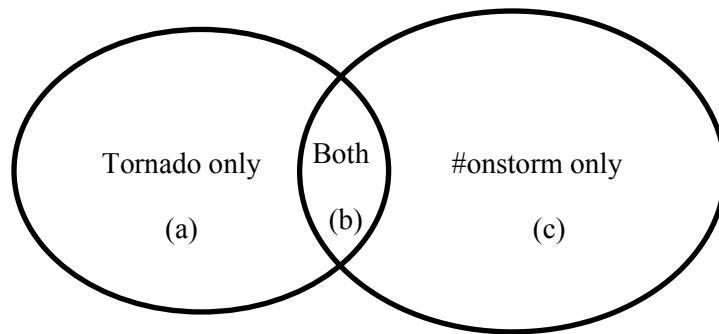
in this dataset being on topic, the signal-to-noise ratio of the tornado tweets was low. For example, the following tweets reflect an example of the “noise” in the tornado dataset:

***Tornado** scores again. 6-4 with 4:46 to play. Certainly will be trickier for SKIF to get back in this. #rwhl #zhl #womenshockey*

*Cleaning my whole apartment because it looks like a **tornado** has come through and I have three rooms left and I think I want to give up 😞😞*

As a result, all tweets containing the word tornado were individually read and coded as to whether they referred to (a) the storm event in Ontario, as described above (b) the same storm event in the United States, (c) discussion of previous storm events, or (d) off topic. If there was any ambiguity, the tweet was coded as (e) “unknown” to ensure that only those tweets that referred to the storms in southern Ontario were included in the analysis. This resulted in 3209 tweets and 2301 unique users that comprised the tornado keyword dataset. By comparison, the #onstorm data set included 5910 tweets and 2629 unique users.

As the overarching focus of this research was to examine how different actors engage in the process of sense-making on social media, the first step was to compare the user profiles of the three subsets illustrated in Figure 4.2. To do this, a random sample of 245 users was obtained for each of the three subsets, which allowed for the estimation of percent frequencies to within  $\pm 5\%$  with a 90% confidence level. Each user included in the sample was looked up using the Twitter search function, and their location, sex, number of followers, number of following users, and personal biography was collected. Sex was inferred from one of two criteria: (1) if they self-identified their sex in their personal biography, or (2) if their name, username, and profile picture were strongly suggestive of a particular sex. In cases of uncertainty, for example when a gender



**Figure 4.2:** Tweets for the 10 September 2016 storm.

neutral name was paired with a profile picture of multiple people, then the sex was coded as “unknown” (n=269, 21%). For Twitter accounts that were associated with organizations rather than individuals, for example Environment Canada twitter accounts, then the tweet was coded as “organization”. In order to ascertain the occupation of users, each individual biography was read and then coded based on the user-entered employment information. For example,

*Meteorologist at MeteoGroup Weather Services Canada. Honours BSc Atmospheric Science & Certificates in Meteorology, GIS & Remote Sensing.*

*Teacher, mother, wildlife gardener, concerned citizen. Working towards minimizing my footprint. All images are mine except RTs. #Gardens, #Wildlife, #Teacher*

were coded as Meteorologist and Teacher, respectively. In cases where the personal biography was blank or where there was insufficient information provided to code for employment, the user was coded as “citizen”. After several passes through the dataset, users were grouped into one of five actor groups (Table 4.1). This grouping allowed for a distinction to be made between those individuals for whom severe weather constitutes part of their professional mandate from those who are interested in the weather on a personal level. It also provided the opportunity to compare these two groups with other professionals who may not be interested in the weather

Actor Group	Example Occupations	%Total Sample	%Total Tweets
Weather Experts	Meteorologists, forecasters	7.0	20
Weather Enthusiasts	Storm spotters, storm chasers	5.3	6
First Responders	Paramedics, health care practitioners, emergency managers	3.0	2
Media	Journalists, broadcast media, automated news accounts	4.7	5
Citizens	Other professionals and citizens	80.0	67

**Table 4.1:** Five actor groups, including example occupations and their percentage of the total sample.

*per se*, but who might be professionally impacted by an extreme weather event (e.g., first responders, emergency managers, media outlets).

**4.3 Results**

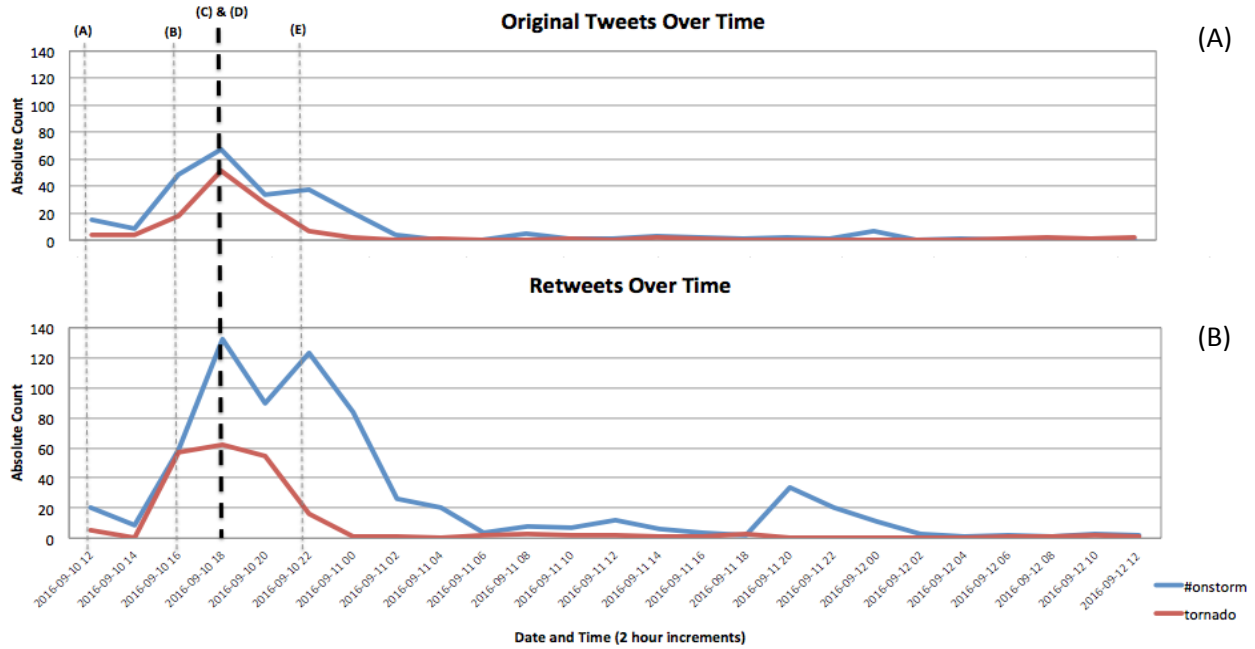
*4.3.1 Different actor groups*

The first part of the analysis addresses research Objective 1 by documenting the activity patterns of different actor groups on social media, and by exploring the ways in which different groups influence one another in sense-making during the severe weather outbreak. As a starting point in understanding actor groups, the three sample subsets outlined in Figure 4.2 were compared in order to identify any statistically significant differences in the occupation, sex, number of followers, and number of tweets. These variables were chosen as they have the potential to influence the process of sense-making; for example, previous research has shown that experts and other knowledgeable persons can act as ‘key stewards’, who “...provide vision, skills, and leadership for [interpretation and sense-making]” (Olsson et al. 2004, p. 86). Similarly, gender

has been shown to influence perception of risk and/or the likelihood of taking protective actions (e.g., Gustafson 1998; Andrade et al. 2011; Wachinger et al. 2013; Sherman-Morris 2005, 2010; de Man and Simpson-Housley 1987). The first set of chi-squared tests focused on those tweets that contained the keyword #onstorm (Figure 4.2c), and compared these tweets to those that contained both the keywords #onstorm and tornado (Figure 4.2b). No statistically significant differences were found. This indicates that it is appropriate to consider all tweets containing the hashtag #onstorm as coming from the same population of users. The next set of chi-squared tests compared the #onstorm sample (Figure 4.2b,c) with the tornado sample (Figure 4.2a). In this case, a number of statistically significant differences were found. First, users of the #onstorm hashtag are more likely to be weather experts (e.g., meteorologists, forecasters) and weather enthusiasts (e.g., storm chasers, storm spotters) than is the case for tweeters who did not use the hashtag (p-value=0.000). It was also found that users in the #onstorm sample tended to tweet more frequently and had more followers than those in the tornado sample (p-value=0.000). The differences across hashtag and non-hashtag datasets reflected here highlight the importance of being attentive to and reflective of the choice of a sampling frame to represent a population of interest when conducting research on social media.

As re-tweeting is seen to be an indicator of sense-making, it was important to examine both original tweets and re-tweets in this study. As shown in Figure 4.3, the timing of tweets and retweets varied for the two sample sets. When comparing original tweets (n=384) and re-tweets (n=900), the original tweets containing either #onstorm or tornado peak at approximately the time the first tornado warning was issued. However, the keyword #onstorm peaks again shortly thereafter, when Environment Canada ended the last tornado watch and warning—a trend that is



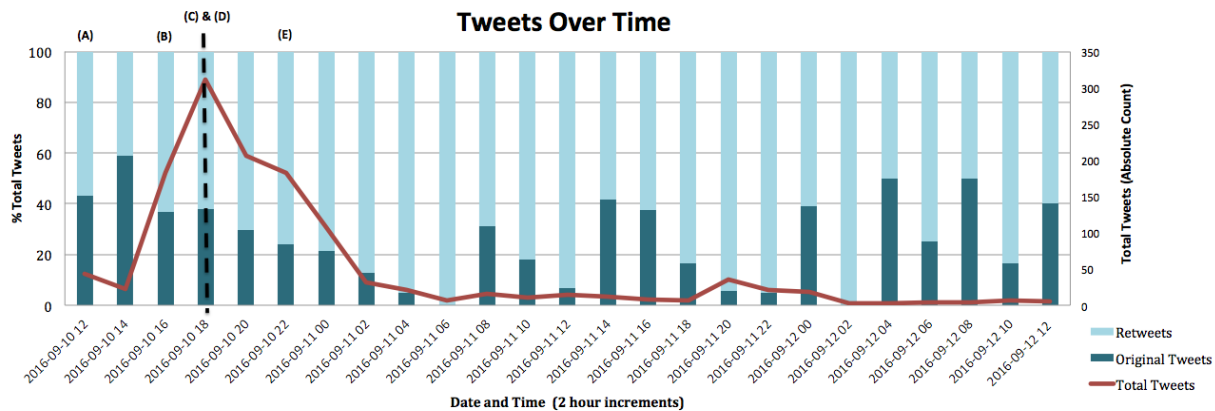


**Figure 4.3:** Original tweets and re-tweets for the keywords #onstorm and tornado. Time begins at noon on September 10<sup>th</sup> 2016 and continues in two-hour increments. The first severe thunderstorm watch (A), severe thunderstorm warning (B), tornado warning (C), and tornado touchdown (D) are all marked, as well as the time that all tornado watches and warnings were ended (E).

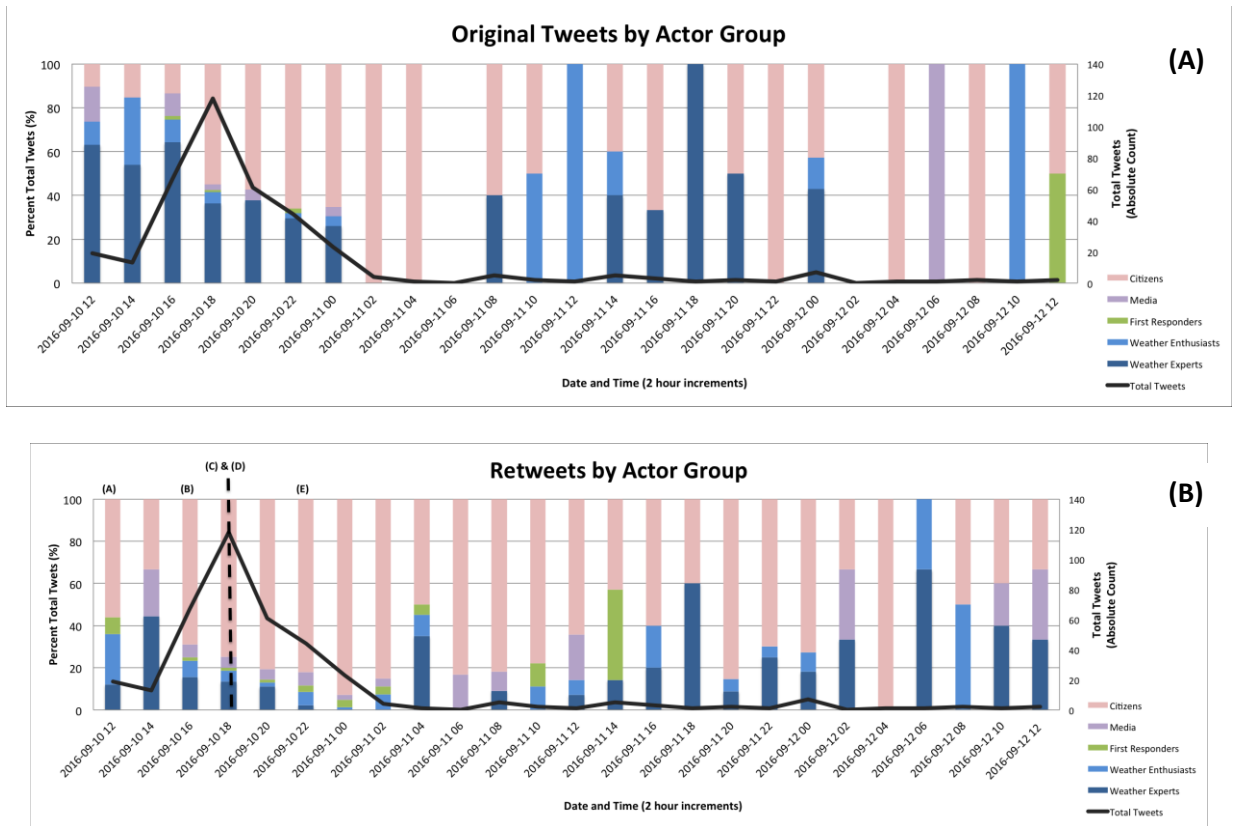
not true of tweets containing only the keyword tornado. Original tweet activity markedly declined once the last tornado warning was dropped, and it did not peak again for the remainder of the study period. As with original tweets, re-tweets containing both keywords peak approximately when the first tornado warning was issued, and the keyword #onstorm sees a sharp increase in tweets when the last tornado warning is dropped. However, unlike original tweets, re-tweets peak again the following day. A textual analysis of the re-tweets that occurred in the second, smaller peak, on 11 September 2016, reveals that citizens were sharing pictures and videos of the storm and its impacts. This underscores the fact that activity on Twitter can be indicative of both sense-making activities as well as interests that are not necessarily related to reducing uncertainty.

### 4.3.2 Key actors

This next section explores the ways in which sense is made of warning information, as well as the roles that different actor groups play. For this part of the analysis, all of the tweets for the three sample sets were combined to create a dataset of 1283 tweets, representing 11% of the total tornado sample and 16% of the total #onstorm sample. The rationale for combining the datasets is that most Twitter users view tweets on their own tweet-streams, rather than searching for key words using Twitter’s search function. An individual user’s tweet-stream contains all of the tweets of the users they follow, including tweets with and without hashtags, sorted chronologically by time and date. So while the two groups can be characterized as having different propensities, they do overlap and interact in ways that co-construct sense and co-create attention. When analyzed in this way, it is evident that the number of tweets and re-tweets are roughly equal in the hours leading up to the 10 September 2016 storm (Figure 4.4). However, there is a noticeable “lag-effect”, whereby original tweets peak during the storm event itself and



**Figure 4.4:** All original tweets and re-tweets over time. An absolute count of total tweets is shown in the red line. Time begins at noon on September 10<sup>th</sup> 2016 and continues in two-hour increments. The first severe thunderstorm watch (A), severe thunderstorm warning (B), tornado warning (C), and tornado touchdown (D) are all marked, as well as the time that all tornado watches and warnings were ended (E).



**Figure 4.5:** Original tweets and re-tweets broken out by user category. Time begins at noon on September 10<sup>th</sup> 2016 and continues in two-hour increments. The first severe thunderstorm watch (A), severe thunderstorm warning (B), tornado warning (C), and tornado touchdown (D) are all marked, as well as the time that all tornado watches and warnings were ended (E).

re-tweets peak shortly thereafter. Next, the chronology of tweets was organized so as to reveal how the activity of different actor groups (e.g., weather experts, weather enthusiasts, first responders, media, and citizens) compared to and influenced one another (Figure 4.5). Weather professionals (e.g., meteorologists, forecasters) and weather enthusiasts (e.g., storm spotters and chasers) dominated the discussion before and during the storm event, particularly for original tweets. In comparison, citizens comprised the majority of the re-tweets. Interestingly, the “lag-effect” is also present here, suggesting that original tweets and re-tweets by citizens are a major contributor to this effect. In other words, weather experts and enthusiasts tended to lead the

discussion, and citizens tended to engage shortly thereafter, predominately by re-tweeting. This is a trend that holds true for both the storm event on 10 September 2016, as well as the discussion that occurred on the following day.

#### *4.3.3 Sense-making on social media*

The second research question investigates how individuals and groups make sense of extreme weather events, and whether and how this sense-making relates to protective action decision-making. To explore this question, all tweets (n=1283) were coded based on two main attributes, which were (1) inclusions, and (2) sense-making. The inclusions that were coded included whether a tweet had a hyperlink, a picture, a hashtag, a RT, or an @ mention. The coding for sense-making was developed from research on public attention to environmental hazards (Silver, submitted), which drew on insights from Dervin's sense-making theory (Dervin, 1983; Dervin, 1998) and Weick's research on sense-making in crisis (Weick, 1988; Weick 1995; Weick 1993). Tweets were coded for three sense-making attributes: (1) information seeking; (2) information providing; and (3) emotion-related. The information seeking and information providing attributes were further broken down and coded for types of information, including: official warning information, personal observations, action recommendations, and damage/injury reports. The emotion-related attributes were coded as expressing positive emotions, negative emotions, or uncertainty.

In terms of the sense-making attribute "information seeking", only 1.6% of tweets (n=21) actively sought information in the form of asking questions. Of these, five tweets were sent by news outlets asking users to send pictures and videos of the weather they were experiencing. On

the surface, this result seems inconsistent with existing research both within and beyond the hazards literature that underscores information-seeking activities as a primary coping mechanism when confronted with uncertainty. However, it is possible to glean additional insights about information seeking through re-tweeting behaviour. Previous research and conventional wisdom suggest that in order for an individual to re-tweet information, they must have first have been exposed to the tweet, read/scanned it, and then decided to disseminate that information to their on-line network (Sutton et al. 2014). This suggests that individuals interpret the information that is being re-tweeted to constitute messaging that other users may find to be useful.

A textual analysis of the top 15 re-tweets provides insights about the types of information that users sought out and subsequently disseminated to their own networks (Table 4.2). The most frequently re-tweeted tweet was a video of the storm as it came ashore into Prince Edward County. The original tweet that contained this video was made by a weather photographer, and it was disseminated to a network of approximately 3300 followers. This tweet is notable in that it is the only tweet in the top 15 re-tweets to advocate seeking shelter. Eight of the top 15 re-tweets contained information about the tornado watches and warnings, and 10 of the top 15 re-tweets contained personal observations of the storm in the form of pictures and video. Given that re-tweeting is a visible sign of sense-making, this indicates that users seek out and/or value tweets containing information about the severity, timing, and impacts of the storm—information that is crucial when deciding whether to take protective action. Lastly, it is important to note that 11 of the 15 originators of these tweets are either weather professionals, self-proclaimed weather enthusiasts, or media outlets dedicated to weather news. This reveals the importance of these users as key propagators of information during extreme events.

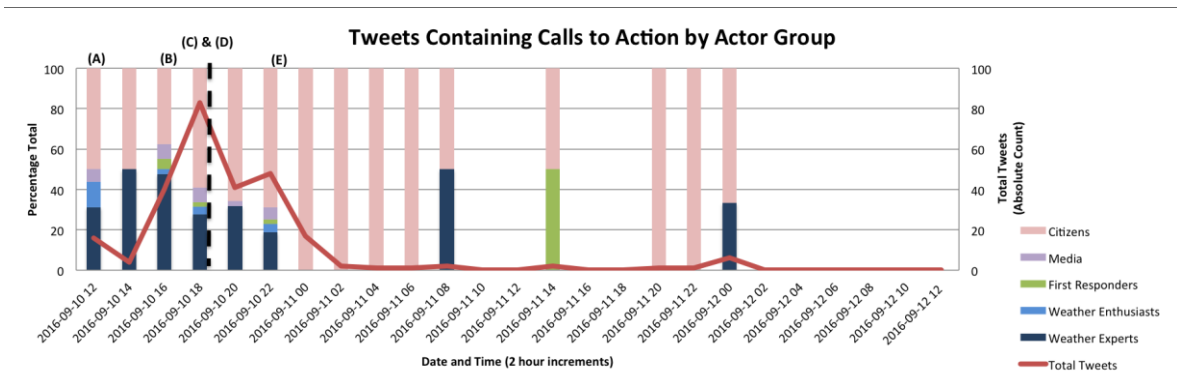
Originator	Originator's Occupation	Tweet	Inclusion(s)	# RTs
@KylesWeather	Weather enthusiast	I knew it was time to stop recording and seek shelter. Damage photos/pics to come soon. Shot in Bloomfield #onstorm	Video of storm	25
@KylesWeather	Weather enthusiast	I can confirm there is a tornado in Bloomfield, Ontario. Just hit the house. Severe damage. #onstorm		22
@weathernetwork	Media outlet (weather)	Tornado WATCH: Pickering, Oshawa, Uxbridge, Beaverton, Belleville, Quinte, Northumberland, Kingston, Peterborough		22
@kylebrobertson	Storm chaser	Severe thunderstorm right before coming ashore in PEC #onstorm	Picture of shelf cloud	17
@B911Weather	Weather enthusiast	Incredible timelapse of a Tornado-warned storm coming ashore in Prince Edward County, Ontario.	Video of storm	16
@CP24	Media outlet	WEATHER: Environment Canada has issued tornado watch for several areas east of Toronto, including Pickering, Oshawa, Peterborough		15
@weathernetwork	Media outlet (weather)	Waterspout, funnel clouds, damage reported amid severe storms in Ont. Photos here. #onstorm	Link to website with pictures and videos	15
@AnthonyFarnell	Meteorologist	Time lapse of the the tornado warned storm coming ashore in Prince Edward County. #onstorm	Video of storm	13
@JeremyGlobalTV	Journalist (weather enthusiast)	Brief rainbow seen from Vaughan, as an @AirCanada flight on approach to @TorontoPearson passes by. #onstorm	Picture	13
@B911Weather	Weather enthusiast	This was the scene just before a tornado impacted Bloomfield, Ontario. Severe damage reported after it struck.	@KylesWeather video	12
@weathernetwork	Media outlet (weather)	Tornado watch DROPPED for Pickering, Oshawa, southern Durham Region, Peterborough, Lakefield, southern Peterborough county		11
@CP24	Media outlet	DEVELOPING: Tornado watches issued for parts of GTA	Link to news website	10
@erinwenckstern	Meteorologist	Tornado-warned cell tracking towards #Kingston for ~8 PM. Gusts estimated over 120 km/h, with large hail & torrential rain		10
James_Head_	Citizen	Another photo from this evenings storm. This photo was taken at around 7:25 pm. #onstorm #kingstono #storm	Picture	10
@Starfest2016	Citizen	higher res shot of the approaching super cell at Wellington Beach around 7pm this evening #ONSTORM #PEC	Picture	10

**Table 4.2:** Top 15 re-tweets, including the occupation of the originator and the type of inclusion (if any).

In terms of the sense-making attribute “information sharing”, 8.5% of tweets (n=109) shared information about damage and/or injuries, 33.8% of tweets (n=434) shared information about personal observations of the storm, and 48% of tweets (n=622) provided information about severe thunderstorm and/or tornado watches and warnings. Approximately 28% of tweets (n=364) provided meteorological details about the storm, including information about wind speed, precipitation, and associated hazards. Interestingly, only 15% of tweets (n=197) provided both official warning information and meteorological details about the storm. The remaining tweets simply stated the warning and location, for example:

*RT @weathernetwork: Tornado WARNING issued for Gananoque, Mallorytown, Brockville, Prescott, Winchester, Newington. #onstorm*

Although 20.6% of tweets (n=265) offered some form of action recommendation, these recommendations were overwhelmingly either “stay aware” or “seek shelter”, providing limited insight about where to obtain relevant information as the storm unfolds, what type of shelter is appropriate, or how long to stay sheltered. When broken out by user group, the insights on action recommendations tell an interesting story, with weather experts and enthusiasts (who account for less than 13% of users) offering approximately 50% of the action recommendations in the hours leading up to the tornado touchdown (Figure 4.6). From that point in time onwards, however, action recommendations were overwhelmingly made by citizens. This is further exemplified when tweets by citizens and experts are examined in greater detail. Table 4.3 provides ten tweets by experts (Table 4.3a) and ten tweets by citizens (Table 4.3b) that are illustrative of the information



**Figure 4.6:** Tweets containing action recommendations by actor group. Time begins at noon on September 10<sup>th</sup> 2016 and continues in two-hour increments. The first severe thunderstorm watch (A), severe thunderstorm warning (B), tornado warning (C), and tornado touchdown (D) are all marked, as well as the time that all tornado watches and warnings were ended (E).

shared by these two groups. It becomes apparent that experts tended to create original tweets that call for action, whereas citizens tended to disseminate these tweets to others. In fact, of all of the tweets issued by experts that call for protective action (n=74), 85% are original tweets. The remaining 11 tweets (15%) are re-tweeted from other weather experts. In comparison, of all the tweets issued by citizens that call for protective action (n=245), only 9% (n=22) are original tweets. The rest are re-tweets that were overwhelmingly originated by weather professionals and storm chasers/spotters.

Although the tendency for weather experts and enthusiasts to provide the majority of original tweets was also true for tweets containing official warning information and/or meteorological conditions, tweets containing personal observations of the storm differed markedly (Figure 4.7). These tweets began to increase shortly before the storm became tornado warned and peaked at the height of the event. Citizens contributed the majority of the tweets that contained personal observations of the storm, with 70-90% of these tweets

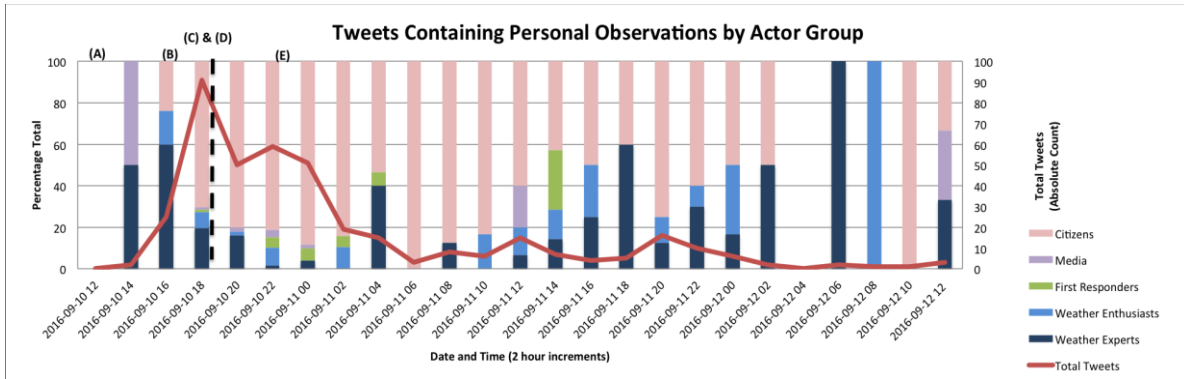


<b>Username</b>	<b>Tweet</b>	<b>Inclusion</b>
GTAWarns	TORNADO WATCH ISSUED.. BE ON THE LOOK OUT! #onwx #onstorm	Link to Environment Canada
WeatherOntario	STRONG WINDS AND ROTATION in the #PortDover area. Please be on alert! #onstorm	Link to Environment Canada
wxKINGSTON	[URGENT PRIORITY] TORNADO WARNING IN EFFECT Issued for Kingston [Updated: Sep 10th 19:07 EDT]	Link to Environment Canada
OntStorm4cast	TORNADO WARNING for Brockville - Leeds and Grenville! Take cover immediately! Nocturnal tornadoes are not visible.	Weather map (image)
StormhunterTWN	Take cover of if you live near Rockport, ON to Brockville, ON #onstorm strong rotation @jwhittalTWN @weathernetwork	Radar image
ECAAlertON121	16:45 EnvCanada issued #Tornado #Weather Watch #Peterborough #ONStorm	Link to Environment Canada
WeatherOntario	A reminder to follow other weather accounts for more info regarding #onstorm as I may not get a chance to post everything	
613Weather	RT @KylesWeather: If you catch yourself in active weather today in #Ottawa (or most of S/E Ont), stay alert: elevated risk of tornado development	
ONWeatherWatch	#onstorm If you see any storm damage or have photos/videos then post them on the page. Only when it's safe to do so.	
reedtimmerTVN	Watch out Wellington to Picton, Ontario this supercell has #tornado potential! @breakingweather #onstorm	Radar

**Table 4.3a:** Ten tweets by weather experts that include a call to action.

<b>Username</b>	<b>Tweet</b>	<b>Inclusion</b>
Jdavis_Halton	RT @matt_grinter: Main threats today include damaging wind gusts, torrential rain & chance of isolated tornado. Be Prepared #onstorm	Weather map
DrewVE3UIN	RT @YGKOEM: 16:44 Tornado Watch for @cityofkingston & #ygc area issued by @environmentca Heads up - eyes out - be aware of your surroundings	
creativeartson	RT @weathernetwork: Tornado WARNING issued for: Napanee, Consecon. Seek shelter immediately. #onstorm	
Cool100McKay	Tornado watch upgraded to tornado warning and severe thunderstorm warning. Stay safe.	Link to Environment Canada
StellarPillar	RT @LionOfJudahdnb: Tornado reported in Bloomfield #onstorm take cover!	Radar (GIF)
allllyn	RT @ethan_barlow: 📢**TORNADO WARNING**📢 Suppose to run near cobourg so be careful everyone!! RT to spread the word!!	
gregcons	RT @GTAWarns: TORNADO WATCH ISSUED.. BE ON THE LOOK OUT! #onwx #onstorm	Link to Environment Canada
Charlebois84	RT @weathernetwork: Tornado WARNING issued for: Napanee, Consecon. Seek shelter immediately. #onstorm	
kelseybeamish	RT @StormhunterTWN: Take cover of if you live near Rockport, ON to Brockville, ON #onstorm strong rotation @jwhittalTWN @weathernetwork	Radar image
Mj27J	RT @kellysonnenburg: Tornado warnings have ended in Ontario. Severe thunderstorm warnings and tornado watches continue. Tune into @weathernetwork	

**Table 4.3b:** Ten tweets made by citizens that contain a call to action.



**Figure 4.7:** Tweets containing personal observations by group. Time begins at noon on September 10<sup>th</sup> 2016 and continues in two-hour increments. The first severe thunderstorm watch (A), severe thunderstorm warning (B), tornado warning (C), and tornado touchdown (D) are all marked, as well as the time that all tornado watches and warnings were ended (E).

originating from citizens. These tweets are also notable in that the majority of them are original tweets, unlike the majority of other citizen-originated content that tended to be re-tweets. This finding is not surprising considering that Environment Canada and The Weather Network actively encourage citizens to share personal observations using the #onstorm hashtag.

Lastly, tweets were coded based on whether they contained emotional language. This is because sense-making involves the comparison of an individual's interpretation of an event with that of others (Eiser et al. 2012). Only 2.8% of the sampled tweets (n=36) clearly expressed an emotion. Of these, 15 tweets expressed positive emotions, namely excitement about the severe weather, and 19 expressed negative emotion, namely fear (n=9) and anger/disappointment (n=6) that the storm was not as severe as predicted. The remainder of the tweets lacked clear emotional indicators. This suggests that individuals

may be adept at interpreting whether others consider a storm to be a serious threat even if their tweets contain relatively neutral language.

#### **4.4 Discussion and conclusions**

Although past research on risk communication provides insights about the ways that individuals and groups obtain and comprehend warning information, there is a paucity of research on the role of public attention to extreme weather events. The broader theoretical and empirical literature on attention suggests that it is a process that involves aspects of exposure, noticing, and focusing—the latter of which involves an iterative process of information seeking and communication as people make sense of extreme events (Hoffman and Ocasio 2001; Neuman 1990; Newig 2004; Newig and Hesselmann 2004; Webster 2011). The rapid proliferation of the Internet in general and social media technologies in particular provides the opportunity to explore how people, both individually and as part of a collective, attend to extreme events and engage in sense-making activities in a digital social arena. Specifically, this research investigated how the activity of different actors influenced one another and how people make sense of extreme events on social media.

The results of this research suggest that weather professionals and enthusiasts are more likely than citizens to tweet about severe weather using regionally specific hashtags. These users also tend to tweet more frequently than those individuals who do not use hashtags and they also tend to have a larger follower base. Previous research has proposed that activity on social networking sites is a reliable indicator of public attention

to extreme events (e.g., Ripberger et al. 2014; Chew and Eysenbach 2010). The results of the present study, however, demonstrate that activity on social media can be indicative of professional attention, rather than public attention to extreme events. This is particularly true for tweets that contain weather-related hashtags that have come to be used within the professional meteorological community. Caution is therefore recommended before drawing conclusions about the relationship between increased activity on social media and the likelihood that citizens (rather than experts) are paying attention to an extreme event.

This is further underscored by the fact that weather professionals and enthusiasts tended to dominate the discussion before and during the 10 September 2016 storm event, and citizens tended to engage in the discussion during and after the event by re-tweeting information. This suggests that weather experts and enthusiasts act as “key stewards” during extreme events. As noted by Olsson et al. (2004, p. 85):

Key stewards are important in establishing functional links within and between organizational levels and therefore facilitating the flow of information and knowledge from multiple sources . . . Key stewards provide vision, skills, and leadership for team work in this process.

Indeed, the originators for 11 of the 15 most frequently re-tweeted tweets were either weather professionals (e.g., meteorologists and weather-related news media) or self-proclaimed weather enthusiasts. This further emphasizes the important role these individuals play as key actors during extreme events.

This is not to suggest, however, that citizens do not also engage in important sense-making activities during severe weather. On the contrary, this research underscores the

role of citizens in both re-tweeting information and providing personal observations of the storm. Re-tweeting is a crucial component of sense-making, as it allows information to propagate along social networks and it increases the number of times an individual can be exposed to the same tweet. Increasing the number of times that an individual is exposed to a message has been linked to increased trust and perceptions of veracity (see Sutton et al. 2014 for a discussion of serial transmission). Citizens provided the majority of tweets containing personal observations of the storm, including pictures and video of meteorological conditions and associated damage. This information is crucial, not just for other citizens who may decide to take protective action as a result, but also for forecasters and meteorologists. Weather professionals can use this information, both during the storm itself (i.e., allowing them to adjust their messaging) and after the storm (i.e., allowing them to assess the magnitude of an event, even if storm damage has already been cleaned up or repaired before storm damage surveyors can personally assess the scene).

The majority of tweets during the 10 September 2016 storm event provided situational information, including weather watches and warnings, personal observations of weather and its impacts, and meteorological information. This result is consistent with previous research on the use of Twitter during severe weather (Sutton et al. 2014). Interestingly, only a small number of tweets provided both official warning information and meteorological details about the storm. Instead, most tweets provided only warning type and location, leaving users to determine for themselves the severity of the storm and what, if any, appropriate actions to take. Although a sizable proportion of tweets did

recommend seeking shelter during the storm event, they did not provide insights about what type of shelter is appropriate or how long individuals should shelter in place.

A relatively small number of tweets actively sought information in the form of asking questions. This suggests that the majority of information seeking behaviour on Twitter is conducted by searching for and/or reading tweets, rather than through interactions with other users. This result was surprising, given the inherently interactive nature of social networking sites. An analysis of the most common re-tweets suggests that users seek out and value information about the severity, timing, and location of the impending storm—information that is useful when determining whether to take protective action, even when calls to action are absent in the tweets themselves.

Only a small portion of tweets contained clearly emotive language—whether positive (excitement) or negative (fear and disappointment). Emotional language is useful during sense-making, as it assists individuals when comparing their interpretation of an event with that of others. The majority of tweets during the 10 September 2016 storm contained relatively neutral language, suggesting that users may be highly adept at interpreting whether others consider a situation to be serious, even when clear emotional indicators are absent.

Taken together, this research emphasizes the usefulness of Twitter as a digital social platform for the facilitation of sense-making during extreme weather. This is due in large part to the highly adaptive, collaborative, and rapid nature of communication through this

medium. Key actors, such as weather experts and enthusiasts, provided their expertise and guidance during the storm event largely in the form of official warning information, expected meteorological conditions, and action recommendations. Citizens who engaged on Twitter did so by propagating information *via* re-tweeting and providing on-the-ground observations. As sense-making as seen to be a link between information and action, the results of this study highlight the usefulness of Twitter not only as a source of information, but also as a decision-support tool for professionals and citizens during extreme weather.

#### **4.5 Limitations and opportunities for future research**

One potential limitation of this research is the specific phrases that were used as search criteria—in this case, #onstorm and tornado. It is possible that the results may differ if alternative search criteria were used, for example if “lightning” was chosen instead of tornado. Another possible limitation lies in the fact that #onstorm was recently incorporated into the text of Environment Canada’s meteorological products, including severe weather watches and warnings. Although this hashtag was in use for several years before being picked up by Environment Canada, it is possible that an alternative weather-related hashtag may have yielded different results. Finally, the results of this research examine how citizens use social networking sites to engage in the process of information seeking, interpretation, and communication. Accordingly, the results of this research are limited to this demographic (i.e., individuals with the ability and knowledge to access and utilize the Internet and social networking sites) and are therefore not representative of all Canadians. Accordingly, it would be useful to gain a better understanding of how Twitter



users (particularly those who engage in weather-related discourse) compare to different sects of the Canadian public. It would also be useful to compare how users engage in sense-making across a variety of different search terms (e.g., hashtagged and non-hashtagged), locations (e.g., rural to urban, Canada to USA) and contexts (e.g., in areas where severe weather is common *versus* uncommon) over time. By adding cross-sectional and longitudinal components to future research, it may be possible to gain a better understanding of how citizens, both individually and collectively, pay attention to and make sense of severe weather events.

## CHAPTER FIVE

### **Manuscript #3:** A Conceptual Model of Public Attention to Environmental Hazards

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**Full citation:** Silver A. (submitted). A conceptual model of public attention to environmental hazards. Submitted to: *International Journal of Disaster Risk Reduction*.

Public attention has been the subject of both theoretical and empirical research for well over a century. Scholars from numerous disciplines have improved understanding of the ways that information, attention, and decision-making relate to and influence one another. However, the attentions literature remains surprisingly fragmented, with research remaining relatively confined to the disciplinary silos from whence it came. This is particularly true within the scope of environmental hazards. Although attention has been noted as being influential within the hazard-response cycle, it has received almost no consideration within the risk and hazards literature. This is surprising, as attention is noted for bridging the gap between information and action. It is prudent, therefore, to draw insights on public attention from other disciplines and bring them to bear on challenges pertaining to the human dimensions of environmental hazards. The first step must be to achieve a coherent understanding of what is public attention, and to distinguish it from related terms. Accordingly, this paper draws on theoretical and empirical insights from research across numerous disciplines in order to scope the concept of public attention within the context of environmental hazards. Next, theoretical insights from the existing literature on public attention were taken together with empirical insights gained from two original research projects, in order to develop a conceptual model of public attention that is presented here. This model highlights the process of attention creation from the initial point of exposure to the iterative process of information seeking and communication that occurs both individually and collectively. This paper concludes by suggesting opportunities for future research that may further improve scholarly understanding of public attention within the context of environmental hazards.

## 5.1 Introduction

Research on the human dimensions of environmental hazards began in earnest with the publication of Gilbert F. White's seminal geographical thesis *Human Adjustment to Floods* (1945). White challenged the prevailing belief that flood hazards are best controlled with engineered structures, such as dams and levees. He suggested instead that human behaviour influences the type and extent of losses incurred from disasters. In the decades since White's pioneering work, social scientists across a broad range of disciplines have made great progress in understanding the human dimensions of environmental hazards. Yet despite these advances, the social and economic losses incurred from disasters continue to rise for a variety of complex geophysical and socio-political reasons. To that end, researchers and practitioners today are faced with the same challenge as their predecessors: to effectively reduce the social, economic, and physical losses incurred from disasters.

Traditionally, social scientists have addressed this challenge through a variety of different lenses. Perhaps most influentially, research on risk perception has yielded insights on the role of socio-demographics (e.g., Silver and Andrey 2013; Olofsson and Rashid 2011; Gustafson 1998; Smith and Cartlidge 2011), culture (e.g., Gierlach et al. 2010; Douglas and Wildavsky 1983; Gregory et al. 1997; Kahan and Slovic 2006; Sjöberg 2000), previous disaster experience (e.g., Silver and Andrey 2014; Sharma and Patt 2012; Dillon et al. 2011; Murphy et al. 2005; Comstock and Mallonee 2005; Weinstein 1989), environmental stimuli (e.g., Lindell and Perry 2012; Burley et al. 2007), and communication (e.g., Sorensen and Sorensen 2007; Sorensen 2000; Mileti and Sorensen

1990; McComas 2006; Handmer 2000; Steelman and McCaffrey 2012; Schultz et al. 2011) on the response to environmental hazards (Vitek and Berta 1982; Slovic 1987; Wildavsky and Dake 1990; Gregory et al. 1997; Horlick-Jones et al. 2003; Sheridan 2007; Zhang et al. 2007; Silver and Conrad 2010; Burns and Slovic 2012; Eiser et al. 2012; Lindell and Perry 2012; Wachinger et al. 2013). This information has been applied in a variety of ways, including the improvement of warning communication (Mileti and Sorensen 1990; Morss et al. 2008; Murphy 1993; Hoekstra et al. 2011; Ripberger et al. 2015; Joslyn and Savelli 2010) and emergency management and response (Froese and Moreno 2014; Murphy et al. 2005; McEntire 2007; Henstra 2011; St. Denis et al. 2014). Yet despite the abundance of research put into practice on the topic, many individuals still fail to take adequate protective measures for high-impact events. This raises several important questions: is there a disconnect between the communication and interpretation of potential risks and recommended responses? What linkages exist between the communication of information and the decision to take action? Are there other lenses that may provide a fuller or complementary understanding of why and how individuals respond to potential threats?

This paper proposes that research on public attention has the potential to address these and other important questions about human behaviour when confronted with uncertainty. Public attention (i.e., the scrutiny or focus on an event/issue) is often noted within psychology and communications research for its importance in eliciting behavioural response, particularly in terms of risk communication (e.g, Hoffman and Ocasio 2001; Webster and Ksiazek 2012; Newig and Hesselmann 2004; Neuman 1990; Webster 2011;

Neuman et al. 2014). Yet despite the substantial influence that attention may have in motivating action, it has received almost no consideration within the risk and hazards literature. This is surprising, as attention is often understood to mediate the relationship between information and action (e.g., Newig 2004), and as such is of central importance for issues pertaining to risk communication and decision making.

Accordingly, this paper will critically examine the concept of public attention, and explore its role as an influential factor in behavioural modification during and after potentially hazardous events. First, literature on public attention within the scope of environmental hazards will be synthesized, and several promising trends in empirical research will be identified. Next, research beyond the scope of the hazards literature will be discussed, and several influential theories will be identified for their potential to guide empirical research on behavioural modification during disaster. Finally, the concept of attention will be framed within the scope of environmental hazards, and a conceptual model will be introduced to demonstrate how information, attention, and perception can intersect in ways that result in decision-making and, potentially, behavioural change.

### *5.1.2 Public attention within the risk and hazards literatures*

Although the related concepts of public perception, risk communication, and protective action decision-making have received substantial emphasis within the risk and hazards literature, public attention has received almost no consideration. This is unexpected, as public attention has been identified as an important variable in the hazard-response cycle. For example, Schipper & Pelling (2006) note that weather disasters catch both public and

political attention, and may act as catalysts for positive social change. In their research on weather salience, Stewart et al. (2012) found that people pay attention to the weather to the extent that it is perceptually salient—that is, people pay attention when the weather becomes noticeable to them. Similarly, Silver (2015) found that individuals typically do not pay attention to the weather unless it becomes inconvenient or threatening. Other researchers have found that hazards compete with other, more routine demands on attention (Lindell and Perry 2000) and that people are more likely to attend to environmental risks when they become personally relevant (e.g., Morss and Hayden 2010).

However, despite these empirical studies that have highlighted the importance of public attention in the hazard-response process, there is a paucity of theoretical and empirical research on this concept. Several notable exceptions include theoretical research conducted on the Protective Action Decision Model (Lindell and Perry, 2012) and empirical research conducted on public attention and social media (Ripberger et al. 2014; Chew and Eysenbach 2010; Chung 2011). The results of this research suggest that public attention is an important link between information and action, which Lindell and Perry (2012) refer to as “pre-decisional processes”. This research also underscores the fact that the Internet acts as an important social environment that may rapidly amplify public attention to risk. Lastly, these studies suggest that more direct measures of public attention (e.g., website traffic, activity on social media) may be better proxies for public attention than less direct measures (e.g., number of newspaper stories, number of minutes aired on radio).

Although these papers are notable for being among the first in the hazards literature to operationalize the measurement of public attention, there are several potential shortcomings of this research. Most importantly, the authors propose that Internet activity may be a reliable indicator of public attention—a conclusion that is premature for two reasons. Firstly, ‘the public’ is not a monolithic entity and there are many distinct subsets or groups that may obtain, interpret, and respond to risk communications in different ways. For example, the ratio between laypersons and weather experts on social media may vary dramatically during a hazardous event (e.g., Chatfield & Brajawidagda, 2014; Mendoza, Poblete, & Castillo, 2010; Palen, Starbird, Vieweg, & Hughes, 2010), such that, in some cases, activity on social networking sites may be less an indicator of “public” attention than “professional” attention to hazardous events (citation withheld for peer review). Secondly, the user base of social networking sites is not demographically representative of the general population. As such, drawing conclusions about public attention and behavioural response based on Internet activity is problematic.

### *5.1.3 A comment of “public” attention*

The majority of existing research on attention has focused on public attention (e.g., Webster 2011; Newig 2004), rather than “individual” attention. This is potentially problematic, as “the public” is not a monolithic entity. Rather, there are many distinct and/or overlapping groups that comprise the “general public” behemoth. These groups vary markedly in terms of personal wealth, education level, political power, geographical location, and so forth. Accordingly, these publics may have very different vulnerabilities,

priorities, capacities, opportunities, and constraints that facilitate and/or impede their actions during severe or hazardous weather. For example, non-English speaking immigrants may find it difficult to obtain official warning information, which is typically posted only in official languages (e.g., English and French for Canada). Similarly, individuals with poor financial credit and substantial household debt would find it difficult to afford hazards insurance and/or to adequately prepare for potential threats. Individuals below the poverty line may also be forced to live in structures or locations that are particularly vulnerable to severe weather, such as mobile homes (Schmidlin et al. 2009; Sutter and Simmons 2010) or in flood plains (Lindell and Hwang 2008; Moore et al. 2004). Taken together, this emphasizes the need to use caution when referring to “public” attention to severe weather, as the public consists of many groups that may obtain, interpret, and respond to extreme weather in distinct ways.

The issue of “public” attention raises another important question about scale: is public attention an aggregate of individual attention, or is attention synergistic at the social scale? Traditionally, research on attention has focused on the aggregate level (i.e., public attention), rather than the individual level. However, insights from social-ecological resilience thinking (e.g., Adger 2000; Adger et al., 2003) emphasize that, although individual processes “scale up”, the social or aggregate level is inherently more than the sum of its parts. This is due in large part to the communication and collaboration that occurs at the social scale, which contribute to learning and social memory (e.g., Olsson et al. 2004).



#### 5.1.4 A comment on “awareness”

As with attention, awareness has only occasionally been the subject of focused theoretical and empirical research within the hazards literature. However, even when awareness is the direct focus of research, it is rarely defined or conceptualized in a way that clearly differentiates it from similar concepts. As a result, some studies that explore awareness may actually provide insights on attention or perception instead. For example, in an early study on storm spotting and “public awareness”, Doswell III, Moller, & Brooks (1999, p. 544) note that:

The users of weather forecasting information must *hear* the forecasts, must *interpret* them in their own terms in order to make decisions, and must *know* what to do in order to achieve some desired result, if the forecasts are to be successful in having a positive societal impact.

However, research within psychology, organizational science, and communications studies have conceptualized attention as: the noticing and focusing of time and effort (Hoffman and Ocasio 2001); the selection and interpretation of one (or more) of a plethora of available stimuli to which people are exposed (Kentrige 2011; Webster 2011); and/or the use of information gained from the acts of noticing, selection, and interpretation (Kentrige 2011). As such, it would seem that Doswell III, Moller, & Brooks (1999) might have uncovered insights on the nature of attention, rather than awareness. Indeed, the results of the study suggest that improved communications technologies of the 1920s and 1930s, as well as the occurrence of the Tri-State tornado in 1925, “...initiated a trend toward public awareness that . . . encouraged preparation for potentially disastrous tornadoes that continues to this very day” (Doswell III et al. 1999, p. 545). Although this is potentially true, it would seem that the results of this research

shed light on the role of traditional media in exciting and focusing public attention that has been previously noted within the broader communications literature.

Other studies explore awareness in a more direct and coherent manner. For example, in their study on flood awareness in the United Kingdom, Burningham et al. (2008) note that flood risk awareness has three components: (1) awareness of living in an at-risk area; (2) awareness of flood warning systems and methods of dissemination; and (3) awareness of appropriate actions to take during a flood or flood warning. Recent research on microblogging during hazardous events provides similar insights on the nature of awareness. In this research, the authors provide a definition of situational awareness as “...an individually as well as socially cognitive state of understanding ‘the big picture’ during critical situations” (Vieweg et al. 2010, p. 1079). Earlier research on aviation psychology provided a similar definition of situational awareness as “All knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation” (Sarter and Woods 1991, p. 55). This definition aligns closely with the notion of conscious awareness, a concept related closely to perception and supported by laboratory research within cognitive psychology (e.g., Hsieh et al., 2011; Hsieh & Colas, 2012). Together, this research underscores awareness as a constantly adjusting state of inherent understanding that is affected by many factors, including experiences, biases, knowledge, communications, and external cues.

## **5.2 Public attention beyond the environmental hazards literature**

The concept of attention has been the subject of academic interest for well over 120 years. At the end of the 19<sup>th</sup> century, psychologist William James (1890:381) remarked that, “everyone knows what attention is”. Yet despite this bold assertion, there is still much discussion on the nature of attention. For example, is attention an outcome or a process? What distinguishes individual attention (micro-scale) from public attention (macro-scale)? Do mass media influence public attention, or is the direction of influence reversed? As these questions suggest, the precise nature and characteristics of attention are still uncertain despite an abundance of research on the topic.

One theory that is centrally relevant to the discussion on public attention is social cognitive theory, which has influenced thinking in psychology, education, and communication studies. At its core, social cognitive theory is an agentic perspective, which posits that individuals are self-reflective, purposeful, rational agents, rather than reactive organisms shaped by environmental stimuli (Bandura 2001a). According to social cognitive theory, cognitive factors partly determine which stimuli will be attended to, what meaning will be conferred to them, and what motivating power these stimuli will have. Thus, attention is one facet of cognition that determines what is selectively observed and what information is extracted for later use (Bandura 2001a).

Insights on social learning can also be gained from research on adaptive co-management of coupled social-ecological systems. Although this body of research tends to focus on longer-term challenges (rather than events with rapid onset and dissipation, such as severe weather), insights from this resilience thinking have the potential to inform

understanding of public attention to severe weather. Berkes (2007; 2009) addresses social learning at length, such as in his discussion of communities of practice (i.e., individuals who share common concerns and actively pursue knowledge through interaction) (Berkes, 2009). He emphasizes the importance of self organization, communication, and collaboration in responding to (and learning from) environmental uncertainty. Importantly, he also underscores the importance of bringing together official and unofficial knowledge for trust building and sense-making as a component of social learning.

The topic of official and unofficial knowledge raises additional questions, particularly as the topic relates to public attention and media consumption. In the earliest studies of mass communications, which emerged from propaganda research in the years following World War I, end-users were often conceptualized as passive receivers of information. However, as early as the 1950s, researchers have noted that "...the communicator's audience is not a passive recipient" (Davison, 1959 in Bauer, 1964). Yet it would be decades before for the idea of nonlinear media systems, whereby both communicator and audience influence the message, would come to dominate the field of communications studies (Bauer, 1964; Kasperson et al., 1988; Krinsky, 2007).

The agenda-setting model originally proposed by McCombs & Shaw (1972) relates to the notion of communication as a transactional process. Specifically, this model seeks to explain whether individuals or media suppliers are responsible for determining whether an issue gains prominence within the media environment. The original study found a

strong relationship between the likelihood that an audience will regard an issue as important and the frequency of its news coverage (McCombs & Shaw, 1972). Indeed, the influence of the media on public attention has been long acknowledged. As Cohen, (1963, p. 13) observed, “The press may not be successful much of the time in telling people what to think, but it [may be] stunningly successful in telling its readers what to think about”. However, if individuals are understood to be purposeful, rational agents, then it is also possible that the public attention to real-world issues may evolve independently of the media (Neuman, 1990). Accordingly, the attention-setting model has come to incorporate a more agentic perspective, with recent iterations acknowledging that users are capable of filtering, amplifying, and interpreting information flows (Neuman, 1990).

The issue of causality (i.e., whether media influences public attention, or the other way around) is further explored in Giddens’ (1984) theory of structuration, which highlights the importance of attention as a scarce or finite resource in a highly competitive media marketplace. There are three central tenets of this theory: (1) individuals are rational actors who choose media channels that best serve their needs and preferences; (2) the quantity of media that individuals can consume is finite, and therefore media consumption has an upper limit, and (3) users both reproduce and alter the media environment; thus, the media environment is jointly constructed—a concept Giddens (1984) called ‘duality’. As Webster (2011:48) explains, structurational theory posits that “...structure and agency are mutually constituted. Individuals rely on structures to exercise their agency and, in doing so, reproduce and alter those very structures”. Thus,

the theory of structuration conceptualizes public attention as both an outcome and a component of the interactive process between people and the media resources they access.

Insights gained from the agenda-setting theory and the theory of structuration have contributed to the development of the highly influential ‘issue-attention cycle’, a theory of public attention originally proposed by Downs (1972). The issue-attention cycle theorizes that public attention to environmental issues experiences cycles of increased and decreased attention over long time scales. The central components of the issue-attention cycle are as follows: (1) attention is a scarce resource for which issues must compete for time and space within public areas (e.g., the press, academic journals); (2) each arena has a carrying capacity, which limits the number of issues that can gain prominence at any one time; (3) individuals select which issues to pay attention to and which to ignore; (4) public attention requires a component of communication and interaction, otherwise it is merely individual attention; and (5) in order for an issue to gain traction within the public area, operatives (i.e., individuals who are intimately familiar with the issue at hand, whether scientific experts or affected laypersons) must share their knowledge with the public (Newig 2004; Hilgartner and Bosk 1988; Hoffman and Ocasio 2001; Downs 1972). The issue-attention cycle suggests that most issues remain unattended by the general public, as public attention is a scarce resource for which competition is intense. In order for an issue to achieve traction, it must exceed some threshold of public attention (Neuman, 1990). Once an issue has gained “critical mass” (Newig 2004), it will undergo a process of heightening public attention, followed

by a saturation/boredom effect, and an eventual decline of attention (Hilgartner & Bosk, 1988; Neuman, 1990).

Despite the influence of the issue-attention cycle, there are several notable limitations of this theory. First, the issue-attention cycle examines the rise and fall of public attention to issues that occur over time periods on the order of weeks to decades. There is little capacity within the model to examine short-notice events, such as high impact weather. Second, the issue-attention cycle focuses exclusively on public attention (i.e., the aggregate level), while excluding individual-level attentional processes. According to Webster (2011, p. 44) individual attention has “little social significance” whereas public attention “...is a more potent, and potentially, tractable manifestation of attention”. While attention at the macro-level or aggregate scale is clearly important, individual attention is also of particular importance for researchers interested in individual perceptions and behaviours. This is particularly true given the contemporary communications landscape, where citizens can become powerful “news makers” that create and disseminate content independently of traditional news media. Third, the issue-attention cycle is largely an explanatory rather than a predictive model, and as such cannot predict why some events achieve critical mass and gain traction while others do not (Hoffman and Ocasio 2001).

Deductive research informed by these theories has contributed to the proposal of various definitions of attention (Table 5.1). Although these definitions are markedly different, they do highlight some potential characteristics of attention. Most notably, attention is most commonly conceptualized as a process, rather than an outcome. For example,

Source	Discipline	Definition
Newig and Hesselmann (2004:2)  Newig (2004: 153)	Resource management	The resources (time and other) that people dedicate towards an issue and often signifies considerable political pressure. Regarded over time, attention can be conceived as an intensity (resource employment per time unit).
Hoffman and Ocasio (2001:415)	Organizational science	The noticing and focusing of time and effort on both the environmental stimuli requiring action and the available repertoire or responses which define that action (Osacio 1997)
James (1890: 403-4)	Psychology	Processing one out of what seem several simultaneously possible objects or trains of thought . . . It implies withdrawal from some times in order to deal effectively with others.
Kentridge (2011:229)	Psychology	A process that selects a subset of what is already conscious.
Kentridge (2011:230)	Psychology	The use of information to facilitate the execution of a task to which many stimuli might potentially provide the solution.
Webster (2011:45)	Communications	Public attention is the extent to which multiple individuals (i.e., agents) are exposed to cultural products across space and/or time . . . At the heart of the construct is the notion of aggregation through space and time. Public attention is realized across space when many disparate individuals attend to some media offering.
Neuman et al. (2014: 199)	Communications	The “buzz” concerning a policy issue.

**Table 5.1:** Select definitions of attention.



attention has been described as: the *noticing and focusing* of time and effort (Hoffman and Ocasio 2001); the *selection and interpretation* of one (or more) of a plethora of available stimuli to which people are exposed (Kentrige 2011; Webster 2011); and/or the *use of information* gained from the acts of noticing, selection, and interpretation (Kentrige 2011). Accordingly, attention may be understood as the resource(s) dedicated towards an issue or problem, which can be expressed in terms of resource employment per time unit (Newig 2004; Newig and Hesselmann 2004). Put more simply, attention can be conceptualized as an intensity or ‘buzz’ (Neuman et al., 2014) surrounding a particular issue or event.

Drawing on and synthesizing the insights gained from this diverse body of theoretical and empirical literature, attention can be broadly understood as having the following characteristics: (1) attention is a finite resource for which a broad range of potential issues and events must compete; (2) attention is a process, which involves elements of exposure, noticing, selection, and focusing; (3) attention can be directed towards certain stimuli and away from others; (4) attention can occur from the individual-level (micro-scale) to the global scale (macro-level); (5) public attention is cyclical, with environmental issues experiencing periods of increased and decreased attention over time; (6) public attention may influence media coverage of issues and events, which in turn may influence public attention (reciprocal causality); and (7) attention can lead to action.

### **5.3 Measuring public attention**

As public attention has been the subject of focused theoretical discussion, so too has it been the subject of a large volume of empirical research across a broad range of disciplines. However, the conclusions drawn from this wealth of data are largely influenced by how attention is initially defined and subsequently measured. As attention remains both under-theorized and lacking in operationalization, the resultant literature has unsurprisingly yielded many inconsistent findings. This raises questions regarding study design and the measurement of attention. For example, how is public attention most often measured, and what are the strengths and weaknesses of these approaches? Is the overall goal to measure, evaluate, or to establish relationships between different variables of interest? Accordingly, what follows is a discussion of the most commonly utilized methods for assessing public attention, with an emphasis placed on empirical results from risk communication research.

Traditional media has been used to explore the concept of public attention in a variety of ways. Media analysis can be as simple as assessing the coverage of one event or issue in one newspaper, or as complex as assessing the coverage of multiple disparate events or issues in numerous print sources over a long periods of time. The strengths of this type of analysis are readily apparent. First, newspapers provide a historical archive of the coverage of events and issues, which allows for the investigation of a broad range of topics at virtually any time scale of interest. Many newspaper archives are also available electronically, which can reduce the time and effort spent searching for and retrieving relevant content (Roche 2004). Media content analysis may also provide insights that are

less biased than those gained through interviews and focus groups, as it provides data on actual coverage, rather than perceived coverage, of events and issues (Newig 2004).

The goal of many media studies is to quantify the coverage of an event or issue, as expressed through the number of stories published in print media or the minutes of coverage on television, and to use this volume as a proxy for or an indicator of public attention. As noted by one researcher, assuming that "...in today's democracies the mass media constitute by far the most important vehicle for shared attention and political communication, media coverage, then, should best reflect public attention" (Newig 2004, p. 159). Indeed, numerous studies have cited this widely held assumption as justification for their methods and support for their conclusions (e.g., Chew & Eysenback, 2010; Newig & Hesselmann, 2004; Ripberger, Jenkins-Smith, Silva, Carlson, & Henderson, 2014). However, this fundamental assumption is worthy of fuller consideration, for how can scholars be certain that volume of media coverage is reflective of "actual" public attention, however that is defined? Research on traditional media suggests that media is a free market enterprise comprised of rational actors (e.g., editors, journalists) whose primary motivation is the optimization of print sales. Accordingly, the coverage of events and issues in a democratic society is driven by public consumption (and is therefore reflective of attention), rather than a media agenda (e.g., Newig & Hesselmann, 2004; Newig, 2004). However, other scholars have rightly noted that media institutions have their own political, economic, social, and organizational interests and ideals, and they are motivated to manage consumption to meet those ends (e.g., Hilgartner & Bosk, 1988; Neuman et al., 2014; Webster, 2011). Additionally, the proliferation of new information

and communications technologies has revolutionized the communications landscape. Now, coverage of events and issues is often dominated by citizens who create and disseminate news stories prior to coverage by traditional news media. Indeed, it is often the case that media outlets turn to citizen-generated content in order to facilitate the development of their news products.

So how then can researchers assess the validity of media coverage as a reliable proxy for public attention? One way is to develop a comparative framework, whereby topics are selected from lists of issues pre-identified by the public as being relevant or important, and then media coverage for those topics is examined. For example, Neuman (1990) selected 10 issues drawn from a Gallup Poll that asked citizens to identify the most important problems facing the country, and examined corresponding media coverage from the New York Times Index (newspaper coverage), the Reader's Guide to Periodical Literature (magazine coverage), and the Vanderbilt Television News Archive Index (television coverage). This research highlighted the fact that media coverage and public attention often covary closely, but other times they do not. For example, some issues receive high levels of public attention and relatively low levels of media coverage (e.g., inflation, unemployment), whereas other issues receive little public attention but high levels of media coverage (e.g., Watergate) (Neuman 1990). Similarly, Neuman et al. (2014) chose 29 political issues from the American National Election Studies survey, in which members of the public were asked to identify all of the important issues facing the country. For each issue, key identifying phrases were developed and used to search both traditional and contemporary media sources (e.g., Twitter, blogs, print newspaper).

Other studies have similarly explored the differences between direct (i.e., as indicated by or measured from the public) and indirect (i.e., as measured from media coverage) metrics of public attention. For example, Webster & Ksiazek, (2012) tracked individual media consumption across television and Internet sources using meters installed on television sets and personal computers. The results of this audience-centric approach found that attendance to issues and events is a highly social process that can occur across media platforms. Social media in particular was identified by the authors as a virtual space that may facilitate and expand communications about issues or events that the public finds noteworthy (Webster and Ksiazek 2012).

The use of social media for longitudinal text mining and analysis is an emerging and promising method for understanding how people obtain, interpret, and disseminate information, with the bulk of academic research on the topic being published within the last five years. This is unsurprising, given that the Internet has only evolved over the last several decades to facilitate interaction and collaboration between the creators and users of content (Kaplan and Haenlein 2010), and social networking sites, such as Twitter and Facebook, are a recent outcome of this evolution. There are numerous benefits associated with the use of text mining through social media. Most notably, social networking sites provide a nearly continuous stream of data that allows for rapid, convenient, and inexpensive longitudinal analysis of issues and events (Chew and Eysenbach 2010; Vieweg et al. 2010). A second benefit is that social networking sites provide both direct and indirect measures of public attention, as many different publics (e.g., laypersons, journalists, media outlets, academics, professionals) can access and utilize social media to

communicate about issues and events. As noted by Ripberger et al. (2015:521) in their study on social media and severe weather:

The logic underlying such measures is rather simple—the more people talk about a particular issue, topic, or hazard (via Twitter, Facebook, Google+ and other social media sites), the more likely it is that they are paying attention to it. Thus, increased discussion of an issue, topic, or hazard is thought to indicate increased attention.

However, there are also several notable challenges associated with this use of social media data. Firstly, although it is true that social networking sites may provide a more direct metric for public attention, this is reliant on understanding who, precisely, is doing the communicating. Within the realm of severe weather research for example there is often an important distinction made between members of the general public (i.e., laypersons) and weather-related experts and professionals (e.g., meteorologists, newscasters, storm chasers). Researchers are particularly interested in understanding how members of the general public obtain, interpret, and respond to warning information during high-risk weather. However, previous research has demonstrated that a sizable portion of activity on social media may be from professionals rather than laypersons—a ratio that is influenced by the type of social networking site, as well as the timing, type, and magnitude of event. For example, in their research on the February 2010 Chilean earthquake, Mendoza et al. (2010) found that 11 of the 20 most active users corresponded to mass media organizations or celebrities related to mass media. Another study on the May 2013 Moore, Oklahoma tornado found that private citizens accounted for only 50% of users (Chatfield and Brajawidagda 2014). Similarly, in their Twitter-based study on the 2009 Red River Flood, Palen et al (2010) found that tweets were contributed by a variety of different account types, including individuals, traditional media outlets, service

providers, flood-specific services, and small business promoters, among others. In an analysis of the #cdnpoli political hashtag, Small (2011) found that individuals accounted for only 31% of the sample, while bloggers (23%), media (10%), and political blog aggregators (26%) accounted for a substantially higher portion of contributors. Accordingly, it is spurious to automatically equate volume of activity on social networking sites to “public” attention without first clearly defining the study population, as many different actors make use of these services.

Secondly, the lack of verifiable socio-demographic information about Twitter users further contributes to the lack of a well defined study population. Descriptive meta-data (e.g., location, occupation, gender, age) is generated by users and therefore ranges substantially in terms of accuracy and completeness. For example, a user’s self-reported location may be highly specific (e.g., geographic coordinates or a street address), generic (e.g., North America or Planet Earth), fictitious (e.g., ‘Dimension X’), or missing altogether. The challenges associated with the lack of a clearly defined study population are further exacerbated by the fact that a sample population of interest (e.g., all users of a particular hashtag) may not be representative of the social networking site, and the userbase of social networking sites is likely not representative of the general public (Chew and Eysenbach 2010; Neuman et al. 2014).

A third challenge associated with the use of social media data for text mining and analysis is that patterns of activity vary over time. Given that social media platforms, such as Twitter and Facebook, are web-based and mobile services, their usage is largely

influenced by technological access. Accordingly, many social networking sites demonstrate patterns in activity that are reflective of access, rather than public attention to a particular event or issue. For example, in their research on agenda-setting, Neuman et al. (2014) noted that activity across different media channels tends to exhibit a weekly cycle, with activity predictably lower on the weekends than on week days. Accordingly, the authors note that it is important to normalize social media data to correct for day-of-week activity fluctuations, which may otherwise suggest a potentially erroneous correlation between study variables (Neuman et al. 2014).

This is not to suggest that the challenges of social media text mining and analysis outweigh the potential benefits. On the contrary, a carefully designed study can account for many of the challenges identified above. Even when ambiguity cannot be fully controlled (e.g., in the case of missing or erroneous metadata), social media data can still provide meaningful insights on the social norms, processes, and cultures that have developed on various social networking sites—findings that are increasingly relevant as the number of social media users around the globe continue to climb into the billions.

#### **5.4.1 Moving towards a comprehensive definition of attention**

Existing research on attention within the broader hazards literature underscores two critical points: (1) attention is an important variable in the hazard-response cycle that may influence how individuals obtain, interpret, and respond to warning information and environmental and social cues, and (2) attention is under-theorized and often conflated with similar concepts, thus contributing to a literature that is not as clear or consistent as



might be desired. To focus and guide any future discussions on attention as it relates to the field of hazards research, it is therefore necessary to first clearly articulate what attention is, and to differentiate attention from other similar concepts. Thus, drawing on and synthesizing the existing body of theoretical and empirical research outlined above, the following definition of attention is proposed:

Attention is the process of noticing, selecting, and focusing on one or more external stimuli (e.g., hazardous event or event-related information) to which people are exposed.

#### *5.4.2 Conceptual model of attention*

As discussed previously, although public attention is often noted with the risk and hazards literature for its relevance, the majority of existing research has focused on risk perception. This literature has provided highly valuable insights into the nature of the warning-response process. However, if theoretical insights from psychology and organizational science are found to extend to the context of hazards, attention may well be as influential as perception in motivating protective action. As such, additional research is needed within the scope of the hazards literature to assess the linkages between attention and decision-making across a broad range of event lead-times, from high risk short-notice events to longer term preparedness and planning decisions. The relationship between mass media, attention, perception, and decision-making is one area that would particularly benefit from theory-driven research, as the empirical findings are not as consistent or comprehensive as might be desired.

To that end, two research projects were recently conducted to examine the relationship between these variables. The first project investigated the use of Facebook and Facebook

groups following a significant disaster in southern Ontario in August 2011 (citation withheld for peer review). This project utilized semi-structured interviews and a computer-assisted content analysis of the *Goderich Ontario Tornado Victims and Support* (GOTVS) Facebook group to investigate: (1) how individuals attended to information during the response and recovery phases, (2) how people, both individually and as part of a collective, engaged in sense-making through social media; and (3) how information provided on the Facebook groups contributed to decision-making. The results of this research underscored the usefulness of Facebook for a platform for information seeking, communication, and decision-making. The main findings of this research include:

- (1) Individuals turned to Facebook to address the dearth of information in the immediate aftermath of disaster. Information seeking was done as a coping strategy for citizens faced with uncertainty during the response and recovery phases.
- (2) Public attention to the event was highest within the first two weeks, and then sharply declined. Accordingly, the window for effective public engagement through social media by elected officials and emergency managers may be narrow.
- (3) The GOTVS Facebook group acted as a digital social environment that facilitated information seeking and communication, an iterative process commonly referred to as sense-making (e.g., Dervin, 1983; Weick, 1988). The results of this study suggest that this process is a highly influential component of attention creation.

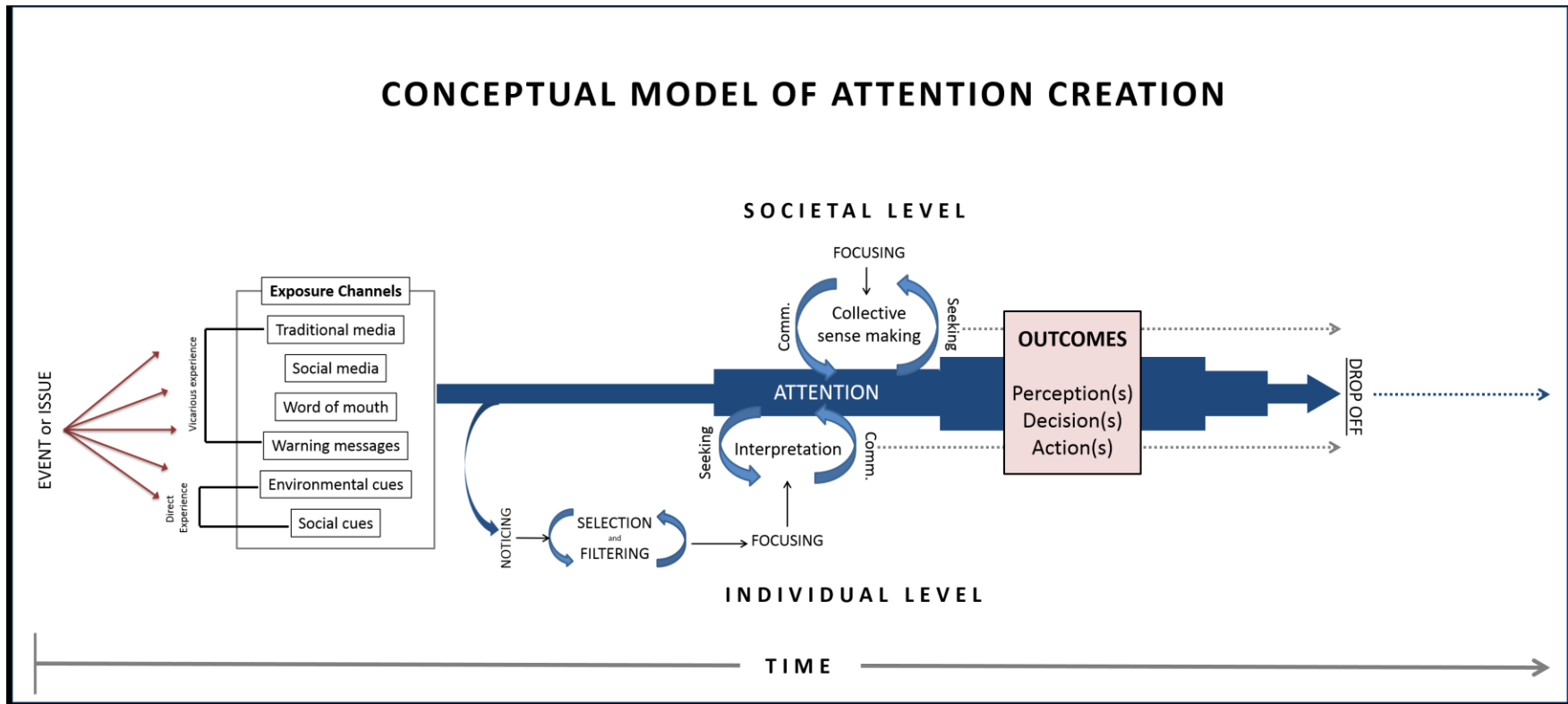
- (4) An example of this sense-making process can be found in the ways that group members confronted misinformation and gossip. Although misinformation occurred, it was the tendency of group members to self-moderate this information, and to rely on key stewards in the community for guidance in interpreting information as false or factual (see also: Olsson et al. 2004, Weick 1995).

The second research project also examined how individuals utilized social media when confronted with environmental uncertainty. This project examined the use of Twitter during a tornado-warned event that occurred in southern Ontario, Canada in September 2016 (citation withheld for peer review). The primary goal of this research was to examine the process of sense-making within a digital social environment. More specifically, this research investigated (1) how the activity of different actors compared to and influenced one another, and (2) how individuals and groups made sense of the event. As with the first project, this research emphasized that social media provides a critical platform for information seeking and communication, and contributes to the collective process of sense-making. Key insights from this research include:

- (1) Weather professionals (e.g., meteorologists, forecasters, and weather media outlets) and enthusiasts (e.g., storm chasers, storm spotters) are more likely to tweet using location-specific weather hashtags (e.g., #onstorm, #nsstorm, #ILwx) than non-professionals. These users also tend to tweet more often during a severe storm event, and they also tend to have a much larger follower base.

- (2) Weather professionals and enthusiasts also dominated discussion before and during the event. Activity from citizens lagged behind that of experts, with citizens engaging in conversation towards the end of the storm event. Accordingly, weather professionals and enthusiasts acted as key stewards, who guided discussion during the severe storm.
- (3) It may not be appropriate to draw broad conclusions about activity on Twitter as an indicator of “public” attention, as experts dominated the discussion during the event. This is important, as previous research has suggested that increased activity on social media may be an indicator of public attention, and as such may be associated with an increased likelihood of citizens taking protective action (e.g., Ripberger et al. 2014).
- (4) Lastly, users seek out and value information about the severity, timing, and location of the impending storm, information that is useful when determining what, if any, actions to take.

When these empirical results are taken together with the theoretical discussion of public attention provided above, it was possible to develop a comprehensive conceptual model of public attention to severe weather (Figure 5.1). This conceptual model begins at the point of exposure to an event, which can happen before the event itself occurs. For instance, in the case of severe and hazardous weather, weather advisories are often posted well in advance of the development of a storm. Individuals can be exposed to the risk event either directly (e.g., personally experiencing environmental cues or by observing others’ behaviours) or vicariously (e.g., mass media, word of mouth). Vicarious channels



**Figure 5.1:** A conceptual diagram of process of attention creation during an extreme event.

are notable because they filter, interpret, and present issues/events for their audience (e.g., Kaspersen et al. 1988). As such, vicarious channels have the opportunity to “spin” stories either positively or negatively. Regardless of whether the event is experienced directly or indirectly at the initial point of contact, there is a point when it gains traction and stands out from other issues/events. It is at this point of “critical mass” (Newig 2004) that the event becomes noticed and people, both individually and collectively, seek information, interpret that information, and (potentially) communicate about the event, a process referred to as sense-making (see Weick, 1998, 2010; Dervin, 1998,1983; Lee 1999). It is important to note, however, that interpretation/sense-making are not synonymous with comprehension. An individual or group can dutifully attend to an event or issue without fully comprehending information they receive (and, in fact, they may *miscomprehend* it). Accordingly, the process of attending to and making sense of an event or issue has several potential outcomes:

1. **Perception(s):** As a result of the information received and interpreted (i.e., environmental and social cues; official watch/warning information) during an event, existing perceptions are either strengthened, eroded, or changed altogether. New perceptions are formed based on the interpretation and/or collective sense-making that occurs during the event itself. Perception of an event/issue will influence how individuals pay attention to and make sense of future events.
2. **Decision(s):** As a result of this process, an individual or group will make some type of decision—even if that decision is to cease attending to the event and to avoid taking action. This decision may not be a conscious one, for example in the

case of another event or issue competing for and winning an individual's attention. However, perception(s) and/or decision(s) can lead to:

3. **Action(s):** As a result of individual interpretation and/or collective sense-making, people may choose to take action—even if their interpretation of an event/issue is discordant with “professional” interpretations. These actions can include protective behaviours (e.g., seeking shelter), information seeking behaviours (e.g., verifying or confirming information received) or potentially harmful behaviours (e.g., driving through flooded roads), among others. Importantly, these actions can serve to vicariously influence the behaviour of others who observe both the action and its consequence (Bandura 2001b). In other words, an individual's actions may cause others to adopt similar behaviours (in the event the action had favorable results) or different behaviours (in the event the action had negative results). It is important to note that not all decisions will result in the intended action. The suite of available actions available to an individual may be more or less limited by internal or external constraints.

This entire process of attention creation occurs across varying time-space scales, and even after “public attention” has dropped off, the event may still be attended to by some individuals.

Although the original research summarized above has provided preliminary empirical support for this conceptual model, there are still several aspects that require additional focus. For example, the point at which an event/issue gains traction or “critical mass” is still poorly understood across the theoretical literature on attention. What, exactly, causes

one event/issue to become the focus of individual and public attention, a finite resource for which there is fierce competition? The fact that some individuals attend to warning information and environmental cues while others do not is an ongoing topic of interest within the hazards literature. Accordingly, additional research into the factors that increase the likelihood of an event/issue gaining “critical mass” stands to improve scholarly understanding of public attention, both within and outside of the hazards literature.

## **5.5 Conclusions**

Attention has been the subject of both theoretical and empirical research across a broad range of disciplines for well over a century. During this time, researchers have contributed to a literature that explores the influence of attention from the individual or micro-scale to the societal or macro-scale. The insights from this research have contributed to scholarly understanding of issue-attention cycles and agenda-setting theories that have greatly improved understanding of the process of attention. However, despite the advances in theoretical and empirical research, the literature on public attention remains surprisingly fragmented and/or under-theorized, particularly within the scope of risk and hazards research. The few hazard-related studies that have addressed attention directly have underscored its role in the warning-response cycle, and called for improved theoretical integration within the hazards literature. To do so, it is first necessary to achieve a clear and comprehensive understanding of attention, and to distinguish it from related terms. Accordingly, this paper draws on theoretical and empirical insights from research across numerous disciplines to present a comprehensive



definition of public attention. This definition was then operationalized, and a conceptual diagram of public attention to environmental hazards is proposed. Scholarly understanding of public attention to environmental hazards would greatly benefit from additional research spanning across a broad range of event lead-times, from high risk short-notice disasters to longer term preparedness and planning decisions.

## **CHAPTER SIX**

### **DISSERTATION SUMMARY AND CONCLUSIONS**

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This chapter begins with a summary of the significant findings of this thesis, followed by a discussion of how Facebook (Chapter 3) and Twitter (Chapter 4) act as digital environments for information seeking and communication, key components of the collective and iterative process of sense-making—one of the most important and influential aspects of public attention. The implications of this research for scholarly understanding of public attention to environmental hazards are also discussed, and future research directions are suggested.

#### **6.1 Study Synopsis**

Within the scope of environmental hazards, a significant portion of research has focused on the factors that influence whether and how individuals and groups will take protective action. This literature is dominated by social science research on the related concepts of risk perception, risk communication, and decision-making. Much of this research focuses on: (1) whether and how warnings are received; (2) how these warnings are perceived and comprehended; and (3) how warning messages influence protective action decision-making. Accordingly, risk perception has become the dominant lens through which much of the existing literature examines human behaviour when confronted with environmental uncertainty.

However, a growing number of studies have underscored the importance of public attention to environmental hazards, and have identified its potential role linking information and action (e.g., Lindell and Perry 2012; Ripberger et al. 2014; Chew and Eysenbach 2010; Schipper and Pelling 2006; Silver 2015; Chung 2011). Despite this, there remains a paucity of theoretical and empirical literature that explicitly explores the role that public attention plays in the warning-response process. The three manuscripts presented in this dissertation address this gap, and explore the role of public attention from the initial exposure of information, through to information seeking and communication and, ultimately, decision-making. The objectives of this thesis were achieved using a mixed methods approach, which included: (1) thematic analysis of semi-structured interviews; (2) computer assisted content analysis of Facebook posts and tweets; (3) a lemmatization process that investigated how the occurrence of key words and phrases changed over time; (4) manual coding and content analysis of digital content; and (5) a thorough review and synthesis of the existing theoretical and empirical literature on public attention. The main findings of each of the three manuscripts are summarized below.

## **6.2 The usage of Facebook following a significant disaster (Manuscript 1)**

On August 21, 2011 an F3 tornado devastated the small rural community of Goderich, Ontario. Within only 12 hours of the tornado's impact, a Facebook group named *Goderich Ontario Tornado Victims and Support* (GOTVS) was created and had thousands of followers. The information exchange that occurred on this Facebook group provided the opportunity to explore how people, both individually and as part of a

collective, sought and shared information in an effort to confront the uncertainty that pervaded the community in the immediate aftermath of the disaster.

Firstly, the results of this research demonstrate that Facebook was a highly influential and popular communications medium for residents and non-residents alike. Members utilized this digital space to ask questions about response and recovery; to provide information, personal anecdotes, and support; and to organize donations and volunteer efforts.

Although the GOTVS Facebook group is still active, the greatest amount of information seeking and sharing occurred within two weeks of the disaster, after which group activity sharply declined. This suggests that the window for effective community engagement through social media by public officials, first responders, and emergency managers is narrow, and that these individuals must have social media plan in place in order to quickly engage with the public during the critical response phase.

Secondly, the difficulty in evaluating the veracity and credibility of user-generated content disseminated through social media has been an issue of concern identified within the risk and crisis communications literatures (e.g., see Jefferson 2006; Kaplan and Haenlein 2010; Hyvärinen and Saltikoff 2010). However, this study found that although misinformation and gossip were common, group members tended to self-moderate content in a process that has been termed “collective error correction” (Sutton et al. 2008). This collaborative and iterative process of sense-making relied on prominent members of the community to act as key stewards in the interpretation and personalization of information. Insights from the semi-structured interview also

suggested that engagement by public officials may further reduce misinformation and uncertainty, and encourage public confidence.

Lastly, it was found that the interactive nature of Facebook allowed for the rapid self-organization of relief aid and volunteers in the days and weeks following the disaster. Many group members commented on the fact that Facebook allowed them to connect with their follow community members without having to wait for official channels, such as town hall meetings. The GOTVS Facebook group also provided a virtual environment for people to share personal stories and to connect with their community. This was particularly therapeutic for those individuals who were left bereft by the physical impact of the tornado in their community.

### **6.3 Sense-making on social media during extreme weather (Manuscript 2)**

This study investigated the discussion that occurred on Twitter as a result of the 10 September 2016 storm that impacted southern Ontario, Canada. The goal of this research was to explore how people engaged in sense-making activities on Twitter, and to understand how this collaborative process influenced decision-making. The results of this study found that weather experts and enthusiasts (e.g., meteorologists, weather-related news media, and storm chasers/spotters) dominated and guided discourse before and during the storm event, and that citizens picked up and continued the conversation by re-tweeting information shortly thereafter. Accordingly, Twitter facilitated and empowered the collaborative process of sense-making during this storm.

In terms of sense-making, the vast majority of tweets during this event provided situational updates in the form of severe weather watches and warnings; meteorological details about the storm; personal observation of weather conditions and damages; and calls to action. Interestingly, the majority of tweets that provided warning type and location did not provide details about the severity of the storm or what, if any, protective actions to take. In comparison to tweets providing situational updates, only a tiny portion of tweets actively sought information in the form of asking questions. This suggests that a large portion of information seeking through Twitter is done by searching for and/or reading tweets, rather than through interaction with others. This finding contrasts with the first manuscript presented in this dissertation, which demonstrated that Facebook acted as a platform for active information seeking as well as information sharing. It is possible that this discrepancy is owing to the different format of these two social networking sites: Facebook allows users to create posts and comments with over 50,000 characters while Twitter only allows users to post tweets of 140 characters.

Lastly, previous research has suggested that activity on social media is a reliable indicator of public attention to extreme events (Ripberger et al. 2014; Chew and Eysenbach 2010). This is significant, as the conclusions of this research draw linkages between public attention (as indicated by increased activity on social media) with the increased likelihood of laypersons taking protective action during severe weather. The results of the present study suggest, however, that activity on social media can be indicative of professional attention, rather than” public” attention. Caution is therefore recommended

before making assumptions about the relationship between increased activity on social media and the likelihood of citizens taking protective actions.

#### **6.4 Public attention to environmental hazards (Manuscript 3)**

The third manuscript in the dissertation conducted an in-depth review of the theoretical and empirical research on attention, both within and beyond the hazards literature.

Although attention has been identified as an influential variable for decision-making in numerous disciplines, including psychology, organizational science, information science, and communications research, the existing literature is surprisingly fragmented. Thus, the goal of the third manuscript was to draw on and synthesize the existing literature in order to provide a concise definition of attention. The characteristics of attention that were repeatedly emphasized in the literature were the *noticing and focusing* of time and effort (Hoffman and Ocasio 2001); the *selection and interpretation* of one (or more) of a plethora of available stimuli to which people are exposed (Kentridge 2011; Webster 2011); and/or the *use of information* gained from the acts of noticing, selection, and interpretation (Kentridge 2011). Accordingly, the following definition of attention was proposed:

Attention is the process of noticing, selecting, and focusing on one or more external stimuli (e.g., hazardous event or event-related information) to which people are exposed.

When this review of the existing literature on attention was coupled with the empirical work undertaken for this dissertation, it was possible to develop a conceptual diagram that outlined how attention is created, both individually and collectively, across space-time (Figure 5.1). Perhaps most importantly, individuals are exposed to many events and

issues that compete for their finite attention resources. It is only once an event or issue reaches “critical mass” that it is noticed and the iterative process of selection (and filtering) and focusing (seeking, sharing, and interpreting information) can occur. As individuals engage in the iterative process of information seeking and (potentially) communicating about an event, they inherently begin to personalize, confirm, and interpret the information that they receive. Shortly thereafter, this interpretation begins to occur at the societal-level (commonly referred to as “sense-making” (Dervin, 1983; Weick 1988). As a result of this iterative collaborative process, groups come to a consensus on what, if any, actions are appropriate to take. However, this does not mean that individuals will take those actions. Public attention will only result in action when individuals: (1) interpret the threat as serious; (2) identify one or more potential actions aimed at reducing the risk; (3) have an appropriate sense of self-efficacy and response efficacy; and (4) have no constraints on the ability to carry through with the desired action(s).

## **6.5 Opportunities for future research**

Within the risk and hazards literature, research on public attention is in its infancy. Although numerous studies have identified the potentially important relationship between public attention and action, very few studies explicitly focus on either theoretical or empirical aspects of attention. Accordingly, the opportunities for research on public attention to environmental hazards are vast, and will certainly provide a richer understanding of human behaviour when confronted with environmental uncertainty. Several avenues of future research are suggested below:



1. Social media represents a major technological and ideological shift for the communication of risk and crisis information. Perhaps most notably for the study of public attention, social media is an interactive, collaborative social environment through which individuals can attend to, make sense of, and respond to information about extreme weather. This dissertation examined the ways that Facebook and Twitter are utilized by people during two tornado events that occurred in southern Ontario. However, despite the similarities these two platforms have in common, there were several notable discrepancies in the findings between these two studies. Perhaps most notably, many members of the GOTVS Facebook group actively sought information by asking questions and seeking clarification of information posted to the group. However, only a tiny percentage of Twitter users asked questions during the study period. This discrepancy may be due to:

1. Inherent differences in the structure of information between the two platforms (i.e., message length and allowable inclusions). Similarly, it may be possible that the “inclusive” nature of the Facebook group encouraged members to engage with other one another.
2. Differences in the events themselves. The Facebook study took place after a significant disaster, when uncertainty and emotions were running high. Although an EF0 tornado did occur during the study period for the Twitter manuscript, no damage or injuries were reported.

Accordingly, additional research on how and why individuals actively seek information on social media would provide important clarification on this topic.

2. Both empirical manuscripts in this dissertation underscored the important influence of “key stewards”, who guided discussion and provided critical insights for other users. Although other studies have similarly identified the important role these stewards play in sense-making (e.g, see Olsson et al. 2004), very few studies fully unpack the role that key individuals play in the entire warning-response process. Future research would benefit from a deeper investigation of how individuals take up the role of key stewards, what type of information these individuals share, and how they interact with and influence other citizens.
3. Both the broader theoretical and empirical literature on public attention, as well as the two empirical manuscripts in this dissertation, identify the importance of the moment that an event/issue gains “traction” or “critical mass” and individuals begin the process of selection/filtering and focusing that will ultimately lead to actions taken or not taken. However, very little is understood about how, exactly, an event/issue gains traction and stands out from the multitude of other events, issues, and information competing for individuals’ finite attention resources. The literature on public attention would benefit greatly from in-depth, qualitative studies that explore this critical moment in the process of attention creation.
4. Lastly, the study on the use of Facebook and Facebook groups in the aftermath of the Goderich tornado highlighted the important role of these digital social environments for sharing personal stories, seeking comfort and companionship, and staying

connected with one's community. However, precious little is understood about the psycho-social value of these media in the aftermath of significant environmental disturbance. Social science research on this topic would benefit a broad portion of the literature on sense of place, place attachment, and psycho-social well-being.

## **6.6 Implications for practitioners**

A number of "lessons learned" during this research could be of potential interest for emergency managers and other practitioners. First and foremost, the willingness to engage with citizens through social media varies markedly from organization to organization. The resistance to utilize social media is often attributed to concerns over liability and public safety. Nonetheless, as the collective user base of social networking sites swells into the billions worldwide, it seems inevitable that these platforms will be increasingly utilized for information seeking and interpretation during crises.

Engagement by public officials, emergency managers, and other practitioners has a two-fold benefit: (1) these individuals can act as key stewards whose training and experience can guide and contextualize on-line discussions, and (2) by engaging with citizens on social media, practitioners can assist the public in identifying and correcting misinformation. However, the window for effective community engagement is relatively narrow, owing to the abrupt decrease in public attention after severe weather has passed. It is therefore advisable that organizations have an adaptable social media plan in place prior to the outbreak of severe weather, in order to maximize on the period of heightened public attention. It may be useful for organizations to re-visit their communications protocols in order to identify realistic changes that could be made to allow for effective

communication and collaboration to occur on social media.

## **6.7 Concluding remarks**

This research has investigated the role that public attention plays in the warning-response process, beginning with the initial exposure of an individual to a significant event, to the moment that event gains “traction” and the individual begins an iterative process of focusing and filtering, through to when the individual engages in a process of information seeking and (potentially) communicating as they personalize and interpret the event for themselves. At the same time, attention is being created at the societal-level, as individuals collectively engage in the collaborative and iterative process of sense-making. The ultimate goal of this extended process of attention creation is the reduction of environmental uncertainty, whether in terms of fulfilling information needs or by taking protective action.

The results of this dissertation underscore the usefulness of public attention as a lens through which social scientists and other researchers can explore human behaviour when confronted with risk. Perhaps most notably, this research demonstrates that public attention complements and expands upon existing research on risk perception, which focuses on how individuals interpret and respond to environmental threats. The major contributions of this thesis include the development of a concise definition of public attention as well as the introduction of a new conceptual model that ties together existing research on public attention, risk perception, risk communication, and decision-making. The empirical components of this dissertation provide new insights on the nature of

public attention to environmental hazards. In doing so, these manuscripts both lend support for and raise questions about existing empirical work. Ultimately, research on public attention to environmental hazards is in its infancy, and as such there are numerous opportunities for research in this subject area. Accordingly, the insights from any future research on public attention stand to greatly benefit scholarly understanding of human behaviour when confronted with uncertainty—a topic that is of interest across the social sciences.

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