Barriers to Communicating Disaster Response Information to the Public during Disaster Situations

Zur Erlangung des akademischen Grades eines

DOKTORS DER NATURWISSENSCHAFTEN

von der Fakultät für

Bauingenieur-, Geo- und Umweltwissenschaften

des Karlsruher Institut für Technologie (KIT)

genehmigte

DISSERTATION

von

Trevor Girard
Bachelor of Architectural Science,
MSc. Disaster Management and
Sustainable Development (with commendation)

Aus Scarborough, Kanada

Tag der mündlichen Prüfung: 16.01.2017

Referent: Prof. Dr. Friedemann Wenzel

Koreferent: Prof. Dr. Louise Comfort

Karlsruhe 2016

Abstract

Effective communication of disaster response information before, during and after a disaster event can save lives and help those affected access the aid they need to recover. Messages inform the public and attempt to influence the public's actions. Yet, in many cases, actions by the public either do not materialize, or are not sufficient to withstand disaster impacts. The result is that many people are impacted by disasters and lives are lost, despite warnings being issued. Likewise, many people suffer after disasters, despite aid being available.

The purpose of this research was to identify barriers to effective communication during a disaster situation. Though the actors in the disaster communication system attempt to inform the public, they often do not adequately consider communication problems. Communication problems can prevent messages from either reaching the public or being fully understood. The less informed the public is during a disaster situation, the more likely they will make decisions that will put their lives at risk.

I approached the problem from a systems perspective. The goal of any disaster communication system is to keep the public safe in disaster situations. It achieves its goal through the operations of communication. The typical disaster communication system is made up of a complex network of people, agencies and communication channels. The disaster communication system operates within a disaster environment that is constantly changing. The combination of a complex communication system with a dynamic disaster environment magnifies communication problems.

Three case studies were implemented to gain an in-depth understanding of how disaster response messages reached the public during actual disaster situations. The disasters investigated were typhoons Haiyan and Hagupit in the Philippines and the Gorkha Earthquake in Nepal. Quantitative surveys were conducted with individuals and local officials from disaster affected communities. Qualitative interviews were conducted with key informants from various government and non-government agencies.

The results of the case studies explain how individuals and government officials typically seek information and communicate during a disaster situation in both countries. The results revealed that a variety of information seeking and communication behavior were dependent on gender, location and age. The case studies also helped to identify the various actors in the disaster communication system and the relations between those actors.

Thematic analyses were also completed to gain a deeper understanding of the typical content of disaster response messages. Hundreds of disaster situation updates were analyzed for 21 disasters altogether. The thematic analyses have led to the development of a classification scheme to categorize the information contained in disaster response messages so that further investigation can take place. A methodology for analyzing disaster response messages in near-real-time is presented.

Integrating the results of the case studies, thematic analyses and literature has culminated in the development of a conceptual model of the typical disaster communication system. The intent of the model is to enhance discussion of disaster communication plans and problem solving activities. With reference to the identified barriers to effective communication, the model is tested by discussing how it can be used by practitioners to help lift those barriers. The results of

this research have practical implications for any individual or agency who is attempting to communicate with the public during a disaster situation.

Kurzfassung

Effektive Kommunikation von Gefahrenabwehrinformationen vor, während und nach einer Katastrophe kann Leben retten und dazu beitragen, dass Betroffene Zugang zu Rettungsmaßnahmen erhalten. In dieser Hinsicht dienen Meldungen dazu, die Allgemeinheit zu informieren und deren Handlungen zu beeinflussen. Dennoch bleiben gewünschte Reaktionen in vielen Fällen aus, oder erweisen sich als unzureichend um den Folgen von Katastrophen entgegenzuwirken. Somit wird trotz der Veröffentlichung von Warnungen eine große Zahl an Menschen von Katastrophen beeinträchtigt oder kommt sogar zu Tode. Außerdem leiden viele Menschen im Anschluss an Katastrophen weiter, obwohl Hilfe zur Verfügung steht.

Die Absicht dieser Forschungsarbeit besteht darin festzustellen, welche Faktoren effektive Kommunikation innerhalb einer Katastrophensituation erschweren. Obwohl die jeweiligen Akteure im Katastrophenkommunikationssystem darauf abzielen die Allgemeinheit zu informieren, berücksichtigen sie Kommunikationsprobleme oft nicht angemessen. Allerdings können Kommunikationsprobleme der Grund dafür sein, dass Meldungen die Allgemeinheit entweder nicht erreichen, oder nicht vollständig verstanden werden. Je weniger Informationen der Öffentlichkeit zur Verfügung stehen, desto größer ist die Wahrscheinlichkeit, dass Menschen Entscheidungen fällen, die ihr Leben gefährden.

Meine Herangehensweise an dieses Problem erfolgte von der Systemperspektive. Ziel eines jeden Katastrophenkommunikationssystem besteht darin, die öffentliche Sicherheit in Bezug auf eine Katastrophensituation zu gewährleisten. Dieses Ziel wird durch den Kommunikationsvorgang erreicht. In aller Regel umfasst ein Katastrophenkommunikationssystem ein komplexes Netzwerk aus Menschen, Organisationen und Kommunikationskanälen. Hierbei fungiert das Katastrophenkommunikationssystem im Rahmen einer Katastrophenumgebung, die sich fortlaufend ändert. Die Kombination aus einem komplexen Kommunikationssystem zum Einen und einer dynamischen Katastrophenumgebung zum Anderen verschärft Kommunikationsprobleme.

Mit Hilfe von drei Fallstudien wurde ein tiefgreifendes Verständnis erlangt, wie Gefahrenabwehrinformationen die Allgemeinheit während einer Katastrophensituation tatsächlich erreichen. In diesem Zusammenhang wurden Typhoon Haiyan und Hagupit auf den Philippinen sowie das Gorkha Erdbeben in Nepal untersucht. Quantitative Umfragen mit Individuen und lokalen Amtsträgern aus Katastrophengebieten wurden durchgeführt. Mit Schlüsselpersonen aus verschiedenen Regierungs- und Nichtregierungsorganisationen wurden qualitative Befragungen absolviert.

Die Ergebnisse der Fallstudien erläutern wie Individuen und Regierungsvertreter in beiden Ländern im Verlauf einer Katastrophensituation einerseits Informationen ersuchen und andererseits miteinander kommunizieren. Ebenso zeigen die Ergebnisse, dass Verhaltensweisen hinsichtlich Beschaffung und Kommunikation von Informationen von Geschlecht, Standort und Alter abhängen. Zugleich haben die Fallstudien dazu beigetragen, die verschiedenen Akteure innerhalb des Katastrophenkommunikationssystems zu benennen und ihre Beziehungen untereinander zu verdeutlichen.

Des Weiteren wurden thematische Analysen ausgearbeitet, um fundierte Kenntnisse über charakteristische Inhalte der Gefahrenabwehrmeldungen zu gewinnen. Dazu wurden für insgesamt 21 Katastrophenereignisse die dazugehörigen Meldungen bezüglich der Sachlage ausgewertet. Die thematischen Analysen führten zur Entwicklung von Klassifikationsschemen. Diese unterteilen den Inhalt einer Gefahrenabwehrmeldung in bestimmte Kategorien um weiterführende Untersuchungen unternehmen zu können. Vor diesem Hintergrund wird eine Methodik zur Analyse der Gefahrenabwehrmeldungen in Echtzeit vorgestellt.

Durch das Zusammenführen der Fallstudienergebnisse, der thematischen Analysen sowie der Literatur ist ein konzeptionelles Modell für ein typisches Katastrophenkommunikationssystem entstanden. Der Zweck des Modells liegt darin, die Diskussion bezüglich Katastrophenkommunikationsplänen und Problemlösungsvorschlägen zu verbessern. Im Hinblick auf die ermittelten Hindernisfaktoren gegenüber effektiver Kommunikation findet dieses Modell Anwendung bei der Frage, wie es Akteure dabei unterstützen kann eben solche Hindernisfaktoren zu beheben. Schlussendlich haben die Ergebnisse Auswirkungen auf alle Individuen und Organisationen, die bestrebt sind mit der Öffentlichkeit im Verlauf einer Katastrophe zu kommunizieren.

Acknowledgements

First and foremost, I would like to sincerely thank my supervisor Prof. Friedemann Wenzel for the indispensable guidance and for supporting my pursuit of this important and unique research topic every step of the way. Thank-you also to my co-supervisor Prof. Louise Comfort for the valuable discussions that have inspired many of the ideas put forward in this dissertation. Thank-you to Dr. Charlotte Kämpf for the extensive time spent reviewing and discussing my written work. Thank-you to my colleagues at CEDIM and KIT, particularly Bijan Khazai and James Daniell for their helpful feedback throughout the research. This research was generously funded by the Center for Disaster Management and Risk Reduction Technology (CEDIM) at the Karlsruhe Institute of Technology (KIT), Germany. Partial funding for the field research was also provided by the Karlsruhe House of Young Scholars (KHYS) at KIT.

Implementation of the surveys would not have been possible without a support team in the Philippines and Nepal. In the Philippines, I thank Ginbert P. Cuaton for his professional implementation of the surveys and to his team of enumerators from the University of the Philippines Visayas Tacloban College. Thanks to Dr. Khunz Solis for supporting our research team with accommodation, boat transportation and guide. In Nepal, a warm thanks to my former colleague and like-minded bamboo expert Rashmi Manandhar for translating the surveys, leading the survey training sessions and the variety of ways you helped to organize our research team. Thanks to Utsav Upreti and Shyam Thapa from AAROH for coordinating and implementing the surveys in Nepal and for all of the long hours spent together driving or stuck on the mountain roads.

Thank-you to all of the participants in the surveys and interviews in the Philippines and Nepal. The honesty and hospitality that the respondents so often demonstrated while recalling disaster experiences that most would rather forget, was greatly appreciated and truly inspiring. Finally, a big thank-you to my family for their support over these last few years, and an even bigger thank-you to my toughest critic, my wife Susanne.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ACORAB – Association of Community Radio Broadcasters

CDO – Chief District Officer

CFP – Inter-Agency Common Feedback Project

DAO – District Administrative Office

DILG – Department of Local and Interior Government

DDRC – District Disaster Relief Committee

DOST – Department of Science and Technology

DRRM – Disaster Risk Reduction and Management

DSWD – Department of Social Welfare and Development

FEMA – Federal Emergency Management Agency

I/NGO – International or local non-government agency

ICT – Information and Communication Technology

KLL – Kathmandu Living Labs

NDRRMC – National Disaster Risk Reduction and Management Council

NOAH – Nationwide Operational Assessment of Hazards

OCD – Office of Civil Defense

PADM – Protective Action Decision Model

PAGASA – Philippine Atmospheric Geophysical and Astronomical Services Administration

UNOCHA - United Nations Office for the Coordination of Humanitarian Affairs

VDC – Village Development Committee

1. Introduction

During a disaster situation the public will need to make critical decisions regarding what to do, where to go and how to get there. Individuals need a variety of information before and after disasters in order to make the right decisions that will keep them safe or help them recover from disaster impacts. Information detailing potential disaster impacts can help individuals identify their personal level of risk. Information detailing the recommended actions to avoid harm can help individuals reduce that risk. Finally, after a disaster, information explaining how to access rescue services, medical assistance, shelter, food, water and sanitation, can help affected communities recover.

In the ideal situation, an individual will perceive all information available, and combine this with their own understanding and experience, to achieve a high level of 'situational awareness' (Dominguez 1994). However, the average individual will not access all relevant information, nor will they be aware of every relevant information source. Furthermore, due to issues with the information or the situation, it is often difficult for individuals to correctly apply the information they receive to their unique situational context. The less information an individual has, the lower their situational awareness, and the less likely they are to implement an adequate disaster response.

A disaster response is defined as the actions taken immediately before, during and after a disaster with the purpose of reducing harm and other disaster impacts (Mileti 1999: 899). I will use the term 'disaster response information' to refer to the information which helps an individual enact a disaster response. Hence, a 'disaster response message' contains information intended to initiate a disaster response action. Disaster response messages issued before a disaster, I refer to as disaster warnings. Disaster warnings focus on preparedness activities and may include details of the impending hazard (e.g., location, size or time until impact), recommended actions (e.g., evacuating, sheltering or avoiding hazardous areas), and details to help implement actions (e.g., location of evacuation sites or transportation routes). Disaster response messages issued after a disaster, I refer to as relief information. Relief information focuses on rescue and relief activities and may include details of how affected populations could request help (e.g., search and rescue or medical attention), access aid (e.g., food, water or shelter) and reduce further disaster impacts (e.g., boiling drinking water, avoiding hazardous areas or handling fatalities).

Inaccuracies with the above information can have negative consequences. For example, the incorrect prediction of when Typhoon Haiyan would make landfall in the Philippines resulted in the residents of Guiuan being unprepared for the strongest typhoon to make landfall (Mori et al. 2014). They were awakened by the destructive force of the typhoon at 4:40am (Lagmay et al. 2014), three full hours ahead of predictions suggested (Zoleta-Nantes 2013; Tripathy et al. 2014).

Even when scientifically accurate disaster warnings reach the public on time, they can still fail to promote actions if they are not understood by the public. Warnings issued before Typhoon Haiyan made landfall were also criticized for failing to explain the term 'storm surge' used and failing to emphasize the storm surge threat, resulting in the public not understanding the danger posed by the approaching typhoon (Neussner 2014). The failure to communicate the intended meaning of the warning had devastating consequences. Neussner (2014) estimates that storm surges caused 94% of the deaths in Tacloban, Palo and Tanauen, totaling over 4,500 lives which could have been saved had they been convinced to evacuate.

The reason why such mistakes in communicating messages and meaning can persist, is partially due to the complex nature of the disaster communication system. A disaster communication system often involves multiple actors, disseminating a variety of information through different channels, to an intended audience in the thousands or more. Furthermore, the disaster environment in which the disaster communication system operates is dynamic. The disaster communication system must continuously adapt to changes in the environment. The typical barriers to effective communication are magnified by the complexity of the disaster communication system and the dynamic nature of the disaster environment.

1.1. Problem Statement

The purpose of producing disaster response information is to influence public decision making and ultimately lead to actions that will keep the public safe. Yet, in many cases, actions by the public either do not materialize, or are insufficient to withstand disaster impacts. The result is that many people are impacted by disasters and lives are lost, despite warnings being issued. Likewise, many people suffer after disasters, despite aid being available.

The failure of disaster response messages to compel the public to take the actions intended by the source of the message is a communication problem. Communication scholar Dean C. Barnlund argues that effective communication reduces uncertainty (1970 p. 60). Consequently, effective disaster communication creates certainty about whether or not individuals may be affected, their level of risk, and the actions needed to avoid risk or improve their well-being after being affected. In contrast, ineffective disaster communication produces uncertainty (Button 2010).

Transmission of disaster response messages to the public is not guaranteed to elicit a disaster response. Disaster response messages must also be understood by the public. The heterogeneous makeup of the typical public does not only result in different interpretations of a single message, but different disaster responses to each interpretation (Lindell and Perry 2004, 2011). What successfully convinces one person to evacuate may not convince another person.

Ensuring effective transfer of meaning of disaster response information in a disaster environment presents various challenges worth studying. The technical and semantic constraints are critical to overcome so that lives can be protected in the future. Disaster communication has been based on linear models of communication. These models have measured success based on technical performance (Shannon and Weaver 1949) or observable effects (Lasswell 1948). This has resulted in a flawed stimulus-response model that assumes delivery of a warning message will elicit the intended disaster response (Mileti and Sorenson 1990, p. 7.13).

Though general practice continues to follow a stimulus-response model, disaster researchers have acknowledged the importance of semantic issues. For instance, the social-psychological aspects have been researched at length (Drabek 2013; Lindell and Perry 2004, 2011; Mileti 1999; Mileti and Sorenson 1990) and are based on substantial empirical evidence. Review of public response to disaster warnings in particular has resulted in an increased understanding of the variety of ways the public may understand and react to disaster warnings based on their own attributes and the attributes of the message (Mileti 1999; Mileti and Sorenson 1990). The research clearly demonstrates the design of disaster warnings can no longer be based on a stimulus-response model. The public does not simply follow instructions: the public's reaction to disaster response information is complex, and difficult to control.

Communication problems are also often critiqued in isolation from the overall communication system, instead of being viewed as a result of the system. The design of a disaster communication system can present limitations and opportunities for solving communication problems. However, it is often unclear what the design of the overall disaster communication system looks like. For example, little research has been done to track the flow of disaster response information from original source (such as the scientific agency) to the end receiver (the individual in the community). Research into information seeking behavior has identified how the end receiver obtained their information, through television, radio, or neighbors, but this does not provide a complete picture. There is a need to identify those actors which contribute to disaster communication as well as strategies for improving their contribution.

Wersig and Nevelling argue that "transmitting knowledge to those who need it is a social responsibility" (1975 p. 28). In addition, disaster researchers Lindell and Perry (2004 p. 1) argue that anyone with information about risk has a responsibility to convey that risk to decision makers or the public. These arguments are crucial to my theoretical perspective. Those who produce information that could help communities survive or recover from disasters, have a responsibility to attempt to deliver that information to the public. The scientific agency who produces maps of predicted storm surge heights, or the relief agency who compiles lists of emergency contacts, both have a responsibility to distribute information in a way that people in the potentially affected areas can access.

Numerous actors strive to inform the public in disaster situations; however, they often do not consider the various communication problems which prevent their messages from either reaching the public or being fully understood. These problems can only be solved through the operations of the disaster communication system. Without knowledge of how the system operates, it is difficult for a sender to overcome communication problems. If the disaster communication system can be modelled, then potential pathways for informing disaster affected communities can be identified. The model could be used to help identify and subsequently fix communication problems. Furthermore, during a disaster, one could adjust the model in near-real-time to account for changes in the environment which affect the system.

1.2. Aim and Scope

The aim is to investigate the various components of a typical disaster communication system which may influence how effective a disaster response message and its meaning are transferred from a sender to the intended receivers. These components will include actors (people or agencies), information and communication technology (ICT), as well as elements of a message and meaning. The limitations of the different components as well as the relations between them will be discussed.

The investigation will include both pre-disaster warnings and post-disaster relief information. The investigation is limited to the handful of days before and after a disaster. The messages are limited to those which are relevant to the public's disaster response decision making. I will not be discussing the internal sharing of messages between government agencies which are not meant for the public.

Thematic analyses were conducted for 21 disasters to develop a classification scheme for disaster response messages and to design and test a method for analyzing messages in near-real-time. The data collected for the thematic analyses included disaster warnings and relief information issued

by disaster management authorities, as well as scientific, news, and relief agencies. Quantitative surveys and qualitative interviews were implemented with participants from typhoon affected areas in the Philippines and earthquake affected areas in Nepal. Participants included individuals and officials from local communities, as well as key informants at the municipal and provincial/district level who have an important role in the disaster communication system.

1.3. Significance of the Study

I will introduce a theoretical model to reflect the communication of disaster response information. The structure of the model is based on data collected from actors in the disaster information distribution chains of the Philippines and Nepal. As such, the model is a better reflection of communication in a disaster environment than those models which are based on communication theory alone. Unlike previous models, it will cover both disaster warnings and relief information. The concepts behind the model are borrowed from general communication theory and modified to be applicable to the disaster environment. An original aspect of my take on the communication problem is the inclusion of semiotic theory to examine the generation and interpretation of meaning in disaster response messages.

The benefit of the model is that it can be used by practitioners to visualize the disaster communication system, where they fit into it, and the relations of the various components. As such, the model can enhance discussion and problem solving activities. During the disaster preparedness, warning and response phases of a disaster, the model can be used as a reference to plan communication and deal with problems as they arise. After the response phase is over, the model can be used to discuss what went wrong, and thus supports lessons learned investigations. To promote the model's functionality, I provide a number of recommendations for how a sender could apply the concepts of the model to their communication plans.

Three in-depth case studies have provided the testing grounds for theory development as well as examples for practical application. I have investigated the communication of disaster response information before and after the landfall of Typhoons Haiyan (2013) and Hagupit (2014) in the Philippines, and after the Gorkha Earthquake (2015) in Nepal. The value in the approach is that the barriers to communicating disaster response information in the case studies are extended to disasters in general. The concepts which have shaped the model can also be used to develop similar models for other countries and disaster situations.

1.4. Overview of the Study

The literature review in the next chapter identifies key issues which need to be considered when communicating disaster response information to the public. I then discuss the research questions and methods in Chapter 3. Chapter 4 presents the classification scheme, which is based on thematic analyses of the disaster response information collected from online sources following 21 disasters. The results of the quantitative surveys and qualitative interviews conducted in the Philippines and Nepal are presented in Chapters 5 and 6, respectively. In Chapter 7, I propose a model of disaster communication which is based on the literature, the thematic analysis and the case studies. I discuss how the model could be used to enhance disaster communication planning and problem solving.

2. Literature Review

2.1. Purpose of Chapter

This literature review will begin with exploring three theoretical approaches to addressing disaster communication problems. The first two are well established in the disaster communication field, whereas the third is borrowed from the field of semiotics and applied to disaster communication. I will then provide arguments to support the notion that communication can be monitored and evaluated in near-real-time. Following this, I provide an overview of the components of the typical disaster communication system. The goal of this chapter is to discuss the issues which can be expected to occur when communicating disaster response messages, as well as the relevant literature which provides guidance for overcoming these obstacles.

2.2. Overview of Approaches to Solving the Communication Problem

Communication is defined as "those acts in which meaning develops within human beings" and which "arises out of the need to reduce uncertainty, to act effectively…" Barnlund (1970 p. 47). Communication of disaster response information is meant to reduce uncertainty and elicit response actions by the public. Though the message may originate from a specific person or agency, the sender can include any intermediary who relays that message to someone else. The interaction of the sender and receiver culminates in an interpreted meaning by the receiver. Sociologist Niklas Luhmann (2013) argues that communication occurs when information is either understood or misunderstood (p. 54). Whether understood or misunderstood, the interpreted meaning initiates response actions (Mileti and Beck 1975). The interpreted meaning may change from one person to the next, and is influenced by factors beyond the message content (Drabek 2013; Lindell and Perry 2004; Mileti and Sorenson 1990).

Effective communication during a disaster situation improves the public's understanding of risk, options for mitigating risk, and options for protecting themselves and others. Communication has multiplying effects (Luhmann 2013, p. 213). This argument is supported by disaster communication literature. For instance, Appleby's evaluation of the response to the 2011 Tohoku Earthquake and Tsunami stresses the importance of communicating information to the public and concludes that "information saves lives, that communication itself is a form of aid…" (2013, p. 9). Maxwell (2003) explains that better informed citizens are able to make the correct decisions to protect themselves during disaster situations, which has the added benefit of reducing the strain on government resources. Helsloot and Ruitenberg (2004) go further to argue that the flow of information before and during disasters should be directed at the public, because they are major actors in rescue and relief.

Traditionally, there have been two major approaches to studying disaster communications. The first approach is to study the physical process of transmitting a message from a sender to a receiver, potentially through a multiplicity of intermediaries and communication channels. The second approach is to study the mental process the receiver goes through when making a decision to react to the message. This approach considers the various receiver, message and contextual characteristics which influence the process. Naturally, both approaches need to be combined to gain a wider perspective on any communication problem. A third approach from the general field of communication theory, is to study the elements of meaning in a disaster

response message. Though highly relevant to disaster communication, this semantic approach is not commonly applied to disaster research. These three approaches are employed to address the technical problem, the social-psychological problem, and the semantic problem, respectively. I will now discuss each of these three approaches in further detail.

2.3. The Technical Approach

In classic linear process models of communication, a sender ("information source") transmits a message via a channel to a receiver (Shannon and Weaver 1949, see Figure 2.1). According to sociologist and communication scholar Everett M. Rogers (1986), Shannon and Weaver's model is "the most important single turning point in the history of communication science" (p. 85). Linear process models are limited to physical observations, such as the content of the message, the type of communication channel, and the reaction by the receiver. This technical approach has been the guiding framework used by disaster management authorities to send disaster response information to the public (Lindell and Perry 2004, 2011; Sellnow and Seeger 2013, p. 10; Pechta et al. 2010), as well as by mass communication practitioners in general (McQuail 2010 p. 75).

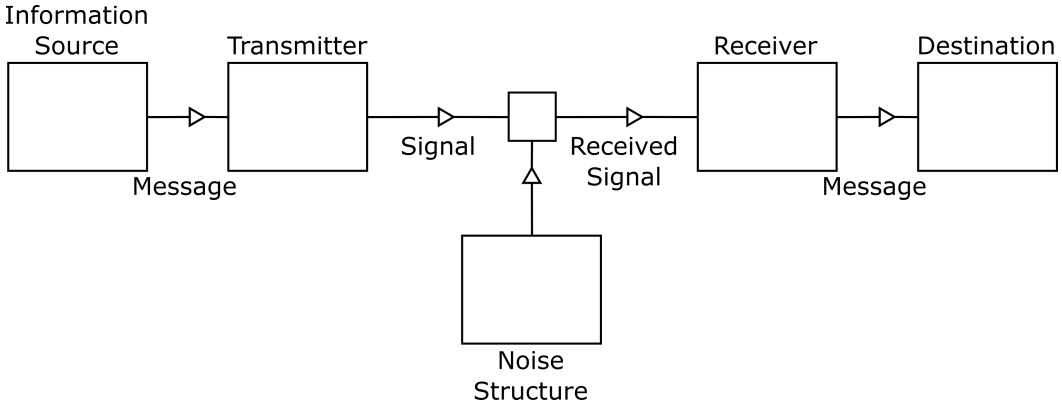

Figure 2.1: Schematic diagram of a general communication system (Shannon and Weaver 1949 p. 34)

A verbal description of Shannon and Weaver's model is presented by communications theorist Harold D. Lasswell (1948), who proposes the questions: who (source), says what (message), in which channel, to whom (receiver), with what effect? According to Lasswell (1948), each question represents an area of study in communications. Lasswell's questions and Shannon and Weaver's conceptual model only address the technical problem. Shannon and Weaver suggest that the semantic problem could also be accounted for in the schematic model, with the inclusion of 'semantic noise' (1949 p. 25). But as Rogers (1986, p. 86) points out, communication scientists largely ignored the semantic problem for decades, and instead focused on the technical aspects and effects of communication as the basis for measuring success.

Sociologist Stuart Hall criticizes linear models of mass communication for placing too much focus on message exchange and not paying enough attention to the relations between the different components involved in communication (1980 p. 128). Renowned sociologist Niklas Luhmann also criticizes the process model for assuming that meaning is automatically transferred along with the message (2013, p. 214). In its most rudimentary form, the process

model ignores the characteristics of the receiver and assumes that receiving the message will stimulate response.

Communication theorist Denis McQuail explains that process models fail because "signals simply do not reach receivers, or not those intended; messages are not understood as they are sent; and there is always much 'noise' in the channels that distorts the message" (2010 p. 66). Process models do not consider components beyond those which can be physically observed. Whereas effects can be physically perceived, such as witnessing a community evacuate, the reasons for those effects are often unobservable mental concepts, such as a fear for safety. Explaining the behavior of the individual who hears the disaster warning cannot be done through a process model (Perry 1979).

The process model is typically one-way, and describes only one act of communication between a sender and receiver. This is a poor reflection of how communication actually occurs in general (Rogers 1986 p. 179), and especially during a disaster (Lindell and Perry 2004 p. 15). Lindell and Perry (2004 p. 16; see Figure 2.2) state that in reality the original source of the message is not directly linked to the receiver but passes the message indirectly through another person or agency, which they refer to as an 'intermediary'. There may be a large number of intermediaries for a larger number of receivers (Lindell and Perry 2004 p. 16).

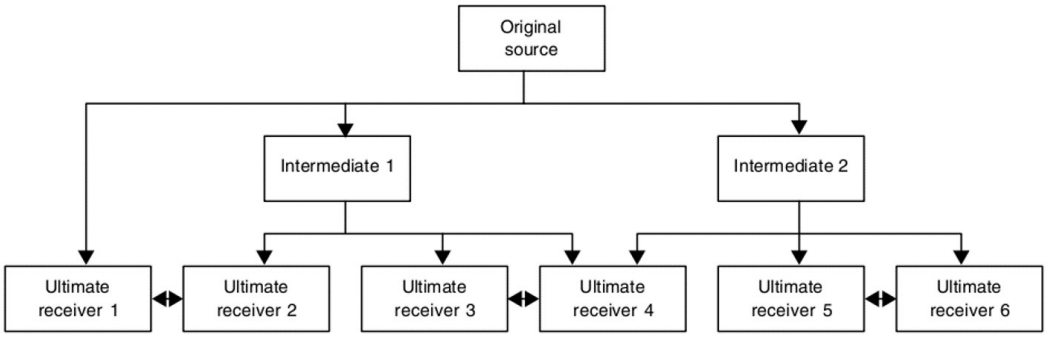

Figure 2.2: Model of source, intermediaries and receivers (Lindell and Perry 2004 p. 16)

Although there has been much criticism of the process model, it is useful for understanding the physical components involved in sending messages in a system. As Wiener (1961 p. 18) argues, one cannot begin to understand a system without investigating how that system communicates. Hence, the technical aspects of communication are important to understand, but the traditional process model needs to be expanded to better reflect how communication occurs in a disaster environment. I will further discuss the various components of the disaster communication system in Section 2.7. The process approach has been incorporated into the model introduced in Chapter 7.

2.4. The Social-Psychological Approach

2.4.1. Information processing

Sociologist and disaster researcher Thomas E. Drabek (2013, p. 70) argues that "the typical human response to disaster warnings is disbelief, denial, and reinterpretation to reduce or

eliminate the threat potential". After taking time to process the information, and with additional supporting evidence, a person may change their initial perception of risk. Failing to adequately process the information, or failing to obtain enough supporting evidence, may explain why some individuals remain in hazardous areas during cyclones, floods, and tsunamis, despite receiving disaster warnings.

Research on public response to disaster warnings has provided extensive evidence to prove that once a disaster warning is perceived, people go through a social-psychological process to decide what action they will take (Drabek 2013; Lindell and Perry 2004; Mileti and Sorenson 1990; Mileti 1999; Mileti et al. 2006; Quarantelli 1980; Sorenson 2000). Mileti and Sorenson (1990) describe this process as follows:

> Hearing/seeing
>
> Understanding
>
> Believing
>
> Personalizing
>
> Deciding and responding
>
> Confirming

Understanding refers to the individual's interpretation of the message. The individual attaches meaning to the message. This meaning may differ from the sender's intended meaning. Understanding is the basis for perceiving risk (Mileti and Sorenson 1990). Factors such as the source of the warning and the content of the message will influence the likelihood of an individual believing the warning to be real and accurate. Real and accurate are two different qualities. While an individual may believe that a warning is advising of a real threat such as a tsunami, they may not believe that the warning message accurately identifies who is at risk. Individuals then personalize the meaning of a disaster warning. They view it in terms of how it will affect them personally. Together, the understanding, belief and personalization will lead to a decision to respond in a certain way.

Personalization will always occur; even information deemed irrelevant is personalized by the individual for them to reach such a conclusion. However, personalization can be carried out incorrectly if there are issues in understanding or believing the disaster warnings. In other words, a person may understand the meaning intended by the message, but believe it does not fully apply to them. Their judgement may be affected by their attitude towards various factors of the situation, such as the strength of their home, or typhoons in general. This attitude is a combination of the person's "strength of beliefs that an object has certain attributes and [the] evaluations of these attributes" (Perloff 2010 p. 50 – 51).

Attitudes can become stronger over time and can open the door for using heuristics as the basis for making important decisions (Mileti 1999: 3174). A heuristic argument may conclude that because the person's house has never flooded before, it could not flood in the future. Similarly, people who have survived one disaster may believe they can survive a future disaster and as such will not seek further information to make a decision (Wenger 1978). The social-psychological process is repeated with each additional piece of information from authorities, media, family, friends, or the surrounding environment, leading to confirmation or revision of response decisions (Mileti and Sorenson 1990).

There are a number of attributes which characterize an individual at the time of hearing a disaster response message. Examples are the availability of environmental cues, proximity to the hazard, available social networks, available resources, social role, culture, activity at time of message, knowledge, stress or fatalism, hazard experience, and disabilities (Mileti and Sorenson 1990: 5.5 – 5.6). Each attribute influences how the individual will respond to the message.

Though Mileti and Sorenson (1990) refer to disaster warnings, the processing of relief information after a disaster will also be influenced by most, if not all, of the same attributes. For example, a person living in a remote area does not benefit from the same level of social cues that someone living in an urban area has access to. Social cues before a disaster may consist of observing neighbors evacuating, whereas social cues after a disaster may involve observing neighbors accessing food distribution sites.

2.4.2. Decision making

Lindell and Perry (2004) complement Mileti and Sorenson's model by examining in further detail the mental stages an individual goes through to finalize their decisions to act, in what they refer to as the Protective Action Decision Model (PADM). As the title suggests, the model is focused on the process that leads to protective actions, such as evacuating, sheltering in place, or avoiding hazardous areas. The model highlights the importance of the individual's perception of the risk and perception of the protective actions to avoid the risk.

Regardless of the level of understanding, belief and personalization reached, the individual will need to create a response plan made up of several key components. The stages proposed by Lindell and Perry (2004) are risk identification, risk assessment, protective action search, protective action assessment, and protective action implementation. At any point in the process, the individual may recognize their need for more information. At such a time, they will carry out information seeking activities which include an information needs assessment, communication action assessment, and communication action implementation (Lindell and Perry 2004).

The PADM describes a public response that goes according to plan. It assumes that people generally find the information they seek. It states that protective actions are implemented only after all previous questions have been answered satisfactorily (Lindell and Perry 2004 p. 60). This would suggest that if a question is not answered, a person freezes up, unable to act, instead of the individual using their own judgement. Research has shown that those without sufficient information often base decisions on heuristics (Chaiken and Maheswaren 1994; Mileti 1999: 3174). Alternatively, those individuals who lack sufficient information may copy the actions of the people around them (Mileti 1999: 3286).

Completion of the PADM process will result in implementation of an 'adaptive plan'. Lindell and Perry (2004 p. 60) argue that those who lack an adaptive plan have been found to be more affected by disasters. The authors (p. 64) suggest that a lack of information may halt the PADM process, prevent the individual from implementing an adaptive plan, and result in denial or panic. Drabek (2013 p. 70) supports the argument that denial occurs, but the claim that the public will panic due to a lack of information is not commonly observed in the literature. Public panic during a disaster has traditionally been viewed as a myth, but such arguments have been associated with panic due to receiving too much information (Rubin 1987; Mileti 1999: 4399; Sorenson 2000; Auf der Heide 2004; Helsloot and Ruitenberg 2004; Seeger 2006).

Mileti and Sorenson (1990) on the other hand argue that not all of the steps they identify are required for a response to occur. Both arguments highlight the potential negative impacts of not providing sufficient disaster response information to the public. Mileti and Sorenson (1990) suggest that a lack of sufficient information may lead to inappropriate actions, whereas Lindell and Perry (2004) suggest that a lack of information may lead to no actions being implemented at all, or panic.

2.4.3. Uncertainty absorption

Thus, an individual may arrive at a decision to act or not act, without first obtaining all of the information relevant to their decision making. This acceptance of a certain level of uncertainty is referred to as 'uncertainty absorption' (Luhmann 2013 p. 224). In a disaster situation, it may occur because of the person's perceived urgency to act, trust in those issuing instructions, social norms, or the inability to obtain more information.

2.4.4. Perception of response actions

Chaney et al. (2013) and Lindell and Perry (2004 p. 39) suggest that a person's intended response is more positively related to their perception of the response action than to their perception of the hazard itself. For example, an individual with little experience with wildfires may have limited perception of the risk of a wildfire approaching their community. On the other hand, they may be well experienced with evacuation protocols and view them as a positive means to avoid hazard. Hence, reinforcing the need for evacuations, and providing details about how to evacuate, may result in more people implementing protective actions than attempting to increase perception of the hazard itself.

The implementation of response actions also relies on the individual's belief that they have the skills and resources to carry out the actions. This belief is referred to as 'self-efficacy' and is key to individuals implementing actions in general (Bandura 2001). A second highly relevant concept introduced by Lindell and Perry is "response efficacy", which refers to the individual's belief that the response actions will be successful at keeping them safe (2004 p. 43).

An individual's perception of their ability to act and the consequences of actions could be more or less accurate. For example, someone may decide not to travel to a shelter site because they feel they are unable to reach it safely, or because they believe there are greater risks at the shelter site than at their home. Actual disaster events will determine whether the person's perceptions are right or wrong.

The research implies that effective disaster response information could enhance an individual's knowledge, thus improving their capacity to carry out response actions, and helping them make an accurate assessment of their ability to act and of the consequences of those actions. For example, prior to Cyclone Ita making landfall in Queensland, Australia on 11 April 2014, warning messages to the public did not stop at recommending that homes be equipped with sandbags. Messages also identified where the public could acquire and fill sandbags, and explained the process of filling and placing sandbags, including the tools needed (Uhr et al. 2014). Likewise, after the 25 April 2015 Gorkha Earthquake in Nepal, in addition to distributing tarpaulins, the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA, 2015a) also disseminated guidelines for properly fixing tarpaulins to structures. By explaining how to carry out response actions, disaster response messages not only enable the public to

implement those actions, but improve the public's perception of their own ability to act. Furthermore, disaster response information, which explains how the actions will achieve positive results, will sharpen the individual's perception of the consequences of those actions.

While the literature connects pre-disaster protective actions with the concepts of self-efficacy and response efficacy, there is a void of research applying the same concepts to post-disaster response actions, such as seeking medical treatment, food, water or shelter. If these concepts are applicable to relief information, then messages should go beyond identifying aid available, to explaining how to access aid and how that aid will help.

2.4.5. Barriers to implementation

In a revised version of the PADM model, Lindell and Perry (2011) demonstrate that decisions to act do not always result in actions being taken as planned. During Hurricane Katrina, individuals receiving warnings and evacuation orders, but were unable to leave because they lacked the means to do so (Comfort 2007a). Similarly, communication disruptions or lack of merchandisers selling phone credit, can prevent an individual from contacting relief agencies after a disaster. Those factors which prevent or limit a person's response are referred to as situational impediments (Lindell and Perry 2011).

Many of the attributes listed by Mileti and Sorenson (1990, pp. 5.5 – 5.6) also apply to the implementation problem, such as available resources, proximity to hazard, social role and disabilities. These attributes can influence the person's ability to respond to both disaster warnings and relief information. Thus, a person who lacked the resources to evacuate prior to the disaster, may also lack the resources to travel to a food distribution site after the disaster. Likewise, someone responsible for the safety of others who lack mobility, may find themselves physically bound to a place (nursing homes, hospitals, prisons), preventing them from evacuating before a disaster or leaving to seek relief after a disaster.

In some cases, the failure to act is the product of uncertainty absorption rather than physical barriers. For example, not owning a vehicle does not prevent an individual from evacuating if buses are available. Perceptions of barriers can therefore be more or less accurate. Actual disaster events will determine whether the person's perceptions are right or wrong, but at the time the decision is made, the individual's perception is their reality (Seeger 2006). A stakeholder responsible for distributing disaster response information should therefore anticipate the various barriers which could be perceived to prevent people from implementing actions and include supplemental information to address these barriers.

2.5. The Semantic Approach

Meaning is not inherent in a message (Krippendorf 2004, p. 22), nor is it static: meaning changes depending on who is perceiving the message. Meaning is also based on social context at the time the message is received (Shannon and Weaver 1949 p. 27; McQuail 2010 p. 67). A robust process for disseminating disaster response information can result in a large audience receiving the message, but it can still fail if the meaning intended by the sender is not understood. In such cases, the public may be unable to interpret any meaning, or may interpret a meaning which is different than what the sender intended. For example, a disaster warning may state that there is a risk of flash-flood in low lying areas. While this message could lead to appropriate action for some, others might not fully understand what is meant by the term 'flash-flood', or what

constitutes a 'low lying area'. Even when the terms are understood, some may associate the hazard to be a risk to human lives, while others associate it with a mere risk of property damage. The way in which a person interprets the meaning of a warning message will guide their decision to implement response actions (Rogers and Sorenson 1993).

In order to understand how meaning is generated and interpreted, I turn to the field of semiotics. Semiotics is the study of signs, which convey meaning in a message. Examples of signs in disaster response messages are the words used to describe a hazard, the image which identifies the areas at risk, or the colors used to indicate the level of risk. Semiotics can help explain how disaster response messages can fail to transfer the intended meaning.

2.5.1. Semiotic communication models

Semiotic models of communication are typically non-linear, and focus on the relationships of the elements of meaning in communication. One of the founders of semiotics, Ferdinand de Saussure, stated that a sign consists of the physical properties (signifier) and the concept (signified) generated in the mind of the perceiver (1959, p. 65; see Figure 2.3).

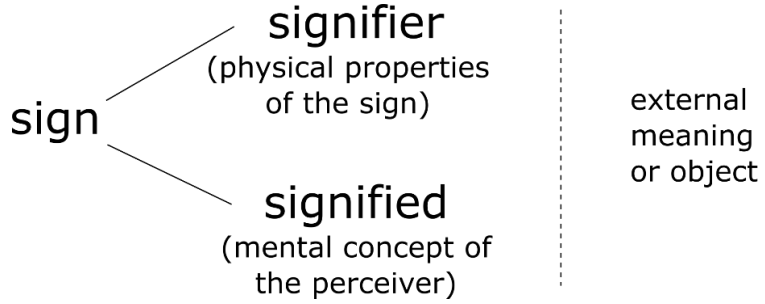

Figure 2.3: Saussure's elements of a sign (adapted from Saussure 1959 p. 65 and Fiske 1990 p. 44)

Saussure places little importance on the external meaning (or object), and argues that the meaning of the signifier is arbitrarily assigned by the people who use the sign. These cultural conventions need to be learned (Chandler 2007 p. 28). When designing a disaster response message, it is important to consider the likelihood that the audience has previously learned the meaning of the words, symbols, images, and sounds that the message contains. For example, prior to Typhoon Haiyan very few Filipinos in Tacloban, Palo and Tanauen had learned the meaning of the word sign 'storm surge'. Thus, when the term 'storm surge' was used in warning messages, many could not conceptualize the threat to which this sign alluded (Neussner 2014). This example supports the argument of semiotician Umberto Eco (1979) that the perceiver of a sign plays a critical role in assigning meaning to the sign.

2.5.2. Encoding and decoding

Drabek (2013 p71) cautions against warnings that are open to interpretation, because people will select convenient personal interpretations which suggest little impact on their daily life. For both sender and receivers to interpret the same meaning when creating/perceiving a sign, they must share a code. Eco (1968) defines a code as "a system of rules given by a culture" (p. 130 cit. in Nöth 2013). For example, Dudley and Haaland (1993) describe how survey respondents in

Nepal did not understand the positive and negative connotations of the symbols "✓" and "X", nor the danger associated with the skull and cross-bones symbol. Similarly, scientific explanations are often full of codes which are not shared by the public. The following warning issued by the Central Weather Bureau (2016) before landfall of Typhoon Nepartak in Taiwan is just one example:

> "Typhoon 201601 (Nepartak 201601) Position: 061800Z at 21.8N, 123.0E. Movement next 24hrs: WNW becoming NW 17km/hr becoming 14km/hr. Min surface pressure: 910 HPA. Max sustained winds near center: 55m/s, gust: 68 m/s. Radius of over 15m/s winds: 200km, over 25m/s winds: 80km."

It is expected that many individuals in the public did not fully understand this warning message. The process of understanding a message is given the term decoding. Eco (1972) introduced the term 'aberrant decoding' to refer to what occurs when a receiver decodes a message using a different code as compared to the sender. While not expected to occur when a specific receiver or group is targeted, aberrant decoding is quite normal during mass communication involving a diverse range of recipients (Eco 1972, p. 239). Likewise, disaster response information is typically disseminated to a heterogeneous mass of receivers with different social norms, languages, experiences, and education. The risk of aberrant decoding is thus high in the communication of meaning through disaster response information.

Chandler (2002 p. 181) states that codes used within a sign will position those who understand the codes as 'ideal readers'. Only ideal readers will be able to interpret the meaning in the way intended by the sender, in what Hall (1980 p.134) refers to as the 'preferred reading'. The more the sender knows the characteristics of the receiver, the better they can encode the message in a form that the sender will understand. In the disaster environment, preferred readings of disaster response messages are presumed to be hard to come by.

To complicate matters even further, the sender may not want the entire mass of individuals to interpret the meaning in the exact same way. The meaning of a relief message may be that only those whose homes have been damaged should be utilizing public shelters. Hence, the 'preferred reading' should be specific to an individual, or a group of individuals with the same characteristics, such as those identified by Mileti and Sorenson (1990) and others. The literature argues that disaster warnings need to be designed to address the potential attributes of a heterogeneous public, yet disaster management authorities often view the public as a "homogenous" group (Mileti 1999, Receiver Characteristics section, para. 1).

2.5.3. A potential semiotic process model

Typical semiotic models refer only to a 'perceiver', rather than a sender and receiver, which could lead one to ignore the source of the sign. The signs in disaster response messages are typically placed there by the disaster management authority, with the intent of addressing the public. In this instance, the disaster management authority and the public fulfill the roles of sender and receiver, respectively. Hence, I argue that the transfer of meaning from sender to receiver can be modeled as if it were a linear process.

Like Saussure (1959 p. 66), I place little importance on the external object, which the sign refers to, such as the actual wave of water arbitrarily given the word sign 'tsunami'. Instead, I focus on the mental concepts that the word generates for both sender and receiver, as well as the relationship between those concepts. To reflect the relationship between the sender's intended

concept and the receiver's interpreted concept, I have modified the typical semiotic triangle (see Figure 2.4).

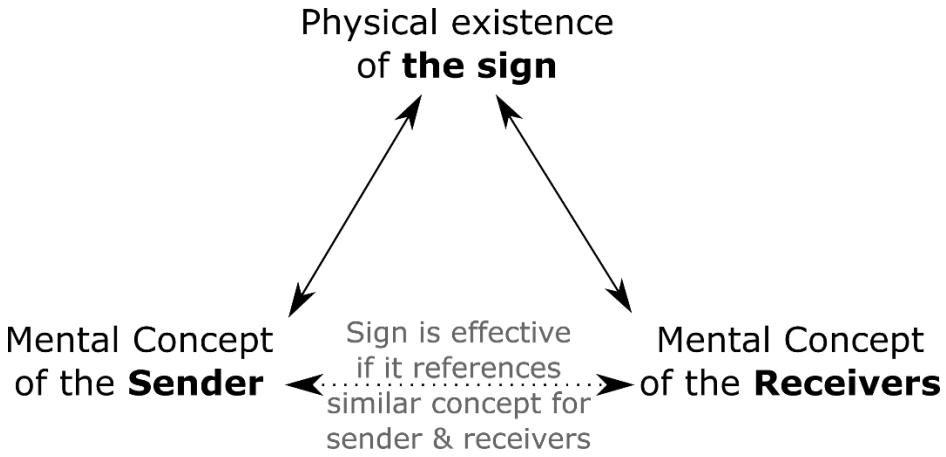

Figure 2.4: Elements of meaning in a disaster warning sign (adapted from Eco 1972, Peirce 1960, and Saussure 1959, p. 66)

In order to improve the design of a disaster response message, a sender must identify first whether the signs contained in the message are effective or not. Similar to Ogden and Richards (1923, p. 102) definition of a true symbol, I argue that an effective disaster response message correctly records the intended concepts of the sender as long as it generates very similar concepts in the mind of the intended receivers. For example, an icon of a big wave placed near the coast is only an effective sign for "tsunami area" if that sign generates the same meaning when viewed by a member of the general public travelling in the area. A message that does not trigger the intended concept in a receiver's mind, is thus an ineffective message. The line in Figure 2.4 which connects the mental concept of the sender and receivers is dotted to highlight the fact that receivers may interpret the signs in the message to mean something very different than what the sender intends.

The resulting sender-sign-receiver model resembles the sender-message-receiver process model discussed in Section 2.3. This suggests that the transfer of meaning can be studied as a process, rather than the traditional semiotic models which study elements of meaning in a sign independent from those who produced them. In order to confirm how the receiver interpreted the sign, the sender must obtain feedback. Feedback, a concept from cybernetics (Wiener 1961), has been applied to process models of communication, albeit in an add-on fashion. By viewing the transfer of meaning as a semiotic-process, feedback can be incorporated.

2.5.4. Multimodality

The way a sign is communicated via words, colors, images, or sounds, is referred to as the semiotic mode. Multimodality refers to the use of a number of semiotic modes for delivering a single message, with each mode selected for its ability to communicate meaning (Kress 2009 p. 1). A warning message broadcast on television could contain a map of areas at risk, which uses a colored scale to denote levels of risk, as well as written words to identify landmarks and spoken words to reinforce the urgency of the situation. Multimodal messages can be very effective, especially when there are temporal and/or situational constraints (Kress 2009 p. 1). Hence,

multimodal messages are ideal for disaster situations. The use of photos for instance has proven useful in emergencies, with different photographic techniques, such as distance to hazard suggesting either a future threat or immediate impact (Liu et al. 2008).

Where communication channels allow for multimodal messages, senders can capitalize on the distinct potentials of each mode for creating meaning. It is assumed however, that the typical channels used in a disaster will place limitations on employing multiple modes. There is a lack of research investigating the effectiveness of different modes of communication in disasters. I will at least investigate the barriers, which limit multimodal messages from being sent or received.

2.5.5. Redundancy and consistency

Regardless of the number of semiotic modes a disaster warning may employ, individuals need to perceive multiple disaster warning signs to convince themselves of the seriousness of the situation. The fewer signs they observe, the less urgent they will perceive the threat (Drabek 2013, p. 69). This supports the argument of Nöth (1990, p. 140), that reducing redundancy threatens the effectiveness of the message.

While having the same warning repeated will help convince the individual that the threat is real (Mileti and Beck 1975), people will also seek additional sources for validation (Sorenson and Mileti 1988; Streeter 1991), such as family and friends, television, and radio. Although redundancy within a message increases the intelligibility of the message (Hartley 2002, p. 198; Nöth 1990, p. 141), multiple messages can lead to confusion if they do not convey a consistent meaning (Quarantelli 1983; Button 2010). Any contradictions among the various disaster warning messages will cause people to seek more information for validation and will delay response decisions and actions (Lindell and Perry 2011). Contradictions can also cause people to downplay the danger (Auf der Heide 2004).

Thus, uniformity of signs across a multitude of communication channels and senders is critical to convince people that threats are real. It is assumed that changes in semiotic modes as well as limits in channel capacity will have negative impacts on maintaining meaning in a message.

2.5.6. Meaning of silence or inaction

Communication theorist Paul Watzlawick (1967) famously stated that "one cannot not communicate". Watzlawick (1967) argues that there is "message value" in every behavior, even silence or inactivity. As such, communication can be unintentional. This suggests that if a warning does not discuss a particular hazard, it may be communicating that there is no risk of that hazard. Similarly, the sender may interpret inaction on the part of the receiver to mean that they have ignored the disaster response message. However, inaction is only an indication of a communication problem: it does not identify what the problem is. Only through feedback can a sender confirm why the message failed to result in the desired action. Through feedback, the sender can distinguish among those who did not receive the message, ignored it, did not understand it, or who lacked the means to implement the disaster response actions.

2.6. Lessons-learned Reports and Real-time Evaluations

A common method for analyzing disaster response is to carry out post-response evaluations, often referred to as "lessons learned" or "after action" reports. The main purpose of such reports is to identify what changes should be implemented in order to improve future responses.

Post-response reports can take a long time to produce. Following Hurricane Katrina, Hurricane Sandy, and the 2011 Christchurch Earthquake, official post-response reports were issued 6, 8, and 16 months after each disaster respectively (The White House 2006; FEMA 2013; McLean et al. 2012). Thus, post-response reports do not have the ability to enhance the disaster response being assessed for the obvious reason that they are carried out long after the response phase is over. The result, is that lessons learned can only be applied to future disasters.

In the field of humanitarian relief, the inability of post-response reports to enhance the response under investigation has led to the development of real-time evaluations. The typical time-frame of such reports is to begin field work 4 – 6 weeks into a mission and complete a report within a month (Jamal and Crisp 2002). The strength of real-time humanitarian evaluations is that results are produced while the mission is still operational (see Figure 2.5). Results can therefore influence the mission under investigation.

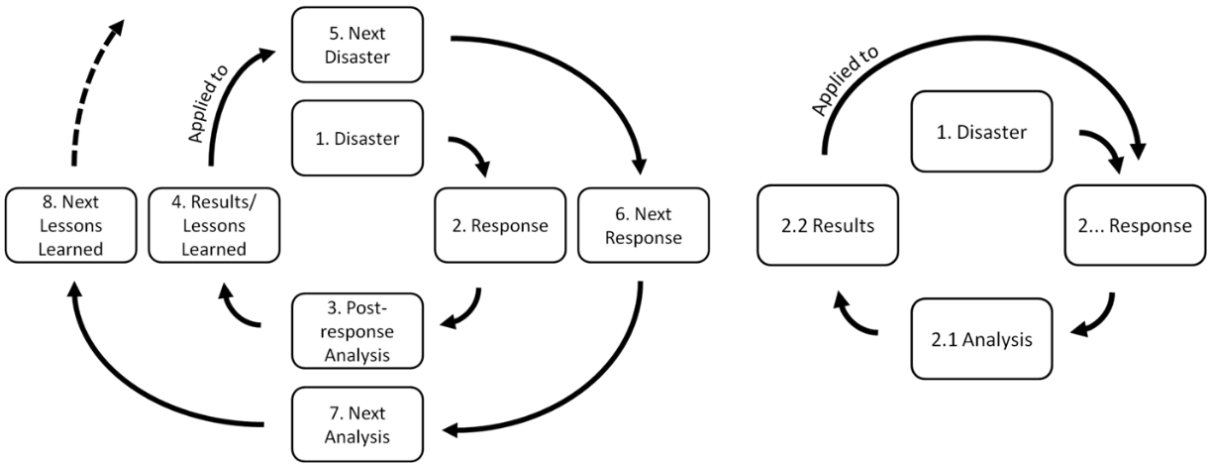

Figure 2.5: Post-response analysis (left) vs. Near-real-time analysis (right)

A key hypothesis is that certain properties of disaster response messages can be analyzed shortly after they have been made public. Based on such an analysis, future disaster response messages could then be improved in near-real-time (Figure 2.5). Furthermore, disaster response information producers could critique their own messages prior to releasing them to the public, if they have an appropriate strategy for doing so.

Some of the issues raised in post-response reports could theoretically be identified within days of a disaster rather than waiting months for a full report to be compiled. If communication issues can be identified within days of the disaster, then those issues could potentially be corrected during the response phase. For example, months after Typhoon Haiyan (2013), it was revealed that many of those who died due to storm surge, likely did not understand the meaning of the term 'storm surge' used in the typhoon warnings (Neussner 2014). If this revelation was made prior to landfall, the warnings could have been altered to explain the details of the hazard. In

turn, the public may have gained an increased understanding of the risk associated with the typhoon, and more would have evacuated, saving many lives.

The clarity of hindsight is achieved in part because it is not constrained by the temporal, physical or technical constraints associated with the disaster environment. Post-disaster critiques also benefit from the knowledge of what went wrong, and often use this as a starting point for investigation. Communication of disaster response messages on the other hand, demand action within hours or days, rather than months, requiring an entirely new approach to produce an analysis so quickly. Furthermore, real-time evaluations in their current form are aimed at enhancing international humanitarian relief projects. Carrying out an analysis of disaster response messages during the handful of days before and after a disaster requires a shift in focus from the international actors to the national government and subsequent disaster communication system.

2.7. The Disaster Communication System

A simple strategy for describing any system is to break it down into its various components. The typical components of the disaster communication system include the information being distributed, as well as the actors, channels and ICT involved. The following discusses these components and the key barriers associated with each. The barriers can compromise the effectiveness of disaster response messages.

2.7.1. The Content in a message

The content of a message will influence how the public responds (Perry 1979; Sorenson and Mileti 1991; Sorenson 2000; Lindell and Perry 2004). It is recommended that a warning message contains the locations at risk, characteristics of the threat, guidance about what to do and time until the threat occurs (Drabek 2013; Mileti and Sorenson 1990, 5.4; Sorenson 2000). Details also need to be specific (Mileti and Sorenson 1990; Mileti 1999: 3512; Sorenson 2000). For example, Arai (2011) documents how local residents in areas hit by the Tsunami created from the 2011 East Japan Earthquake, while knowing that a tsunami warning had been issued, underestimated the threat because specifics, such as the time and height of the tsunami were unclear.

Mileti and Sorenson (1990) also argue that the characteristics of the receiver need to be addressed by the content of the message. Table 2.1 provides the list of receiver factors, mostly identified by Mileti (1999: 4290 – 4327). To the right of each factor I have provided an example of content which could potentially address each factor. For example, the first two factors regarding cues suggest that people who perceive physical or social cues are more likely to respond. The content of the warning message could include an explanation of those cues. By identifying cues which the public can expect to see, and explaining what they mean, the message can improve the likelihood that those cues will be perceived and understood. There is also an element of redundancy which is positive, since by the time the person perceives the cue, they will have already contemplated it beforehand, resulting in a greater effect if it is consistent with the previous information.

Table 2.1: Potential content to address receiver characteristics

Factor	Examples of content to address factors
*Physical cues	Identify/explain physical cues
*Social cues	Identify/explain social cues
*Perceived risk	Specify risk
*Knowledge of hazard	Explain hazard
*Experience	Remind of past experiences
*Family plan	Outline potential plans
*Fatalistic beliefs	Describe actions to combat threats
*Resource level	Identify resources
*Family united	Specify family uniting services
*Kin relations (number)	Advise to relay message to family
*Having children	Identify children specific response plans
*Personal contact	Identify response agency contacts
*Proximity to threat	Specify location of risk
*Number of channels	Identify other channels
*Frequency	Identify when future messages will be sent
*Message consistency	Reference other sources
*Message certainty	Clarify uncertainty
*(Authority) of source	Confirm authority of message
*Fear of looting	Address concerns
*Time to impact	Specify time to impact
*Source familiarity	Explain who source is
Mobility	Advise of alternative transportation options
Disability (comm.)	Enhanced message (e.g. subtitles)

* source: Mileti (1999: 4290 – 4327)

Mileti and Sorenson argue that disaster warnings should address receiver attributes and highlight the importance of effective disaster warnings for those receivers characterized by attributes that may limit their ability to correctly process and act on disaster warnings (1990, p. 5.12). For example, clearly explaining a hazard would benefit those with a low "knowledge of hazard", detailing alternative transportation options would benefit those without vehicles, and providing warnings on television with subtitles would benefit those with impaired hearing.

Table 2.1 above acts as a list of content to include in a disaster response message, or at the very least, factors that the content should address. An alternative approach to identify the contents of a message, is to ask what questions that content should answer. Drabek (2013 p. 71) provides a set of questions that he argues every disaster warning needs to answer. These questions focus on the hazard, whereas Lindell and Perry (2004) present questions which focus on the protective actions. When a question cannot be answered, Lindell and Perry (2004) state that an information seeking process will be initiated. The questions associated with these different stages, and additional potential semiotic questions are presented in Table 2.2.

Table 2.2: Questions the public needs answered in warning phase

Basic questions to answer (Drabek 2013 p. 71): ✓ What is threatening? ✓ Who is threatened? ✓ When is it coming? ✓ What protective action should be taken?
Protective action questions to answer (Lindell and Perry 2004 p. 47): ✓ Is there a real threat I need to pay attention to? ✓ Do I need to take protective action? ✓ What can be done to achieve protection? ✓ What is the best method of protection? ✓ Does protective action need to be taken now?
Information seeking questions to answer (Lindell and Perry 2004 p. 47): ✓ What information do I need? ✓ Where and how can I obtain this information? ✓ Do I need the information now?
Semiotic questions to answer: ✓ What do the codes in the message mean? ✓ What meanings is the message trying to convey? ✓ What meanings are the most important to me?

Lastly, the content could also include information to address impediments to implementing the response actions. For example, in addition to advising the public to evacuate, authorities could identify which routes to take, expected travel time due to congestion, and how one is expected to evacuate if they lack a vehicle.

The combination of the list of potential content and questions to answer can act as a baseline for information producers to strive to meet. It is assumed that not all information can be provided in a single message. If true, then a method to prioritize the information needs of the public is required.

Information overload

The literature suggests that a lot of information must be included in disaster warnings; however, providing too much information may prove ineffective due to the problem of 'information overload'. Rogers (1986 p. 181) defines information overload as "the state of an individual or system in which excessive communication inputs cannot be processed, leading to breakdown". Having more information than can be processed, leads an individual to miss potentially critical information (Case 2002 p. 8). Information overload is a common problem with online information. As Verma et al. (2011) argue, the abundance of information available online about a disaster, can render a search for specific information ineffective. Information overload is not only a problem for individuals, but also for responding humanitarian agencies (Harvard Humanitarian Initiative 2011; Aoyama et al. 2013).

2.7.2. Relationship between actors

Information sources, intermediaries and channels are closely linked. An information source is identified as the person or agency who produced the original message. This may be the scientific agency monitoring a weather disturbance, the disaster management authority who is enacting a mandatory evacuation, or a member of the public who is witnessing disaster impacts. An intermediary is anyone who relays a message to a receiver. A channel is the method employed to send a message. The use of the term "channel" is similar to ICT; however, ICT also includes the details of the equipment used, such as whether it is a smartphone or a basic cellphone receiving a text message. Thus, a 're-tweet' involves a person (source) sending a message, which is shared by another person (intermediary), via social media (channel) to a receiver accessing it with a smartphone (ICT).

Every source and intermediary are also considered a sender. It is often hard to distinguish the source. For example, due to the volume of information collected, edited and reposted on social media platforms like Facebook and twitter, it is difficult to know who produced the original message. Furthermore, the entire message may not originate from a single source. News agencies often edit content of messages originating from government agencies or individuals affected by a disaster. This blurs the line between who produced what information. Potential information sources are national scientific agencies which monitor weather developments, government agencies in charge of disaster response and relief, news media, emergency services (police, army, firefighters, or coastguard), emergent groups, and the public themselves.

Communication scholar Wilbur Schramm (1954) developed a model of communication in which he introduced the concept of 'field of experience'. Both sender and receiver have their own unique field of experience which may be influenced by a variety of factors, such as their education, job, location or social status. Schramm (1954) argues that only those parts of the message that are common to the field of experience of the receiver will be fully understood. In communicating disaster response information, each sender and receiver may have different experiences of disasters, knowledge of hazards, and understanding of risk.

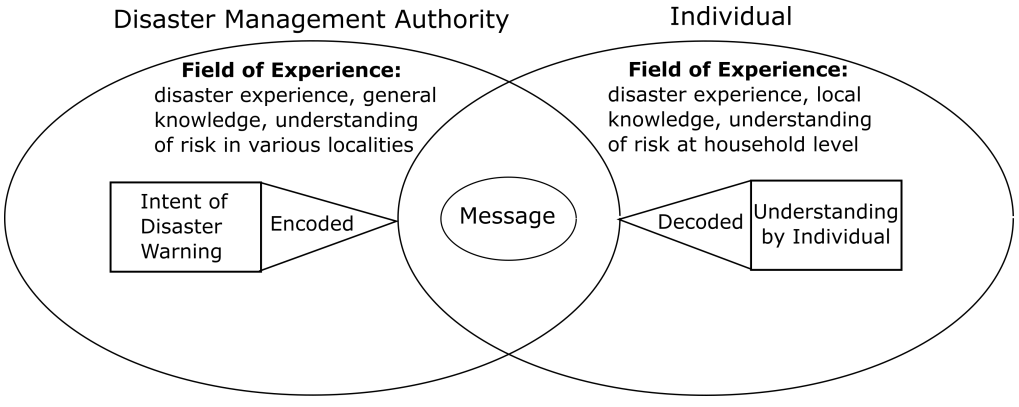

Figure 2.6: Adaptation of Schramm's model to disaster communication

The relationship of sender and receiver can be affected by the level of trust between the stakeholders or the role each stakeholder assumes they and their counterpart are filling. Watzlawick (1967) states that the way in which the receiver interprets the message is influenced by this relationship with the sender. While this relationship may be pre-existing, this should not

be assumed in all cases. A relationship can also be created by the act of communication itself (Watzlawick 1967; Schulz von Thun 1981).

Schulz von Thun (1981) argues that every statement made contains a *self-assessment* and a *relationship indicator*. The 'self-assessment' refers to how the speaker perceives their own role in the communication exchange. Conversely, the 'relationship indicator' refers to how the speaker views the listener in relation to them. Both a self-assessment and relationship indicator are often present in disaster communication. The self-assessment may contribute to confirming that the information comes from a legitimate authority on the subject. A disaster warning typically connotes that the government is in charge, and that the public is in need of direction, protection, rescue, and relief from government resources. Communication can be ineffective when the public does not perceive the government to be in charge, to be experts, or simply does not trust the government in general (Tyler 2001).

Watzlawick (1967) states that as two individuals or groups continue to communicate over time, each participant's behavior will progressively become more pronounced. The behavior of the two sides will advance symmetrically or complementary to each other (Watzlawick 1967). If both sides promote preparedness, then the level of preparedness for each will grow symmetrically with each communication. Similarly, if both sides promote ignorance, or control over the situation, then these behaviors will also progress symmetrically with each communication.

A complementary progression in behavior would be if one side is assertive in issuing evacuation instructions and the other submissive in following them. In such a case, the former will become more assertive over time, and the latter will become more submissive. This argument would suggest that the more an individual acts in opposition to government instructions, the more likely they will do so in the future, resulting in a hopeless battle if one wants to alter their behavior. This would be the case if it were not for the person's ability to learn from past experience. If an individual is impacted by a disaster as a result of ignoring warning instructions, they may alter their behavior in future instances. Watzlawick's axiom suggests that if there were no negative results from ignoring a warning, then an individual will be more likely to ignore a similar warning in the future. In such cases, changes to the messages could strengthen the arguments for evacuating.

2.7.3. Official actors

While there are many potential information sources, it is important to distinguish between the official and unofficial sources. I define official sources as those which have a mandate to inform the public of disaster warnings and relief information. The official information sources typically include national scientific agencies, various levels of government, and emergency services. Though the news media is critical to informing the public, they do not have a mandate to produce information. Hence, the news media can be viewed as a channel through which official information sources distribute messages.

After a disaster, it is typically the duty of local governments and emergency services to fulfil the information needs of the individuals affected. If the local government does not have the capacity to manage the response, then higher levels of government will be activated. Only in major events does the international community respond, but their response is subject to national government approval and conditions. This order of response underlines the fact that even after a disaster, the duty to inform lies mostly with a nation's government and their various institutions, rather than

the international community. Thus, international sources of information may have greater success in reaching the public if they collaborate with official actors.

Scientific agencies

Scientific agencies provide details of the threat and often estimate a certain level of risk. Being at opposite ends of the disaster information distribution chain, there is a large disconnect between the scientific community and the public. Hence, it is often observed that scientific advisories detailing potential hazards do not translate to an understanding of risk by the public (Asian Human Rights Committee 2011; UNOCHA 2013a; Neussner 2014).

Government authorities

The national government issues information to lower levels of government, news media, and sometimes directly to the public via social media. The national government typically only issues general warnings, as it is not in a position to understand or discuss every hazard, preparedness or post-disaster issue in every locality. It is assumed that the national government will greatly rely on the lower government units to ensure general disaster messages are supplemented with local knowledge and context. If this does not occur, then general disaster messages would simply be relayed down the chain without any attempt by lower levels of government to explain what the warnings mean to their locality.

Local government or community organizations are at a critical point in the disaster information distribution chain as they have access to both the public and to information sources. These local institutions collect and distribute disaster messages to the community, and often times convert from one communication medium to another, or translate/contextualize the content. For example, Voltaire (2015) documents how the local government of Daram, an island municipality in the Philippines, converted online media and hazard maps into text messages sent to village councils in the local language prior to the arrival of Typhoon Hagupit.

2.7.4. Unofficial actors

Although there is a formal system in place to disseminate disaster response information, the communication scholar Donald O. Case warns of the myth that information can only be obtained through official sources (2002 p. 8). Countering this myth, Kuhlthau (1993, p. 108) found that informal sources are more likely to be sought for general information than formal sources.

News agencies

The public learns about general issues in society through mass media news agencies operating with television, radio and print media found in newsstands or online websites. The general dependency of the public on news agencies is related to the stability of the society, and whether or not the media are providing important information (McQuail and Windahl 1993, p. 111). In disaster situations, news agencies have proven to be important intermediaries for distributing warnings to the public (Garnett and Kouzmin 2007), and are potentially the most important source for information in the days after a disaster (Scanlon 2011).

The advantage of news agencies is that they are easy to tune-in to with television, radio or online websites. News agencies also have access to a wide variety of information sources. Reporters often interview disaster management officials or disaster affected individuals. Social media and other online platforms are also greatly increasing the capacity of news agencies to collect and disseminate information.

The media has many flaws. A major flaw is their general lack of critical analysis in framing news stories. For example, because warnings are based on scientific evidence, and news agencies are not scientific experts, they may simply relay the warnings to the public, meaning that local context is not taken into account. Unless followed up with localized disaster messages, such warnings may run the risk of being too general to be effective. During disaster situations, news agencies have also been known to provide misleading and oversimplified information, leading the public to focus on the wrong issue or threat (Mileti 1999: 4960).

The meaning of news stories can also lead to confusion. As Hall (1980 p. 135) explains, meaning can become distorted in a systematic way because the public may not be operating within the news agency's preferred code (Hall 1980 p. 135). McQuail (2010 p. 459) argues that in news stories, there is no automatic transfer of meaning, but rather a negotiation of what the news agency is offering as its angle, with all of its flaws, and what the public is able to decode and is willing to accept. Palen and Liu (2007) suggest that the use of news agencies as the main intermediary between a disaster management authority and the public after a disaster is outdated. Palen and Liu (2007) predict that other forms of communication will become more prevalent, especially internet based peer-to-peer information sharing platforms.

The public

Case (2012 p.8) states that in day-to-day situations, people rarely use formal sources to obtain information, and instead turn to family and friends. Rogers (1983 p. 5) describes how innovations can be spread among a population by various means of communication over time, in a process he refers to as "diffusion". Similarly, Rogers and Sorenson (1993) discuss the importance of disaster warnings reaching individuals through social networks, in what they term "diffusion of emergency warnings". Sorenson (2000) estimates that the diffusion of emergency warnings through informal communication channels can account for one half of initial warning. Perry (1987) also provided evidence that informal actors can extend the coverage of warnings within communities in a short period of time.

Advancements in ICT have increased the visibility and impact of the public in disaster response and citizen journalism (Palen and Liu 2007). Individuals can now disseminate information to thousands of others, bypassing the media, in what is termed *self-directed mass communication* (Castells 2005 p. 13). A communication model by Pechta et al. (2010) has placed the public at the center of a disaster, informing other publics, authorities and responders about the situation and identifying response needs. As a result, disaster management authorities are engaging with the public more and more.

Shklovski et al. (2008) state that people often do not know how to obtain relevant information. When official information is too slow, communities often rely on each other for information. Individuals make use of internet based tools such as social media, community forums, or even create their own tools to meet the needs of the disaster such as finding missing persons (Shklovski et al. 2008).

Emergent groups

Disasters represent dramatic change in a society. Fligstein and McAdam (2012 p.4) claim that "in times of dramatic change, new ways of organizing 'cultural frames' or 'logics of action' come into existence". This often results in social space occupied by different groups who need to interact for each other's benefit, but have not yet established a stable way to do so (Fligstein and McAdam 2012 p. 86 – 87). Groups within shelter camps, aid distributors, and temporary workers can all be seen as occupying a newly created social space in which they will need to cooperate with each other. Many of these individuals or groups will come together to form larger emergent groups.

The collapse of organizations which could have helped the response efforts, is often accompanied by self-organizing groups of individuals working to fill the gaps in the response (Comfort and Kapucu 2006). Groups of individuals with common goals often emerge after disasters (Quarantelli and Dynes 1977). Some of these groups act as information brokers, as they collect disaster information and share it with disaster affected communities. Examples of emergent groups include fishing organizations, camp management committees, and farmers' associations.

Individuals need to be able to change their behavior to adjust to the needs of the situation, which may involve helping others. They need information to do this, and as they begin to work with others, they also share information with each other. As a self-organizing group emerges after a disaster, their effectiveness will be tied not only to their ability to act, but to their ability to gather information, evaluate it, share it, and adapt their actions based on that information (Comfort 1995). Appleby (2013) argues that the information produced by these emergent groups needs to be integrated with the official disaster message distribution chain.

Digital humanitarians

Traditionally, international actors, such as foreign media or scientific agencies, as well as any individuals living outside of the country in question, were not major information sources for disaster response information. However, advances in information and communication technology (ICT) have made it possible for international actors to collect data about hazards, risks and impacts remotely or through local contacts, and produce information which could be useful to communities before and after a disaster.

Examples of these groups include Crisis Mappers, Digital Humanitarian Network, Humanity Road, Kathmandu Living Labs, Standby Taskforce, and Ushahidi. Starbird and Palen (2013) traced the development of Humanity Road, whose origins started with a desire to counter the lack of information available to disaster affected communities.

This new internet-based community of volunteers are referred to as 'digital humanitarians' (Meier 2015). Case after case is emerging in which digital humanitarians have been major contributors to the response effort. At the core of every digital humanitarian response is the communication of disaster response information. The online response to the 2010 Haiti Earthquake is considered the birth of digital humanitarians (Meier 2015), and major online responses to disasters have continued since. A notable large-scale response launched by digital humanitarians followed the 25 April 2015 Gorkha Earthquake in Nepal. The response included

local and international actors, with links to local governments, the national army, and local and international relief agencies (Kathmandu Living Labs 2015).

Digital humanitarians can fill enormous information gaps, especially after a disaster when altruistic behavior is at its highest. While some disaster management authorities incorporate some digital humanitarians into the response effort, there is often a substantial amount of useful information produced by digital humanitarians that reach the disaster affected population by informal means. In such cases, the technical, social-psychological, and semantic problems are often compounded by the physical and cultural disconnect between the online community and the affected individuals. The need to bridge this gap reinforces the argument for developing a model that can help sources visualize the technical and semantic barriers to communicating with the public.

Humanitarian agencies

Many humanitarian agencies may also be emergent groups or digital humanitarians. Humanitarian agencies appear to be able to respond quicker and in greater number than ever before. Within two weeks of the 25 April 2015 Nepal Earthquake, a total of 513 humanitarian agencies were in Nepal responding to the disaster (Standby Task Force 2015). Many of these agencies gathered data on impacts, needs and relief, and issued reports, maps, or info-graphics to the online community (ReliefWeb.com). A number of these agencies also engaged in two-way communication with the government, news agencies and with individuals from disaster affected areas.

2.7.5. Channels and ICT

A wide range of channels are now available to transmit disaster response information to the public. Improved communication technology has been a major factor, such as enhanced cellphone capabilities (smartphones and radio applications), increased internet penetration, text message alert systems, and social media platforms. As the technology improves, more people will receive disaster response information than ever before if those who produce disaster response information incorporate the new technology into their communication plans. For instance, the Canterbury Emergency Management Group established the Canterbury Earthquake website as the official website for disaster response information following the Christchurch earthquakes of 22 Feb and 23 Dec, 2011 (canterburyearthquake.org.nz). The website acted as a one-stop shop for disaster information.

Appleby (2013) argues that rather than rely on a single channel, multiple channels should be used, because every channel has its place in a disaster situation. In India, prior to landfall of Cyclone Phailin in 2013, the government's disaster communication plan appeared to use a variety of communication channels to reach a very wide audience. The government distributed disaster warnings to the public via face-to-face interaction, loudspeaker, newspaper, radio, television, email, social media, cellphone calls, and text messages (Padhy et al. 2013). The government also distributed satellite phones to government offices in 14 of the most vulnerable districts to maintain communication during the cyclone (Government of Odisha 2013). The result was the successful evacuation of approx. 2 million people; the largest in India in 23 years (Padhy et al. 2013).

Sociologist and communication scholar Everett M. Rogers categorizes communication channels into three types: face-to-face interpersonal communication, interactive communication, and mass media (Rogers 1986 p. 21 see Table 2.3).

Table 2.3: Main Characteristics of Communication Channels: Interpersonal, Interactive, and Mass Media (Rogers 1986 p. 21)

Characteristics of Communication Channels	Face-to-face Interpersonal Communication	Interactive (Machine-Assisted Interpersonal) Communication	Mass Media
1. Message flow	One-to-few	Many-to-many	One-to-many
2. Source knowledge of the audience	Source has knowledge of the receiver as a single individual	Source may have a great deal of knowledge of the participants in an interactive system	Source is a media organization with little knowledge of the receivers
3. Segmentation	High (de-massified)	High (de-massified)	Low, the same message is transmitted to everyone (massified)
4. Degree of interactivity	High	High	Low
5. Feedback	Plentiful and immediate	Somewhat limited; may be either immediate or delayed	Highly limited and delayed
6. Asynchronicity (ability to preserve the message)	Low	High for most types of the new media	Low, but high for some media, such as books and newspapers
7. Socio-emotional versus task-related content	High in socio-emotional content	Low in socio-emotional content	Low in socio-emotional content
8. Nonverbal band	Lots of nonverbal communication	Some new media provide nonverbal communication	Visual mass media provide much nonverbal band; audio mass media do not
9. Control of the communication flow	Potential for equal control by the participants	Potential for equal control by the participants	Little control by the receivers of the mass media
10. Privacy afforded	Low	Usually low	High

Communication channels vary in their ability to capture attention and provide comprehensible messages (Lindell and Perry 2011). Rogers (1986 p. 21) rates a number of characteristics of the three types of communication channels. Each characteristic is important to consider when attempting to reach an audience. Targeting certain groups of people ("segmentation"), for example, is better done through interpersonal and interactive channels.

Kress and Leeuwen (2006 p. 154) state that the type of channel can influence the receiver's belief in how reliable the message is. To some, newspapers may be more credible than social media,

and to others the exact opposite may apply. While they will change from person to person, many of the characteristics in Table 2.1 are likely to influence the person's perception of credibility. For instance, the ability to provide feedback may be important to some receivers, while the ability to preserve the message may be important to others.

While language is still the predominant form of communication, visual modes are increasing in credibility (Kress and Leeuwen 2006 p. 35 – 36). For instance, a photograph or video, of an oncoming cyclone or of impacts after landfall, may be regarded as a more reliable representation of the event than written or verbal descriptions (Liu et al. 2008).

Interpersonal face-to-face communication

Interpersonal "face-to-face" communication is trusted more than other modes of communication (Mileti and Beck 1975). Perry (1987) stressed the importance of face-to-face communication during disasters, which was often selected in lieu of the quicker option of making a phone call. There are a number of reasons which could explain this. Mileti and Beck (1975) argue that people are more likely to believe a message if it was specifically targeted to them, then if it was meant for the general public. Face-to-face communication is also argued to be effective in persuading someone to adopt a new idea or practice which may contain a level of risk (Rogers 1983 p. 18). Face-to-face communication allows for social skill to be applied to its fullest. Fligstein and McAdam (2012 p. 46) define social skill as "the ability to induce cooperation by appealing to and helping to create shared meanings and collective identities".

Interactive interpersonal communication

Although written in 1986, Everett M. Rogers' *Communication Technologies* approached computer technology in a way that is surprisingly still relevant to the use of modern ICT. Rogers (1986 p. 5) likens "machine-assisted" communication to face-to-face communication. A large reason for this was that machine-assisted communication can be two-way and is capable of targeting individuals. Interactive communication today is also two-way, can target individuals, and is even quicker and more mobile than in 1986.

The public can now communicate with each other through either text message or via internet based platforms, such as live discussion forums or social media. During an emergency, individuals may use those same platforms to connect with anyone monitoring the platform or with a targeted recipient directly. The mobility provided by smartphones improves the utility of internet based communication platforms during disasters.

Improved technology such as social media may facilitate conversation (Crowe 2012, p. 16); however, such improvements can increase both wanted and unwanted interaction (Axelrod and Cohen 1999, p. 79). Though there are calls for tools to monitor social media to learn about the disaster environment (Beneito-Montagut et al. 2013), the fact that there are often millions of tweets one would need to filter and sort (Imran et al. 2013), makes the task very difficult. That being said, social media is becoming widely used during disasters. The 2010 Haiti Earthquake was the first major disaster in which affected people requested help via social media using smartphones (Harvard Humanitarian Initiative 2011). Various researchers have identified social media as a robust and useful technology for disaster communication (Haddow and Haddow 2014; Meier 2015; Palen and Liu 2007; St. Denis et al. 2014; Sutton et al. 2008; Verma et al. 2011).

The integration of social media into official response is also changing. In the past, the incident command system was criticized for being too rigid for the incorporation of social media (Palen and Liu 2007). In recent years, however, incident command systems like the Federal Emergency Management Agency (FEMA) have recognized the utility of social media and embraced it as part of their official communication strategy (Haddow and Haddow 2014). In the Philippines, disaster management authorities have been praised for setting new standards of practice for social media use during disasters (Meier 2015 p. 32).

Communities can now supplement news agencies' and national government's lack of local information, by actively engaging and sharing information with others in their community (St. Denis et al. 2014). Potts (2014) lists a number of internet-based communication channels that the public can use to connect with their fellow community members (p. 66). Often, the information produced and shared at the community level are picked up and distributed by officials or news agencies (Sutton et al. 2008).

Though internet and social media platforms are useful tools, they are often not available to key vulnerable groups (Appleby 2013). This is a critical point to consider. It is assumed that lacking internet access greatly reduces a person's ability to receive internet based information. If true, this would mean that alternative modes of communication need to be employed by those who typically transmit information exclusively online. Case (2012 p. 9) supports this argument, stating that information producers should not assume that their standard format of distributing information can be effectively used by the public.

Social media has also been criticized for its ability to spread rumors; however, rumors can be spread through any communication channel, even word of mouth and mass transmission channels. During the days after Hurricane Katrina, many of the horrific stories distributed by major news agencies on television, radio and newspaper about sexual assaults, gang violence, carjacking, and even helicopters being shot at, turned out to be rumors (Welch 2005). These rumors caused unnecessary panic, delayed response efforts, and prevented the delivery of aid in some cases, as agencies altered their behavior to deal with problems which did not exist (Welch 2005). While social media has the potential to spread rumors quicker and to a wider audience than other channels of communication, social media platforms can also counter misinformation with equal speed and coverage (Beneito-Montagut et al. 2013; Lopatovska and Smiley 2013; St. Denis et al. 2014).

Mass transmission

Traditionally, disaster management authorities have distributed information to the public through news agencies which transmitted the message via television, radio and newspaper. The term used by Rogers (1986) in Table 2.3, "mass media", is difficult to define today. It is no longer restricted to television, radio and print media. Internet websites and social media platforms such as Facebook and Twitter may also be used as a vehicle to transmit messages to the masses. A common alternative term, "mass communication", is also misleading, since two-way messaging is typically association with the term communication. As such, McQuail states that "mass transmission" would be a more appropriate term (2010, p. 57). Hence, I will use the term mass transmission, to refer to the transmission of a message through any channel, to a large mass of individuals, in one direction only, i.e., that does not allow for two-way communication.

McQuail (2010 p.57) argues that aside from being one-directional, mass transmission is often one-sided, impersonal, and manipulative. Yet, mass transmission can be beneficial during disasters because it maximizes speed, scale, consistency, and potentially authority. Television for instance, can disseminate a large amount of information to a wide audience. In-depth coverage of disasters can discuss disaster response information at length. Television can also broadcast information using a variety of formats, such as images/video, sound, and written text.

The detail of the information contained in mass transmission messages is typically related to the scale of transmission itself. For example, a radio or television station with a nationwide audience, would transmit very general information in comparison to local radio stations with a local audience. Community specific disaster response information, such as the houses at immediate risk of flooding, orders to evacuate, and available transportation to safe areas, are typically more available at the local level than at the national level.

Certain information channels may also be better suited to one information processing stage than another. Sorenson (2000) identifies outdoor sirens, electronic media and route alert as the most common technologies employed for initial disaster warning. Drabek (2012 p. 122) however, claims that mass transmission is rarely a major component of initial alerts for evacuation. Rather he argues that television and radio are used as a secondary source for validation (Drabek 2012 p. 122). Printed material, on the other hand, can provide detailed information once a person is already aware of the hazard (Mileti 1999: 3508).

Text messages and social media can also take on the form of mass transmission, if no response is planned. Disaster management authorities in many countries now send text message alerts to a targeted section of the public based on their location (Aloudat et al. 2007). The Indian government for example, sent warnings to more than 10,000 people by text message before Cyclone Phailin made landfall (Price 2013). Likewise, government and relief agencies post important information to social media pages for information purposes rather than as a way of engaging in two-way communication.

Finally, online information which is communicated one-way can also fall under the category of mass transmission. Hurricane Katrina is documented as being one of the first disasters which resulted in an overwhelming amount of information produced by internet based groups (May 2006). Today, any major disaster will result in hundreds of reports, maps, blogs, and websites. For instance, within the first two weeks after the 25 April 2015 Nepal Earthquake, more than 1,000 documents were posted to the humanitarian relief information website, ReliefWeb alone (Daniell et al. 2015).

2.7.6. Information limitations

A disaster information website, such as ReliefWeb, can contain a seemingly endless amount of information. While research suggests that more information is better to inform people of hazards and response options (Auf der Heide 2004), temporal and technical constraints can result in only a small amount of information reaching communities. Temporal constraints are greatest at the local level because the local community is typically the last to receive messages. Technical constraints, such as a general lack of internet access, also exist at the local level, and are worse in rural communities and among vulnerable populations (IFRC 2015, p. 186).

Due to these time pressures and technical limitations, local governments may need to inform individuals by quick and simple channels of communication like face-to-face interaction, text

messages, social media or megaphone. Each of these technologies has information capacities which will restrict the amount of information that can be communicated. The time available for face-to-face interaction is short due to the need to inform other people. A text message is limited to 160 characters and a Twitter message is limited to 140 characteristics. Finally, someone traveling on a motorcycle repeating messages through a megaphone may need to adjust the length of their message based on the speed they travel (Lindell and Perry 1989). Thus, local governments typically condense the large amount of information they receive into a transmittable size. Potentially, they lose a substantial amount of meaning in the process.

There is a clear problem in that while the literature recommends a large amount of information be produced to fulfil the public's information needs during a disaster, there is often limitations on the amount of information which can be sent. There are two approaches to solving the problem of sending a message which is larger than the channel is capable of sending. The first is to break up the message into different parts and send with multiple messages. The second is to reduce the size of the message. In practice both are presumed to occur. When selecting the first method, it is assumed that priorities will need to be made, i.e., the most important information sent first. The second method is assumed to result in a loss of information. Both solutions are assumed to lead to major issues if not done right.

2.8. A Systems Approach

The communication of just a single disaster response message from source to receiver involves a number of interdependent factors. The characteristics of the intermediaries involved will influence how the meaning of the message is decoded and encoded as it is forwarded down the communication chain. The characteristics of the communication channels will place limitations on the type and quantity of information which can be sent. The decisions made by the receiver will be based on the information they receive, their interpretation of it, and social-psychological factors. Lastly, the actions the receiver intends to enact may be prevented due to situational impediments.

Anyone who seeks to deliver information to the public during a disaster situation, needs to understand how the various components of the system interact, and what barriers to effective communication can be expected. Luhmann (1989, p. 11) asserts that a system is never as complex as its environment. This is perhaps an understatement for the disaster environment, which is highly unpredictable and rapidly changing. On the one hand, a disaster environment cannot be accurately described until the disaster has occurred. On the other hand, it is challenging to grasp the various elements of a disaster environment once the disaster has occurred. Hence, one of the first steps for any disaster communication system in response to a disaster event, is to assess what defines the disaster environment. In order for a disaster response system to be successful, it then needs to continuously adapt to this dynamic disaster environment (Comfort 1999). When a disaster occurs, in the words of Luhmann describing self-referential systems, "the system produces and reacts to an unclear picture of itself" (1995, p.28)

A systems approach is thus needed to identify the barriers associated with effectively delivering a disaster response message from source to receiver in a dynamic disaster environment. Systems theory acknowledges multiple and interrelated causal factors, and emphasizes process and feedback (Axelrod and Cohen, 1999; Holland, 1995, 2014; Luhmann 2013; Mileti 1999). The challenges which arise in transferring meaning in a disaster response message are presumed to be

the result of interaction between various physical communication systems, social systems, and the environment within which disaster communication takes place.

2.8.1. Adaptability

The computer scientist John H. Holland defined adaptation as "changes in structure (strategy) based on system experience" (1995, p. 9). The adaptive behavior of the immune system, as presented by Holland (1995, p. 2) provides a good example on which to base disaster communication. Rather than attempt to pre-configure a series of anti-bodies to fight every possible virus, the immune system's tactic is to adapt its anti-bodies to each new virus. An adaptive approach would benefit disaster communication. Predefined sets of disaster messages and strategies for delivering those messages, like anti-bodies in the immune system, need to be adapted to every new dynamic disaster environment. The right amount of structure and flexibility is needed for an adaptive strategy to be successful (Comfort 1999, p. 267). The structure of the system facilitates operation. Flexibility allows the system to meet the new and often unpredictable demands of a dynamic disaster environment.

A key to complex adaptive systems is that a small input can have large effects (Holland 1995, p. 5). The same is true with disaster communication: a small but important message, such as a tsunami warning, can potentially save thousands of lives. Similarly, an inappropriately designed or disseminated message can lead to unnecessary loss of life. Holland refers to these small inputs with major effects as "lever points" (1995 p. 5). One potential outcome of this research is the identification of lever points in a disaster communication system. For example, providing the right information, selecting the right intermediary to send that information to, and obtaining feedback from receivers, could prove to be lever points, which could greatly improve disaster response actions.

The actors in the disaster communication system are comparable to the "agents" described by Holland, which make up a complex adaptive system (1995 p. 7). Agents respond to stimulus following IF / THEN rules. If something happens, then they behave a certain way. In the disaster communication system, actors typically follow protocols, that describe what to do if a disaster event occurs in their environment or if they receive certain information from other actors. If a particular weather pattern is observed, then the meteorological agent will send a report to the disaster management agent. If the disaster management agent receives such a report, then it forwards it to the appropriate agents, and the chain continues until it reaches the public.

Axelrod and Cohen define a complex adaptive system as a system which "contains agents or populations that seek to adapt" (1999, p. 7). Any disaster communication system must be adaptive if it is to be successful in directing the public to take protective actions before and after a disaster. The authors state that in many complex adaptive systems, the strategies of all agents may influence the context in which other agents are acting, making it difficult for any agent to predict the consequences of its actions.

In addition to adapting to the dynamic nature of the disaster environment, the disaster communication system also needs to adapt to the dynamic behavior of the public. Being the end-receiver in the disaster communication distribution chain, the public is a key agent in the system. However, the public is very different than the rest of the agents in the disaster communication chain. The individuals from scientific, government, news and relief agencies represent

organizations which control behavior of those individuals. In contrast, each member of the public acts as an individual, or as a representative of a family, but typically not as a representative of an organization. Individuals do not have to react to the environment (Luhmann 1989, p. 16). Hence, the public has no obligation to follow a protocol during disasters, and because of this, their behavior is difficult to predict. Yet, disaster communication in practice, often operates under the assumption that once the general public perceives a disaster response message, they will react in a prescribed way (Lindell and Perry 2004, 2011; Sellnow and Seeger 2013; Pechta et al. 2010). This is often not the case. The disaster communication system is therefore complex, as it must react to a dynamic disaster environment as well as adapt to the needs of an often uncooperative public.

2.8.2. Feedback

The concept of feedback was given new life in the work of cyberneticist Norbert Wiener (1961). Wiener (1961) founded the scientific field of cybernetics. Cybernetics is closely related to general systems theory, and developed from the need to maintain stability of systems in changing environments (Luhmann 2013 p.33). In cybernetics, feedback is the central means of controlling a system in a changing environment (Luhmann 2013 p. 33; Wiener 1961). The cybernetic concept of feedback is highly relevant for identifying communication problems.

One common communication problem is that disaster response messages can be distorted when sent through a chain (Lindell and Perry 2004, p. 76). Lindell and Perry (2004) argue that messages need to be designed to minimize distortion (p.108), and recommend using standard warning messages (p.76). However, some terminology understood by scientific or government authorities, may not be understood by individuals in the community. If such terminology is simply relayed down the communication chain to the public, the meaning of the message may be lost. It seems counterintuitive to think that a message which is relayed without any changes in its wording could somehow become distorted. Instead of viewing the problem as a distortion of words, one must view it as a distortion of meaning.

Meaning can be distorted as messages are sent down a chain of intermediaries, because words or symbols may be unknown or may have a different meaning among individuals at the local level. In many cases, scientific terminology needs to be changed to the local dialect, or descriptions added to clarify the overall and specific meanings. Taking a cybernetic approach, the sender could request feedback from the receivers to ensure they understood the message and that there were no issues with implementing the response actions. Feedback can help re-align future messages so that the meaning is understood and is sufficient to elicit the desired response. Hence standards for disaster communication need to be flexible enough to allow intermediaries to adjust, improve and optimize the message they target to receivers.

Though feedback has become a major component of process models of communication (O'Sullivan et al 1994), it is the original cybernetic concept of feedback that I argue applies best to disaster communication. In the typical process model of communication, feedback is provided from the individual receiving the information back to the original source of information (McQuail 1993 p. 18 – 19; Shannon and Weaver 1949 p. 68). In the disaster environment, an individual can rarely communicate directly with the scientific agency issuing the warning, let alone the national or regional government. Feedback must therefore travel back up the communication chain.

The disaster communication system is similar to Wiener's description of the system of the human body. Wiener (1961 p. 107) states that in order to move a single finger, a large number of joints are required. The movement of each joint is added together to produce the final movements of a finger. Wiener argues that "a complex additive system like this cannot be stabilized by a single feedback" (1961 p. 107). Feedback is required at each joint, or in our case, each node in the disaster message communication chain. A node is the location where the message changes from one actor to another, i.e., where communication takes place. Hence, feedback at each node is needed to ensure that messages result in disaster response actions. The greater the detail and quicker the feedback, the faster the sender can learn how to adapt their strategy (Axelrod and Cohen 1999, p. 123).

2.9. Case Study Areas

The disasters for the case studies were selected from the 10 near-real-time analyses conducted (see Table 3.1, p. 41), thus ensuring that disasters were recent. Because the surveys were meant to discover how those without internet received disaster response messages, it was important that a large proportion of the population did not have internet access. The disasters selected were Typhoon Haiyan (2013) and Typhoon Hagupit (2014) in the Philippines, and the Gorkha Earthquake in Nepal (2015). The two different disaster types were selected to gain a broader perspective on the disaster communication problem. The typhoons allowed for investigation into both warnings and relief information. The earthquake represented a sudden unpredictable impact with a great need for relief information.

2.9.1. The Philippines

The Philippines is among the top three countries in the world with the highest risk to disasters (Garschagen et el. 2015). Typhoons and the hazards associated with typhoons (storm surges, landslides and floods) cause more loss of life and property damage in the Philippines than any other natural hazard, with approx. 20 typhoons occurring every year (Bankoff 2007). A tropical nation with a long history of typhoons, the Philippines incorporates traditional and modern tools for disseminating disaster response information. A traditional system exists, referred to as 'bandilyo', whereby local government officials travel around their barangay (village), typically by motorbike, and advise residents of important information over a megaphone. Some officials also travel house-to-house to deliver disaster messages face-to-face.

News media send official warnings and weather updates over television and radio, and post to their websites and social media accounts. The National Disaster Risk Reduction and Management Council (NDRRMC), several provincial and municipal disaster risk reduction and management (DRRM) offices, the Office of Civil Defense (OCD), and the Department of Interior and Local Government (DILG) have their own Facebook and Twitter accounts to reach a wider audience. Real-time weather reports and alerts can be followed on the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) website. A variety of smartphone applications also provide users with real-time weather reports and alerts.

An interactive website by the Nationwide Operational Assessment of Hazards (NOAH), a project under the Department of Science and Technology (DOST), has been generating maps for storm surges, floods, and landslides since before Typhoon Haiyan. While not ready in time

to be issued before landfall of Typhoon Haiyan in 2013, predicted storm surge maps were issued in the days before Typhoon Hagupit.

Though there are numerous opportunities to access disaster response information online, internet penetration in the Philippines is only 44% (Internet Live Stats 2016), up just 1% from a year earlier (Internet World Stats 2015). Smartphone penetration is estimated at 40% (Bernardo-Lokin 2015). This means a majority of the public still do not have direct access to disaster response information websites or smartphone applications.

The islands of Leyte and Samar in Region VIII were devastated by Typhoon Haiyan in November 2013. One year later, in December 2014, Typhoon Hagupit threatened the same islands (see Figure 2.7).

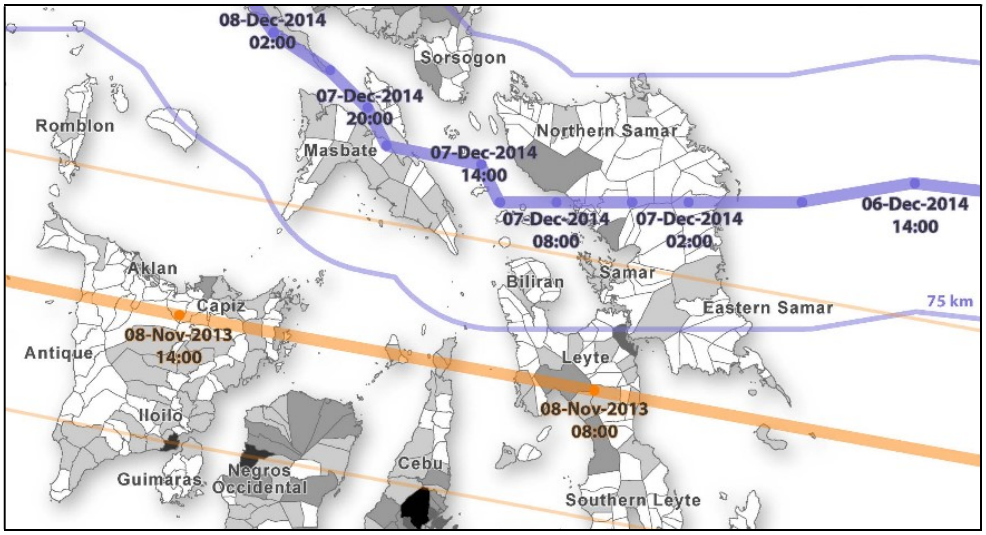

Figure 2.7: Paths of Typhoons Haiyan in 2013 (lower line) and Hagupit in 2014 (upper line) (IFRC 2014)

Prior to landfall of Typhoon Haiyan, only 3,613 people evacuated on the Islands of Leyte and Samar and a total of 5,902 fatalities occurred (NDRRMC 2014). This greatly contrasts to Typhoon Hagupit, in which 347,835 people evacuated prior to landfall on the islands of Leyte and Samar and only 15 fatalities occurred (NDRRMC 2013; see Table 2.4). The response to Typhoon Hagupit is considered a success reflected in the largest evacuation in peacetime history in the Philippines (The Economist 2014). The quantitative surveys and qualitative interviews in the Philippines were implemented in the provinces of Leyte, Samar, and Eastern Samar from 10 Sept 2015 until 03 Oct 2015. Participants included individuals from typhoon affected communities and government officials.

Table 2.4: Typhoon impacts and evacuation data

Impacts to Region VIII (Islands of Leyte & Samar)	Typhoon Haiyan Nov 2013	Typhoon Hagupit Dec 2014
Fatalities	5,902	15
Missing persons	1,005	0
Injured persons	26,186	855
Evacuated persons	**3,613**	**347,835**
Evacuation centers	12	> 650
Homes with total damage	244,550	39,747
Homes with partial damage	248,306	210,363

Source: NDRRMC 2013 and 2014

2.9.2. Nepal

Nepal is a geographically and socially diverse country. It consists of flat plains, rolling hills and the tallest mountain range in the world. The hill and mountain landscape makes Nepal highly susceptible to landslides and road blockages. As one of the few countries with a low urban population, 79% of Nepalis live in rural areas (Central Bureau of Statistics, 2013). The 2011 census identifies 126 different ethnic/caste groups and 123 languages spoken as mother tongue (Central Bureau of Statistics, 2012).

Nepal is also a poor nation with less than $700 (USD) GDP per capita in 2015 (CEDIM 2015). Nepal is ranked 145th in the 2014 Human Development Index falling under the low human development category (UNDP, 2014). According to Transparency International's Corruption Perceptions Index Nepal scores a 27 on a scale of 0 (highly corrupt) to 100 (very clean) (Transparency International 2015).

The 25 April 2015 Gorkha earthquake caused devastation in Nepal on a scale not seen since the 1934 Nepal-Bihar Earthquake. As of 7 July 2015, the Government of Nepal (2015a) reported almost 9,000 deaths, 25,000 injuries, and eight million affected individuals, as well as more than 600,000 homes fully damaged and 285,000 partially damaged. The earthquake left more than 2.3 million people in need of shelter and another 500,000 sleeping in damaged homes (UNOCHA 2015b). Three and a half million people were estimated to be in need of food aid after the earthquake.

Only 41% of Nepalis had internet access at the time of the Gorkha Earthquake (Nepal Telecommunications Authority 2016). Of those with internet access, approx. 95% were connected with unreliable and low-quality internet associated with mobile telephones (Sapkota 2014). Prior to the earthquake, radio and television were identified as the preferred sources of news in the country (Internews 2014).

The quantitative surveys and qualitative interviews were conducted in the districts of Kathmandu, Bhaktapur, and Lalitpur in the Kathmandu Valley, and Dhading, Dolakha, Nuwakot, Rasuwa, and Sindhupalchok outside of the valley (see Figure 2.8). Participants included individuals affected by the earthquake, local government, and key informants from the disaster management authority, police, radio stations, and NGOs.

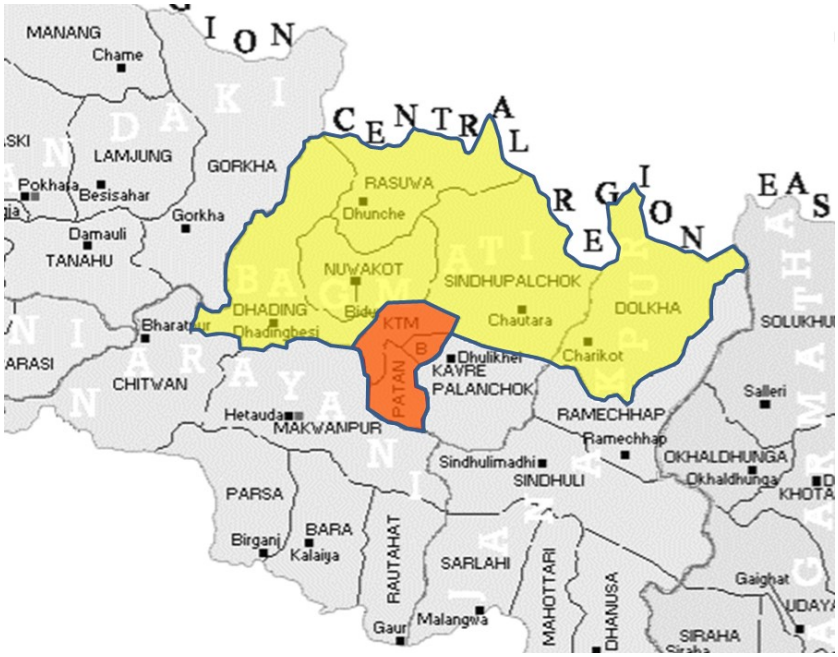

Figure 2.8: Districts where surveys and interviews were conducted in the Kathmandu Valley (red) and outside districts (yellow)

2.10. Conclusions

I first discussed the various mental steps an individual goes through upon hearing a disaster warning to decide how to respond. A variety of factors influence this process. Self-efficacy and response efficacy play critical roles in improving one's perception of protective actions. I borrowed key concepts from semiotics and applied them to disasters. Signs, aberrant decoding, and semiotic modes, are all relevant to disaster communication. Next I described the content which the literature suggests a disaster response message ought to contain. Following this, I identified the various information sources and channels available in a disaster situation. I discussed the information limitations which are unavoidable, due to low information capacity of ICT and time pressures. Finally, I discussed the need to incorporate a systems approach, which includes feedback, in any plan aimed at targeting an audience when sending disaster response messages.

The overall aim is to investigate the barriers that prevent the effective delivery of disaster response messages from source to receiver in a disaster situation. The literature review has provided a good understanding of the barriers which are already known. The case studies will provide further insight into communication barriers. The next chapter describes the research questions and methods.

3. Research Questions and Methods

Chapters 1 and 2 provide the backdrop of the current state of disaster communication research. There is a pressing need for an improved understanding of the intricacies of the typical disaster communication system. Improving the effectiveness of disaster communication is critical for the well-being of the millions affected by disasters every year. The implications can have immediate and long-term effects.

The aim of this dissertation is to investigate the various components of a typical disaster communication system which may influence how effective a disaster response message and its meaning are transferred from a sender to the intended receivers. The theoretical framework draws from the literature on public response to disaster warnings, communication theory, and complex adaptive systems theory. The dissertation applies this framework to understand the communication barriers which arise when distributing disaster response information to the public during a dynamic disaster environment. The methodology embraces the cybernetic perspective that messages are key to controlling a system in a dynamic environment (Wiener 1961, p.8). In a disaster situation, the objectives of disaster response messages are to direct the public towards making decisions which will keep them and others safe.

3.1. Purpose of Chapter

The purpose of this chapter is to outline the research questions and describe the research methods selected to answer each question. A mixed methods approach has been employed. As such, this chapter will describe the steps to the mixed methods approach to data collection, analysis, and integration of results. In the following section I present the main research question along with the four sub-questions.

3.2. Research Questions

In response to failed attempts to inform the public of impending disaster risks, despite information being available, I seek to discover what factors can improve communication of disaster response information. My focus is on the "sender" of the information, which includes the original source and any intermediaries between the source and the final receivers (public individuals). Hence, the main research question is provided below.

> Main research question: When attempting to communicate disaster response information to the public, how can a sender identify and fix communication issues?

The disaster communication system is multi-faceted. Informing the public of disaster warnings and relief information involves a number of steps. First, the information must be packaged into a message. That message must then be transmitted to individuals and organizations who will act as intermediaries to relay the information to the public. This may involve numerous intermediaries and channels (Lindell and Perry 2004, p. 16). Finally, upon reaching individuals, the meaning of the message must be conveyed effectively. An error in any one of these steps can compromise the effectiveness of the message, leaving the intended audience in need of further information to make response decisions, and delaying or potentially inhibiting their response. Answering the above research question therefore requires a multi-faceted approach which considers the content of the message, the variety of intermediaries and channels, the technical and semantic barriers, as well as methods to seek feedback.

3.2.1. The content of the message

I will begin investigating the main research question by exploring the content of disaster response messages. If one was to list the various pieces of information a disaster response message should contain, that list would need to change according to the disaster type, location, severity and other characteristics that make the disaster unique. It is not my intent to produce a separate list for every potential disaster situation. Rather than create a detailed list of what information a disaster warning should contain, a number of disaster researchers have provided a series of questions which any disaster warning ought to answer (Mileti and Sorenson 1990; Mileti 1999; Lindell and Perry 2004, 2011; Drabek 2013). By identifying typical questions to answer, these authors have created guidelines that are applicable to any disaster.

I follow the same view as the authors above, i.e., the content of disaster response messages should answer a series of questions, rather than match a laundry list of descriptive criteria. I acknowledge however, that while certain information can answer a particular question, there may be deficiencies or discrepancies with that answer. Information identifying villages that are at risk to flooding, provides an answer to the question "Who is threatened?" presented by Drabek (2013, p. 71). However, other villages could be at risk even though they have not been identified. In other words, answers can be incomplete. Furthermore, even when every question is answered, it is possible that answers to one question contradict answers to another question. Information identifying where people can find shelters may be contradicted by a hazard map that places some of those shelters within hazardous areas, which people have been advised to stay away from. Similarly, the answers from one source could contradict the answers from another source. This led to the first research sub-question, which addresses the content of messages

> Sub-question #1: How can sources, intermediaries, or external observers identify deficiencies and discrepancies in the content of disaster response messages?

To answer this research question, I have analyzed the content of a number of reports issued in the handful of days before and after 21 disasters. These analyses led to a classification scheme for disaster response information. The classification scheme consists of thematic categories. Each category identifies questions that the information has been observed to answer. Comparing the answers to different questions within a category, as well as between categories, allows for the identification of deficiencies and discrepancies. I refer to this approach as a near-real-time analysis of publicly communicated disaster response information (Girard et al. 2014). The methods of the approach are discussed below in Section 3.3 and the results of its application are detailed in Chapter 4.

3.2.2. The intermediaries and channels

Many of the near-real-time analyses described above were carried out at an early stage in the dissertation research, and thus influenced the overall direction. The collection, categorization and analysis of a large volume of disaster response messages resulted in a better understanding of their typical characteristics. Some characteristics influence how the message can be transmitted. For instance, maps need to be sent through channels that allow image transfer, reports through channels that handle text, and audio recordings through channels with sound. It was predicted that the channels used to distribute disaster response messages and the format or length of the message, would influence how accessible that message was to the public.

A key limitation to the near-real-time analysis approach was realized early on: it is based on information exclusively found on the internet. The analysis could not confirm what information the public actually received. In particular, it was not known if the public in disaster affected areas received any of the disaster response information found online. The internet, in general, can handle any message format. With a good internet connection, large amounts of data can be accessed. However, many in disaster prone areas either lack quality internet connections, or have no access to internet whatsoever. A disaster event can also cause ICT failures which reduce access to the internet even further. This raised the following sub-question.

> Sub-question #2: How does disaster response information typically reach communities, and specifically, how does online disaster response information reach those who lack internet access?

To answer this question, I have conducted quantitative surveys with individuals and local government officials, as well as surveys and qualitative interviews with key informants from disaster affected areas in the Philippines and Nepal. The surveys and interviews help to answer the above question in two ways. First, the individual and local government surveys identify the information seeking and communication behavior of disaster affected communities before and/or after the disaster case studies. Second the combination of the results from the local community surveys and the key informant surveys and qualitative interviews allows for the development of a conceptual model that depicts the structure of the disaster communication system in both countries. The conceptual model illustrates how disaster response information travels from original source to end-receiver through a number of intermediaries. The methods of the surveys are provided in Section 3.4 and the results for the Philippines and Nepal case studies are discussed in Chapters 5 & 6, respectively.

3.2.3. The technical and semantic barriers

The communication theory literature highlights the fact that any communication faces potential technical and semantic problems. Lindell and Perry (2004) stated that a typical disaster communication system may involve multiple intermediaries that relay disaster response information to the public. Voltaire (2014) documented a case in the Philippines during Typhoon Hagupit with multiple intermediaries and channels of communication. I assumed that the technical and semantic problems would be amplified when multiple intermediaries and channels are involved in the process. This raised the following sub-question.

> Sub-question #3: What are the technical and semantic barriers to communicating disaster response information to communities, especially with regards to multiple intermediaries and channels?

Questions from the surveys and semi-structured interviews will identify the technical and semantic barriers to communicating disaster response information in each disaster. The conceptual model of the disaster communication system will be utilized to discuss how multiple intermediaries and channels compound or resolve various aspects of the technical and semantic problems. The model will be informed by the theoretical perspective as well as the case studies.

3.2.4. The methods to seek feedback

With an improved understanding of the content a disaster response message ought to contain, and the intermediaries and channels available, the information source can better target their intended audience. However, taking a cybernetic approach, feedback should also be incorporated to ensure all communication issues have been identified and to confirm when those issues have been resolved. This results in the final research sub-question.

> Sub-question #4: How can a source or intermediary obtain feedback to confirm that disaster response messages reached the receivers and were understood?

The first step to answering this question comes from the surveys and qualitative interviews with government agencies. The findings provide an explanation for how the disaster communication systems of the Philippines and Nepal operate in practice. I then return to the literature, and in particular, the concepts from general communication theory and semiotics. I combine these concepts to the structure of each communication system, to propose a semiotic-process model for the communication of disaster response information in a dynamic disaster environment. The resulting conceptual model is designed to be used as a planning tool by anyone attempting to distribute disaster response information to a community in a disaster situation. By identifying barriers to effective communication, visualizing potential paths for targeting individuals and seeking feedback, the conceptual model can help senders identify and fix communication issues in near-real-time.

3.3. Methods for Thematic Analysis

Thematic analyses were carried out of numerous disaster response messages published online. The guiding objective for theme development was to produce a set of categories which could be applicable to any disaster and which could aid the process of analyzing the content of disaster response messages in near-real-time. A number of near-real-time analyses were then conducted using the categories as the basis for comparison and investigation. The results test and confirm the utility of the classification scheme.

The purpose of analyzing the content of disaster response messages was to identify all of the possible themes in disaster response messages, rather than count the number of times a single theme was mentioned. Hence, the approach employed was a thematic analysis. Thematic analysis is widely used though not consistently defined. Thematic analysis has been described as a type of content analysis (Schreier 2012 p. 37), a process for category development within content analysis (Budd et al. 1967, p. 47), a process for encoding qualitative information used across methods (Boyatzis 1998, p. 4), or as a unique method of scientific inquiry (Braun and Clarke 2006).

I follow the assertion by Braun and Clarke (2006) that thematic analysis is a stand-alone research method, which is separate from content analysis. On the one hand, content analysis can be dependent on frequency outcomes, and bears the risk of losing the context of the message's meaning (Joffe and Yardley 2004 p. 57). On the other hand, thematic analysis places more importance on the analyst's ability to interpret the meaning of the message within the context that the message is sent (Joffe and Yardley 2004 p. 37). There are multiple ways that texts can be interpreted by an analyst (Braun and Clarke 2006; Krippendorf 2004 p. 22; Schreier 2008 p. 20). As such, I recognize that the classification scheme that I present is the result of my interpretation

of the disaster response messages. The interpretation was influenced by literature and my own field of experience in studying disasters; however, other interpretations are possible.

3.3.1. Data collection

The corpus of data collected for the thematic analyses consists of disaster updates produced within the handful of days before and/or after 21 disasters (see Table 3.1). The complete list of disaster reports is provided in Appendix A. The disaster updates were produced by government or other agencies. The disaster updates were collected from publicly available online sources, with a majority being from ReliefWeb. ReliefWeb is an online service of the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) that acts as a clearinghouse for disaster information and collects disaster updates from more than 4,000 sources globally (ReliefWeb 2014). Common forms of disaster updates contained on the website are news and press releases, situation reports, maps, info graphics, analyses, appeals, and assessments. During disasters, these updates are posted on ReliefWeb as they are produced. Since ReliefWeb archives the updates and sorts them by day of release, it allowed for the simulation of carrying out a near-real-time analysis following disasters within ReliefWeb's database.

Table 3.1: Disasters included in the thematic analyses

Disaster	Country	Date of Disaster	Number of reports analyzed
Hurricane Katrina	USA	29 Aug. 2005	19
Cyclone Nargis	Myanmar	02 May 2008	57
Pakistan Floods	Pakistan	July/Aug. 2010	28
Queensland Floods	Australia	Dec. 2010/ Jan. 2011	31
Christchurch Earthquake	New Zealand	22 Feb. 2011	43
Himalayan Earthquake	India/ Nepal	18 Sept. 2011	21
Tropical Storm Washi	Philippines	16 Dec. 2011	37
Visayas Earthquake	Philippines	06 Feb. 2012	16
Hurricane Sandy	USA	29 Oct. 2012	17
Yunnan Earthquakes	China	07 Sept. 2012	24
Typhoon Bopha	Philippines	04 Dec. 2012	18
*Aceh Earthquake	Indonesia	02 July 2013	7
**Pakistan Earthquake	Pakistan	24 Sept. 2013	26
**Cyclone Phailin	India	12 Oct. 2013	28
**Bohol Earthquake	Philippines	15 Oct. 2013	13
**Typhoon Haiyan	Philippines	8 Nov. 2013	51
*Cyclone Ita	Australia	11 Apr. 2014	8
*Ludian Earthquake	China	3 Aug. 2014	1
*Typhoon Hagupit	Philippines	6 Dec 2014	7
*Cyclone Pam	Vanuatu	13 Mar. 2015	32
**Gorkha Earthquake	Nepal	25 Apr. 2015	60

*Thematic analysis carried in near-real-time, i.e., during disaster

**Information gap analysis conducted in near-real-time

Note: see Appendix A for further information on reports included for each disaster reviewed

Simulated near-real-time analyses were conducted for 11 disasters using data collected from ReliefWeb's disaster updates archive. Another 10 near-real-time analyses were carried out as disasters occurred, using either disaster updates posted on ReliefWeb, or government, news and scientific agency websites.

3.3.2. Theoretical rationale for thematic analysis

When reviewing the disaster response messages, they were critiqued from the semiotic perspective that the meaning of a message must be clearly stated for it to be understood by the receiver. Interpretation of the meaning should not require very much mental effort, and certainly no guessing. For instance, if a warning states that heavy rain is expected, the onus should not be on the receiver to interpret this to mean that they should prepare for flash floods. I have extended this logic to all forms of disaster response information. Thus, even a message that warns of a potential seven-meter storm surge (as in the case of Typhoon Haiyan), needs to explicitly state what the dangers are to individuals in the path (i.e., potential death). The warning needs to go beyond stating the details of a threat to explaining how those details equate to personal risk. Likewise, in addition to relief information stating the location of aid distribution sites, messages should identify who is eligible and the process for accessing aid.

I have also considered the context of the disaster situation to guide interpretation. A disaster situation is a dynamic environment in which individuals in the affected or potentially affected communities need to make critical decisions on how to respond. Any information discussing the disaster was included, and unrelated information was ignored. Examples of items included were descriptions of impacts or potential impacts, affected geographical areas or specific communities, disaster relief needed or available, and coordination of emergency resources.

The literature informed me of the variety of information that can typically help people in a disaster situation to make decisions. For example, Lindell and Perry (2004 p.79 – 81) provided guidance for warning information. However, I followed an inductive approach to develop the thematic categories and coding framework. Thus, I did not start with any categories prior to coding. Instead, I based categories on the individual disaster response messages collected, and the overall classification scheme evolved with each additional message and disaster. Altogether, 21 separate thematic analyses were conducted: one for each disaster in Table 3.1. Hence, those completed at the beginning of the study went through a more rigorous inductive process than those which followed. After the first five disasters, the categories were stable enough to capture all but a few disaster response messages collected for the following 16 disasters.

3.3.3. Procedure for thematic analysis

Non-computer assisted thematic analysis was carried out following the five steps identified by Boyatzis (1998) for developing themes:

1. Reducing the raw information
2. Identifying themes within subsamples
3. Comparing themes across subsamples
4. Creating a code
5. Determining the reliability

To reduce the raw information, each report collected was manually broken down into the separate disaster response messages it contained. All information irrelevant to the disaster was not retained. A disaster response message may be a phrase, sentence or entire paragraph if that paragraph was required to understand the information. A disaster response message could also take the form of a photo, a map or an info-graphic. All graphic content was converted to a written description of the information it contained to enable analysis.

Each disaster update was considered as a subsample. I reviewed the various disaster response messages in each subsample to observe and interpret themes. Themes were established from manifest level and latent level thematic analyses. Manifest level analysis refers to perceiving the themes which are directly observable (Boyatzis 1998), such as the names of villages affected by an earthquake or the types of humanitarian needs identified. Latent level analysis refers to reading between the lines to identify themes which are associated with though not specifically identified by the information (Boyatzis 1998 p. 25). For example, information which quantifies the number of tents provided or people served at food distribution sites, leads to the question how many people are without shelter or food, resulting in the development of themes pertaining to "outstanding needs".

The third step consisted of comparing the different themes across subsamples. A helpful tactic when comparing between subsamples was to ask: what information was potentially left out of the disaster updates? This follows the recommendations of Boyatzis (1998 p. 65), and was an important step to interpreting further latent themes.

The themes which resulted from the above analysis formed the initial coding framework. Two levels of content were considered: the "coding unit" and the "context unit" (Budd et al. 1967, p. 33). The coding unit may be a word or phrase that is easy to associate with a theme, such as "tsunami", "shelter" or "post disaster needs assessment". The context unit is composed of the rest of the words in the phrase, sentence or paragraph that are needed to characterize the coding unit (Budd et al. 1967, p. 36). For instance, for the coding units "aid" and "shelter", the context unit may clarify that the data refers to steps for requesting aid or inadequacy of donated shelter material. The final step in designing the coding framework was to clearly define what information should be categorized under each theme.

In line with the goal to develop a widely applicable classification scheme, I devised a series of general questions for each theme to make the sorting process clear and replicable across different disasters. Any data which answered a question would need to be categorized under that theme, and naturally under that question. Consequently, the questions themselves became subcategories under each theme. An inductive approach was followed in developing the questions: I asked what questions does the data under each category answer?

Each thematic analysis was compared to those conducted previously to ensure that the coding framework had not changed and was still applicable to all disasters. Where problems arose, results were compared across disasters and data was compared across datasets. When required, the themes and coding framework were adjusted.

3.3.4. Procedure for identifying deficiencies

The questions established under each thematic category were used to carry out further analysis which went beyond the thematic analysis described by Braun and Clarke (2006). The questions were intentionally designed so that they would not change regardless of the disaster being

analyzed. This allows for the identification of which questions under each thematic category have been answered or not. This approach is referred to as "presence/absence scoring", and is a simple method for quantifying the number of pre-established themes present or absent in a data set (Boyatzis 1998, p. 131). An important theoretical assumption is that "the absence of an observed theme *implies* that something is missing" (Boyatzis 1998, p. 131, emphasis in original).

I returned to qualitative analysis of the categorized data, comparing data within thematic categories and between categories. Key to this step was determining if data in one category could reveal potential deficiencies with the data contained in other categories. For example, data which quantifies a high number of people affected may call into question the low number of people served by shelters, and suggest that information is missing about how the needs of all those affected are being met. This final step was also important to understand the relevance of those information gaps identified by the presence/absence scoring. For example, data which confirms there were no impacts to the food or water supply chains may explain the lack of data (or questions answered) about food or water distribution activities, suggesting that no further information is required. Conversely, data which confirms destruction of road networks could support the argument that further information is required to explain how the affected population's transportation needs are being met. The comparative analysis was tested in near-real-time following five disasters that occurred between July 2013 and April 2015. A key aspect of this comparative analysis is that it is done in near-real-time as disasters unfold.

The thematic analysis, which began at the early stages of this research project, had many of the typical qualities associated with qualitative research: an inductive approach, an emergent design and an attempt to establish a holistic account of the problem (Creswell 2014, p. 186). The evolving nature of the approach and quest to view the disaster communication problem from multiple perspectives, led to the realization that the local perspective was critical to understanding the problem. The importance of context is one of the defining features of disaster research (Stallings 2002). The value of using cases as the basis for research is to learn from the context of the situation in which the phenomena is being studied (Flyvbjerg 2004).

The next section describes the methods for the quantitative surveys and qualitative interviews that were conducted with individuals, local officials, and key informants from disaster affected areas in the Philippines and Nepal. The surveys and interviews contribute to understanding how the disaster response messages discussed in this section could actually be delivered to disaster affected communities.

3.4. Methods for Case Studies

Three case studies were undertaken to understand the many aspects of communicating disaster response information. The two case studies from the Philippines focus on communities affected by either Typhoon Haiyan (2013) or Typhoon Hagupit (2014). The third case study focuses on communities affected by the Gorkha Earthquake (2015) in Nepal. Each case study collected and compared quantitative and qualitative data. Hence, each case study was in-line with a convergent mixed methods approach, defined by Creswell (2014) as a "strategy in which quantitative and qualitative data are collected and analyzed separately and the two databases compared to best understand a research problem" (p. 133).

3.4.1. Data Collection

A convergent mixed methods approach was followed for each case study. Quantitative and qualitative data were collected at the same time, though in some cases, follow-up qualitative questions were used to help explain participant responses to the survey.

First two case studies (the Philippines)

In the Philippines, from September 10th to October 3rd, 2015, I worked with a team of enumerators who conducted quantitative surveys with local individuals and local officials, while at the same time I conducted qualitative interviews with key informants from the municipal and provincial levels of government. The quantitative and qualitative data was collected from two separate areas in the Philippines. Questions for one group of municipalities addressed Typhoon Haiyan while the questions for the other group addressed Typhoon Hagupit.

In total, 349 individuals and 67 local officials (one from each barangay) participated in the surveys. There were four types of surveys, which varied in the questions asked or the typhoon which the questions referred to. The first two types of surveys were for individuals and local officials in Typhoon Haiyan (2013) affected areas. The second two types of surveys were for individuals and local officials from Typhoon Hagupit (2014) affected areas. The number of participants for each survey type is identified in Table 3.2.

Table 3.2: Breakdown of survey participants

Survey	Individuals	Local officials
Typhoon Haiyan survey	159	30
Typhoon Hagupit survey	190	37
Total:	349	67

The surveys were conducted by eight enumerators from the University of the Philippines, Tacloban College. A local research coordinator assisted in the planning, logistics, training and monitoring of the survey implementation. The surveys were also translated by the research coordinator into the local Leyte-Samar dialect of Waray-waray. Hence, the surveys were conducted in the local language and responses were translated into English.

I conducted key informant qualitative interviews in-person with the provincial DRRM officers from each of the three provinces (Leyte, Samar and Eastern Samar), and the municipal DRRM officers from 14 of the 18 municipalities where the surveys were implemented. Further key informant interviews were conducted with representatives from the DILG, DSWD, and NOAH. The duration of the interviews was on average 30 minutes.

Coastal and non-coastal barangays were selected for Typhoon Haiyan (Nov 2013) respondents. Coastal barangays were selected for Typhoon Hagupit (Dec 2014) respondents from a list of localities NOAH (2014a) predicted would receive a storm surge. In each barangay visited, one barangay official and four to five individuals from the public were interviewed, with an attempt to ensure sufficient representation of women in the individual survey. The respondents were

selected at random (probability sampling) with the exception of the local officials, which were typically the barangay captain or available representative in their absence. Killian (2002) argues that probability sampling should be used as much as possible in disaster research, so that results can be generalized, especially when findings relate to individual behavior. The sampling frame consisted of all of those residents of the 67 barangays visited, considering only those 18 years of age or older.

The gender breakdown of the survey was 52.9% female and 47.1% male for Typhoon Haiyan affected individuals and 51.1% female and 48.9% male for Typhoon Hagupit affected individuals. Demographic data for local officials were not taken because they were asked to respond on the behalf of the barangay council and not on a personal level.

Third case study (Nepal)

In Nepal, an initial round of quantitative surveys and qualitative interviews was conducted from June 12th to 19th, 2015, in the districts of Bhaktapur, Dhading, Dolakha, Kathmandu, Lalitpur, Nuwakot, and Sindhupalchok. Because the main focus of the research project was shelter issues, only four of the 43 questions on the survey pertained to information and communication needs. Specifically, the questions asked households living in some form of temporary shelter how they advised authorities of their needs and communicated with those who could potentially offer assistance. In total, 284 households participated in the survey. For 32 participants, qualitative follow-up questions were asked to explain their responses to the communication questions and to further discuss the ways they collected information and communicated in the first week after the earthquake, as well as the challenges they faced.

I returned to Nepal to implement a combination of quantitative surveys and qualitative interviews from November 11th to Dec 3rd, 2015, in the same districts as the initial round of research, plus Rasuwa district. This second survey and interviews were completely focused on disaster response information and communication related questions. In total, 401 individuals and 20 local officials participated in the quantitative survey. Ten of the local officials were also asked qualitative follow-up questions to explain some of their responses and to try and discover further communication issues and solutions. Qualitative interviews were also completed with the following key informants: Dr. Ram Chandra Lamichhane, executive director of the national Association of Community Radio Broadcasters (ACORAB); Dr. Nama Raj Budhathoki, founder and executive director of Kathmandu Living Labs (KLL); a representative from Accountability Lab; a representative from the United Nations Communications with Communities working group; and radio station managers from Nuwakot, Rasuwa and Sindhupalchok.

Surveys and qualitative interviews were carried out in three distinct site types. Urban sites refer to areas within city limits. Semi-urban sites are areas outside of cities, but still close to a main road, with electricity. Rural sites are defined as being away from a main road, without paved road access, and some are without electricity. Unfortunately, "remote areas", representing a potential fourth site type were not included in the survey due to access constraints. Remote sites often take at least an entire day to travel to from a main highway, with a substantial amount of travel on foot. Remote sites are defined as those that are not serviced by any form of public transportation. Remote sites are extremely important to research, as communicating with remote areas is assumed to be more difficult than with the three site types covered by the survey. The size of variances between urban and remote sites is assumed to be even greater than the variances between urban and rural sites identified in the results chapter. From within each site

type, individuals were selected at random. The gender breakdown of the survey was 54.4% male and 45.6% female.

A final set of quantitative surveys and qualitative interviews was conducted one year after the earthquake, from April 27th to May 3rd, 2016. Surveys were conducted with key informants representing the district administrative office (DAO), district disaster relief committee (DDRC), police, and radio stations from Dhading, Dolakha, Nuwakot, Rasuwa, and Sindhupalchok, which are all located outside of the Kathmandu Valley. Qualitative follow-up questions were conducted with approx. half (12 of 25) of the key informant participants to explain some of their answers and to further discuss the research problem. Qualitative interviews were also conducted with the following key informants: Dr. Rajib Subba, Deputy Inspector General and Director of the Communication Directorate, Nepal Police Headquarters; Thule Rai, Senior Superintendent of Police in the Disaster Management Division; and a follow-up interview with Dr. Budhathoki from KLL.

Ethical considerations

All respondents were 18 years of age or older. All respondents were read a short description of what the survey was about, were advised that answering the survey was voluntary, and that they could stop the survey at any time. Participants were also advised that the survey was for research purposes only and their participation would not result in them receiving any aid. Following this, the enumerator asked for consent from the respondent prior to starting the survey. No names of respondents were asked for the surveys conducted in the Philippines. In Nepal, respondents were asked their names, only for the purpose of determining their caste. Once the caste or ethnic group was established, the name was not recorded. Guidelines were provided for the enumerators to ensure they understood the protocol described above, as well as to provide guidance for completing surveys in general and dealing with issues with respondents that may have surfaced (see Appendix B).

3.4.2. Theoretical rationale for surveys and interviews

The rationale for the design of the quantitative surveys and qualitative interviews was based on two assumptions relative to communicating disaster response messages. The first assumption was that an order would be discernable to explain how disaster response information reaches individuals in the community. For instance, it was assumed that certain agencies produce and disseminate disaster response information, and certain intermediaries relay this information to the public. The order was believed to extend to the channels used to become informed or communicate during a disaster. Whether or not actors or channels were officially designated was not a determining factor in identifying this order. The assumption was merely that some order existed, that one could observe, and subsequently model. The second assumption was that there would be differences in the channels and sources used by respondents to receive disaster response information and to communicate. Differences were expected to be correlated to personal characteristics of the respondent (gender, age, social status), geographical characteristics (coastal vs non-coastal, urban vs rural) and disaster impacts (pre-disaster vs. post-disaster).

3.4.3. Design of local surveys

The aim of the surveys was to identify the various sources that the public received disaster response information from as well as the channels used to collect information and communicate. For the Philippines, I asked respondents to provide separate answers to distinguish between the sources and channels used to obtain disaster warnings before landfall and relief information after landfall. In the Nepal survey, I could not ask respondents about warnings in the same way that respondents in the Philippines were asked, because the earthquake in Nepal occurred without warning. Hence, respondents in Nepal were asked about how they received general news before the earthquake, relief information immediately afterward, and advisories about the risk of their areas to future earthquakes and landslides. The survey was also designed to collect information to identify the top sources of information, the most trusted sources, and those sources which engaged in two-way communication with individuals.

In the Philippines, the surveys consisted of 41 questions for individuals and 34 questions for local officials. In Nepal, the surveys consisted of 49 questions for individuals and 38 questions for local officials. On average, the surveys took less than 30 minutes.

A key component of the Hagupit surveys was to specifically track the flow of NOAH storm surge advisories in order to understand how such critical information did or did not reach localities at risk. Prior to Typhoon Hagupit, NOAH published a list of 55 localities with official storm surge advisories onto their website (NOAH 2014a). Each of the barangays surveyed for Typhoon Hagupit areas was found on this list of localities at risk to storm surge. For a number of localities, links on the website (blog.noah.dost.gov.ph) took the user to a satellite image of the municipality overlaid with potential storm surge heights (see Figure 3.1). Ranada (2014) published an online article two days before landfall of Typhoon Hagupit, describing how to use the website to generate a storm surge map and explained how to interpret the map. Communities could therefore avoid the areas identified to be at risk to storm surge.

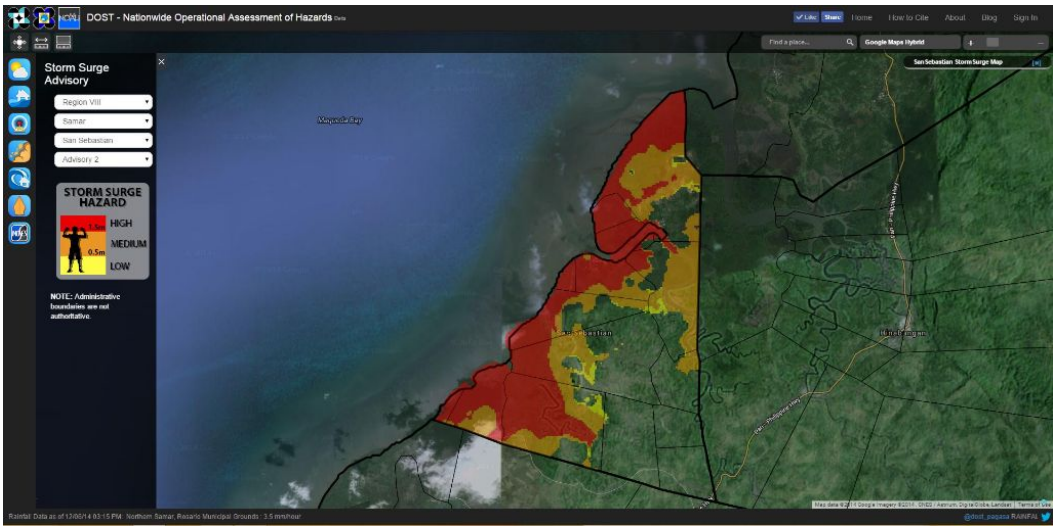

Figure 3.1: Storm surge hazard map of San Sebastian, Samar (Source: NOAH 2014a)

Considering that 94% of all deaths in coastal areas from Typhoon Haiyan were estimated to have been caused by storm surge (Neussner 2014), it was assumed that the disaster management authority would ensure NOAH's storm surge advisories and maps were distributed to

communities prior to Typhoon Hagupit making landfall. This provided a unique research opportunity, because the storm surge advisories and maps were not broadcast by NOAH via mass media but rather posted online. Obtaining this information would have required an active search for it using the internet. Consequently, I specifically asked individuals in the community, barangay captains, and municipal DRRM officers how they received storm surge warnings in order to track the flow of information. It was believed that identifying how this online disaster response information found its way to those without internet access, could provide insight into how individuals without internet access could be targeted during future disaster events.

Finally, the respondents were asked to describe the main challenges to seeking information before and after the typhoons in the Philippines, as well as after the earthquake in Nepal. The answer to this question shed light on the prevalence of the technical and semantic problems.

3.4.4. Key informant surveys and interviews

The surveys discussed above were limited to individuals and government from local communities. This represents only the local level of the disaster response information distribution chain. The key informant surveys and qualitative interviews were conducted to gain a broader perspective of the communication system in each country and specific to the Typhoon or Earthquake event being investigated.

The surveys and interviews with key informants helped to distinguish the general design of the disaster communication system in both countries. Questions pertained to the key informants position within the disaster response information distribution chain, their role as such, the communication channels they employ, how they obtain feedback, and the challenges they face. The key informant surveys and interviews also validated some of the findings from the local level surveys.

The results illustrate how the disaster communication system is designed to disseminate disaster response information in general. In the Philippines, the semi-structured interviews were also key to determine how specific internet based storm surge advisories reached individuals in communities before landfall of Typhoon Hagupit.

3.4.5. Analysis of survey data

The purpose of the quantitative surveys and qualitative interviews was to verify how the various actors sent and received disaster response information, as well as how they communicated with each other. Descriptive analysis was used to describe the patterns or lack of patterns observed in the data. It was hypothesized that the sources and channels used to receive disaster response information would vary per group of individuals, representing potential target audiences. Thus, comparative analyses were carried out to observe differences in the way men and women, urban and rural, or young and old, received disaster response information.

I carried out nonparametric tests for significance, as opposed to parametric. Parametric tests require data with numerical scores; however, the data contained in the surveys was either nominal or ordinal, requiring nonparametric tests to be carried out (Gravetter and Wallnau 2016, p. 261). As such, a chi-square (x^2) test for independence was performed in those cases where variance was observed to confirm the difference could not be explained by mere chance. Cohen

(1988, p. 215 – 216) asserts that a chi-square test for independence is particularly appropriate when variables consist of nominal data or unordered categories.

The chi-square test for independence uses the frequencies of nominal or ordinal data to evaluate the relationship between two variables (Gravetter and Wallnau 2016, p. 574). The null hypothesis for the chi-square test for independence is that there is no relationship between the two variables, i.e., one is not dependent on the other. By proving the null hypothesis false, the test confirms a relation between the two variables. The test does not confirm causation, only relation. Understanding of the circumstances of the relation are needed to confirm that one variable is indeed dependent on the other.

An alpha level of 0.05 was used for all statistical tests, which is associated with a 95% confidence level. All chi-square tests were 2-sided, meaning they only tested to confirm a relationship existed between the two variables without regard to the direction of that relationship. In order to understand the strength of the association, I calculated effect size using phi coefficient and Cramer's V. The phi coefficient was used when both variables being compared had only two potential values (i.e., 2 x 2 table), whereas a Cramer's V is used when one or both of the variables has more than two potential values (i.e., 2 x 3 table or more).

$$\varphi = \sqrt{\frac{\chi^2}{n}} \qquad V = \sqrt{\frac{\chi^2}{n(df^*)}}$$

Figure 3.2: Formulae for calculating phi coefficient (left) and Cramer's V (right), where x^2 = chi square value, n = sample size, and df* = lessor of (# rows – 1) or (# columns – 1) (Gravetter and Wallnau 2016, p. 584 – 586)

Effect size refers to the "degree to which the phenomenon is present in the population" (Cohen 1988, p. 9). The effect size ranges from 0 to 1. If the effect size were 0 this would mean that there was no difference between the two groups under study. The larger the effect size the greater the power of the argument that a difference exists (Cohen 1988 p. 11). The effect sizes for the phi coefficient and Cramer's V test results are interpreted according to the following table (Cohen 1988, p. 224 – 225; Gravetter and Wallnau 2016, p. 586):

Table 3.3: Effect sizes for phi coefficient and Cramer's V test results

	Small Effect	Medium Effect	Large Effect
phi or V when $df^* = 1$	0.10	0.30	0.50
V when $df^* = 2$	0.07	0.21	0.35
V when $df^* = 3$	0.06	0.17	0.29

Low, medium and large effect sizes are not clearly defined. Cohen (1992) offers the following explanation for the scale he developed: "My intent was that medium [effect size] represent an effect likely to be visible to the naked eye of a careful observer... I set small [effect size] to be

noticeably smaller than medium but not so small as to be trivial, and I set large [effect size] to be the same distance above medium as small was below it."

3.5. Integration of Results

The results of the thematic analysis influenced questions in the surveys. For instance, the thematic analyses of Typhoon Hagupit and the Nepal Earthquake led to the identification of the importance of disaster response messages about storm surges and aftershocks, respectively. The limitations of the near-real-time analysis approach also influenced the questions in the surveys. Results from the surveys made up for the knowledge gap about how messages reach communities that lack internet access.

Figure 3.3 provides a simplified illustration of how the results of the variety of thematic analyses, surveys and interviews were integrated. The thematic analysis resulted in a classification scheme for disaster response information. The classification scheme was improved upon with the support of some elements of the literature. Finally, parts of the classification scheme were validated by the surveys and interviews which identified information needs of disaster affected individuals. On the one hand, the classification scheme is intended to act as a baseline for what information should be provided to the public during a disaster situation. On the other hand, the classification scheme is designed to be a tool for analyzing disaster response messages in near-real-time. The classification scheme is designed to be used by senders and intermediaries to improve disaster communication.

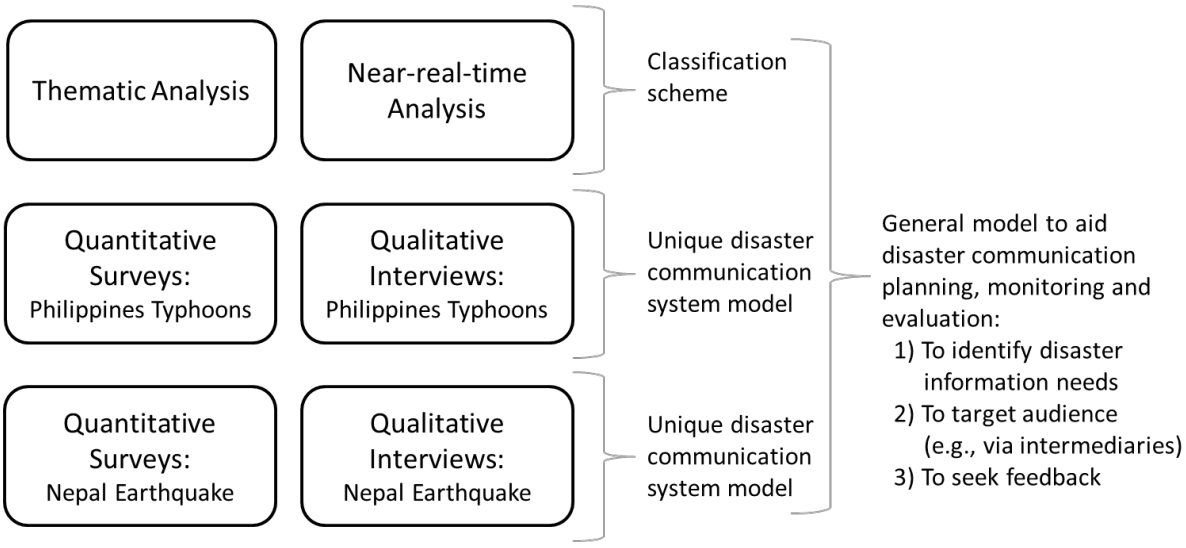

Figure 3.3: Integration of results from mixed methods approach

The combined results of the quantitative and qualitative data have led to the creation of a conceptual model for the communication of disaster response messages. The various characteristics of the sources, intermediaries, messages, channels and receivers, has influenced the design of the model. The model incorporates elements of the classification scheme and near-real-time analysis approach developed. The model is designed to adapt to different disaster environments and disaster communication systems.

3.6. Validation and Triangulation

The thematic analysis began with an inductive approach to develop the thematic categories. Rather than sorting the content of messages into pre-existing categories, the categories were newly created out of the actual disaster response messages reviewed. Such an inductive approach increases the validity of the categories (Boyatzis 1998, p. 30). Following the initial thematic analysis, another 20 thematic analyses were completed. Each time, the categorization scheme was refined. After the first handful of thematic analyses, the categorization scheme was able to capture all content of disaster response messages for the remaining disasters, with only a few exceptions. As a result, the ability to capture all of the content of the disaster response messages collected for 21 disasters helps to demonstrate the validity of the categories developed. That being said, the disasters have included only tropical cyclones, earthquakes and floods. Other disasters such as wildfires and volcanic eruptions have not been tested.

Triangulation was achieved through collecting both quantitative and qualitative data, as well as through including participants with different perspectives on the problem. In general, making use of several sources or perspectives increases the validity of arguments (Creswell 2014 p. 201). Surveys at the community level were complemented by surveys or interviews at the municipal and provincial/district levels. Upper and lower levels of government offices, as well as the public, were also asked overlapping questions. Participants in general were asked who they received disaster response messages from, who they sent them to and who they communicated with. Comparing the answers helped to validate the overall pattern of responses by each respondent group.

I also travelled to the majority of villages where the surveys took place. I personally conducted the qualitative interviews in the Philippines and Nepal; however, I required a translator for most of the follow-up interviews in Nepal. While I was not able to experience the natural setting of a disaster, I was able to witness the aftermath, through seeing the physical damage to villages and homes. I also listened to the stories of the participants about what happened. Being in or near the location where these stories actually occurred was beneficial to understanding their context. Hence, I was able to cross-reference the categories developed for the thematic analysis, as well as the data from the surveys and interviews with my own personal observations. In addition, I have had the benefit of living and working in the rural areas of eastern Nepal for one year prior to the earthquake. This experience was beneficial for planning and carrying out the research, as well as understanding certain aspects of the Nepali culture.

3.7. Conclusions

The main research question asks how a sender can identify and fix disaster communication problems. The four research sub-questions call for an investigation into what information should be sent to disaster affected communities, how information could be sent, the barriers to sending information, and the options for obtaining feedback from receivers. It is intended that the answers to these questions will have practical implications. The thematic analysis, quantitative surveys and qualitative interviews will collect different, but complementary data. The final proposed model of disaster communication will be strengthened by integrating the results of each approach.

4. Results of Thematic and Near-real-time Analyses

The first research sub-question is: "How can sources, intermediaries, or external observers identify deficiencies and discrepancies in the content of disaster response messages?" In order to identify issues in disaster response information, one must have a baseline to compare against as well as a method to compare. While feedback in traditional communication theory is the prime mechanism for identifying communication issues, disaster situations evolve so quickly that the adequacy of disaster messages may need to be evaluated prior to receiving feedback. The approach discussed in this chapter can take place while waiting for feedback, and ideally before disaster response messages are distributed in the first place.

4.1. Purpose of Chapter

The purpose of this chapter is to present the categories that were developed from the thematic analysis of disaster response messages. Combined, these categories form a classification scheme that can be used for further analysis, two types of which I will discuss. The first is a presence/absence scoring to identify information gaps in disaster response messages. The second is a comparative analysis to provide further evidence of potential deficiencies and to evaluate the relevance of the information gaps observed.

4.2. Classification Scheme

The thematic analysis resulted in the development of 22 thematic categories (see Table 4.1). Using the terminology of Dey (1993), these 22 thematic categories were "split" into sub-categorical types of data and "spliced" to fall under overarching headings (p. 139 – 160).

The heading "General Disaster Information" describes the general characteristics of the disaster event in either past, present, or predicted future state, and identifies the affected areas without getting into the details of the actual impacts. Examples of general disaster information include the predicted path of a typhoon or the magnitude and location of an earthquake.

The heading "Effects to People" covers human life safety and basic human needs. This information addresses the direct disaster impacts on physical wellbeing. Items include casualties or potential casualties in the near future, and disruptions to basic human needs, such as lack of drinking water, food, shelter, and sanitation.

"Effects to Critical Systems" covers those systems which are important to the immediate well-being of the local population. Transportation, medical, and communication disruptions therefore signify a potential reduction or elimination of the ability of the affected population to maintain or improve their physical well-being. For example, transportation disruptions hamper the ability to leave hazardous areas or access aid, medical disruptions limit the availability of emergency care, and communication disruptions restrict one's capacity to request help.

The information contained in the first three thematic categories above have been deemed critical based on the information's direct relation to the immediate physical well-being of affected or potentially affected communities. Two further headings were developed to sort thematic categories. "Effects to other systems" includes other systems such as education, finance and agriculture. Finally, "Coordination" includes those themes which are related to the overall management of resources, communication, and assessing needs.

Table 4.1: Thematic categories and coding framework for disaster response information

Heading	Theme	Basic Questions	Semantic/Analysis Questions
General Disaster Information	1. Predictions, current situation, past details	**What** are the characteristics of the event, **where** will/did they occur, and **when?**	-
	2. Affected area or people	**Who/where** could be/or has been affected, by **what** and **when?**	-
Effects to People	3. Warnings	**What** are the dangers, **where** are they expected, and **when?**	**How** do the details equal a threat?
	4. Lifesaving response	**Who** is doing (or needs to do) **what** to combat threats (Evacuation, SAR), **where**, and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
	5. Casualties	**How many** casualties, **who** are they, and **where** are they located**?**	**How** were they injured, killed or missing?
	6. Handling of fatalities	**What** is being done to deal with fatalities and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
	7. Basic human needs disruptions	**Who/where** is (or could be) affected, by **what** and **when?**	**How** did they occur and **how long** are they expected?
	8. Basic human needs solutions	**Who** is doing **what** to meet the basic needs of affected, **where** and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
Effects to Critical Systems	9. Transportation disruptions	**What** disruptions occurred (or could occur), **where** and **when?**	**How** did (or could) they occur and **how long** are they expected?
	10. Transportation solutions	**Who** is doing **what** to meet the transportation needs of those affected, **where** and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
	11. Medical disruptions	**What** disruptions occurred (or could occur), **where** and **when?**	**How** did (or could) they occur and **how long** are they expected?
	12. Medical solutions	**Who** is doing **what** to meet the medical needs of those affected, **where** and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
	13. Communication disruptions	**What** disruptions occurred (or could occur), **where** and **when?**	**How** did (or could) they occur and **how long** are they expected?
	14. Communication solutions	**Who** is doing **what** to meet the communication needs of those affected, **where** and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
Effects to Other Systems (e.g., Education, Finance, Agriculture)	15. Other disruptions	**What** disruptions occurred (or could occur), **where** and **when?**	**How** did (or could) they occur and **how long** are they expected?
	16. Other solutions	**Who** is doing **what** to meet the associated needs of those affected, **where** and **when?**	**How** do actions meet needs and what are the **outstanding needs**?
Coordination	17. Emergency response	**Who** is doing **what**, **where** and **when?**	**How** do activities compare to demand?
	18. Emergency communication	**Who/what** is disseminating info and **how** is it accessed?	**How** many does it reach and **who** does it not reach?
	19. Post disaster needs assessment	**Who** is assessing **what**, **where** and **when?**	**What** areas or issues still need to be assessed?
	20. Prioritized/ critical needs	**What** are the priorities, **where** are they needed, and **when?**	**How much** is needed of each?
	21. Public resources	**What** are the resources and **where** can they be found?	**How** are the resources used and **how** do they help?
	22. Funding	**How much** is being provided **to whom**, by **what means** and **when?**	**How** does funding compare to demand?

Three types of questions were answered by the information sorted under each thematic category: basic, semantic/analysis, and root causes. "Basic" questions make up the majority of the coding framework and ask for the who, what, where, and when. "Semantic/Analysis" questions are answered by the results of inquiry or measurement, such as explaining how a hazard threatens human lives or calculating outstanding needs. "Root causes" questions ask why aspects of the disaster occurred, such as what made the physical systems vulnerable to floods, high winds, or earthquakes in the first place. I will not discuss questions related to 'root causes' due to the fact that they were rarely observed in the first five days after a disaster, and they are not critical to the immediate response. That being said, it is important that root causes are investigated as part of after-action reviews in order to identify factors that increased the vulnerability of people and systems to the external shocks associated with the disaster.

The full set of questions developed under each thematic category are illustrated in Table 4.1. For example, questions that should be answered for the theme *Warnings* are the basic questions "what are the dangers? where are they expected? and when?", and the semantic question "how do the details equal a threat?". Each disaster response message is sorted under the thematic categories according to what question(s) it answers. Hence, the set of questions act as the coding framework for sorting information under the classification scheme.

4.3. Application of Classification Scheme: Near-real-time Analysis

As part of the CEDIM Forensic Disaster Analysis research activities, the classification scheme described above was applied to actual disaster events in near-real-time. Two major outputs resulted from comparing the information provided in actual disasters with the standard series of questions defined by the coding framework. The first output was a simple presence/absence scoring (see Boyatzis 1998, p. 131) to identify which of the questions remained unanswered. The presence/absence scoring reveals information gaps that can be further investigated. For example, when themes such as "meeting basic human needs" and "meeting transportation needs" are missing analysis of outstanding needs, it signifies that the extent to which the affected population needs are being met is unknown. Post disaster needs assessments could therefore be recommended to focus on these themes. Identifying a question as answered does not mean that no further information is required. the information in each thematic category will increase with each passing day of the response.

The second output resulted from comparing the information provided under each theme to the information provided under other themes within and between headings. This approach is meant to address the risk that answers to questions in the presence/absence scoring could be incomplete or inaccurate. The results of both steps are discussed below.

4.3.1. Presence/absence scoring

The presence/absence scoring procedure is a simple method for revealing which questions under each theme were answered by disaster response messages and more importantly, which questions remained unanswered. The timing of information provision was also documented in order to understand how quickly different questions could be answered. The results reveal that basic questions can be answered within 1 day (24 h) of a disaster for all thematic categories. Semantic/Analysis questions regarding how impacts occurred were typically answered within the first 1–2 days, but identification of outstanding needs was often missing in the first five days

after the disaster. Root causes were typically not observed in the first five days after the disaster, which is understandable considering this information does not typically help the immediate response. I will now discuss the findings from the presence/absence scoring of the three disasters associated with the case studies: Typhoon Haiyan and Typhoon Hagupit in the Philippines, and the Gorkha Earthquake in Nepal.

Typhoon Haiyan

Figure 4.1 illustrates the results of the presence/absence scoring completed five days after landfall of Typhoon Haiyan, in the Philippines. The review was conducted of NDRRMC (2013) situation reports available from their website. The reports that I have analyzed were issued two days before to 4.5 days after landfall. The presence/absence scoring was complete on the fifth day after landfall. Each report was broken down into the disaster response messages it contained, resulting in over 500 messages. The content of each message was then manually sorted into the properties of the corresponding themes. For example, the NDRRMC discussed clearing of transportation routes two days before landfall, clearing operations soon after the typhoon, and by two days after identified which roads and bridges were and were not passable. This information combined to answer all questions under the transportation solutions category, consisting of the basic questions "who is doing what to meet the transportation needs of those affected, where and when?" and the semantic/analysis questions "how do the actions meet the needs of those affected and what needs are outstanding?".

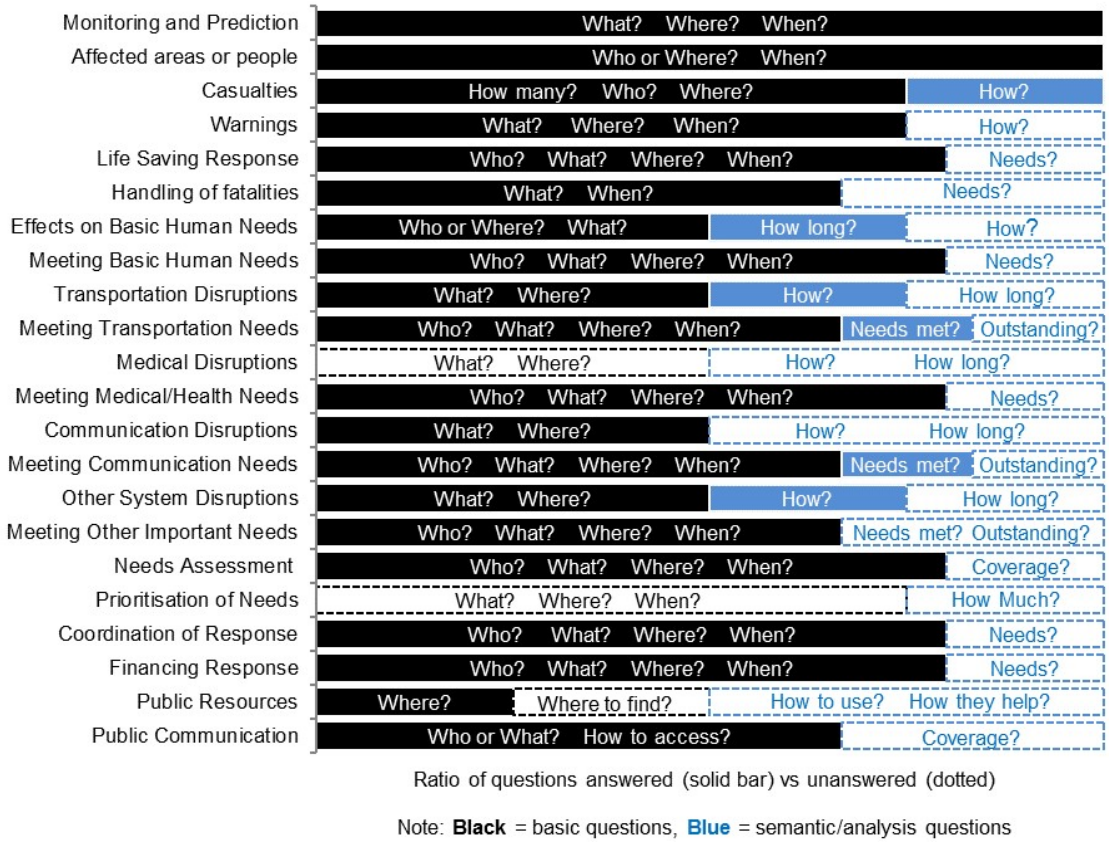

Figure 4.1: Presence/Absence scoring for Typhoon Haiyan - completed five days after landfall

In contrast, the NDRRMC did not answer any of the questions under the theme "Medical Disruptions". The reports answered the basic questions under the theme "Medical Solutions"; however, they did not answer the semantic/analysis questions: how do the actions meet the needs of individuals? and what are the outstanding needs? The NDRRMC reports focused on the pre-positioning of medical supplies and personnel. After landfall they discussed some actions being taken such as free medical check-ups. But nowhere in the NDRRMC reports were damages to hospitals or stresses on the healthcare system discussed. Even the NDRRMC's 43rd situation report (2013), issued 18 days after landfall, only identified the cost of damages to medical facilities without describing the damages.

The absence of answers to the questions in the medical disruptions thematic category was a common occurrence in the various thematic analyses. In spite of the absence of information on medical disruptions, the thematic analyses typically contained a substantial amount of information on medical solutions. However, without a clear understanding of the medical disruptions, the various agencies were incapable of confirming the outstanding medical needs. Providing evidence of this is the fact that most of the presence/absence scoring cases looked similar to Figure 4.1, in that they failed to identify both medical disruptions and outstanding medical needs. Throughout all of the presence/absence scoring cases, answers to the semantic/analysis questions were absent more often than the basic questions. For Typhoon Haiyan, the semantic question "how do the details equal a threat?" was notably unanswered.

Typhoon Hagupit

The thematic analysis of Typhoon Hagupit was carried out using only reports issued prior to landfall. Hence, only warnings were reviewed. Seven sources and 165 disaster response messages were reviewed from both government and new agencies. One can see that the information that was missing from reports was predictions about what the effects might be to people and systems (see Figure 4.2). In this case, information was provided to answer the semantic/analysis question "how do threats equal a risk to human life?"; however, this information was provided by news agencies and was not found in the NDRRMC warnings.

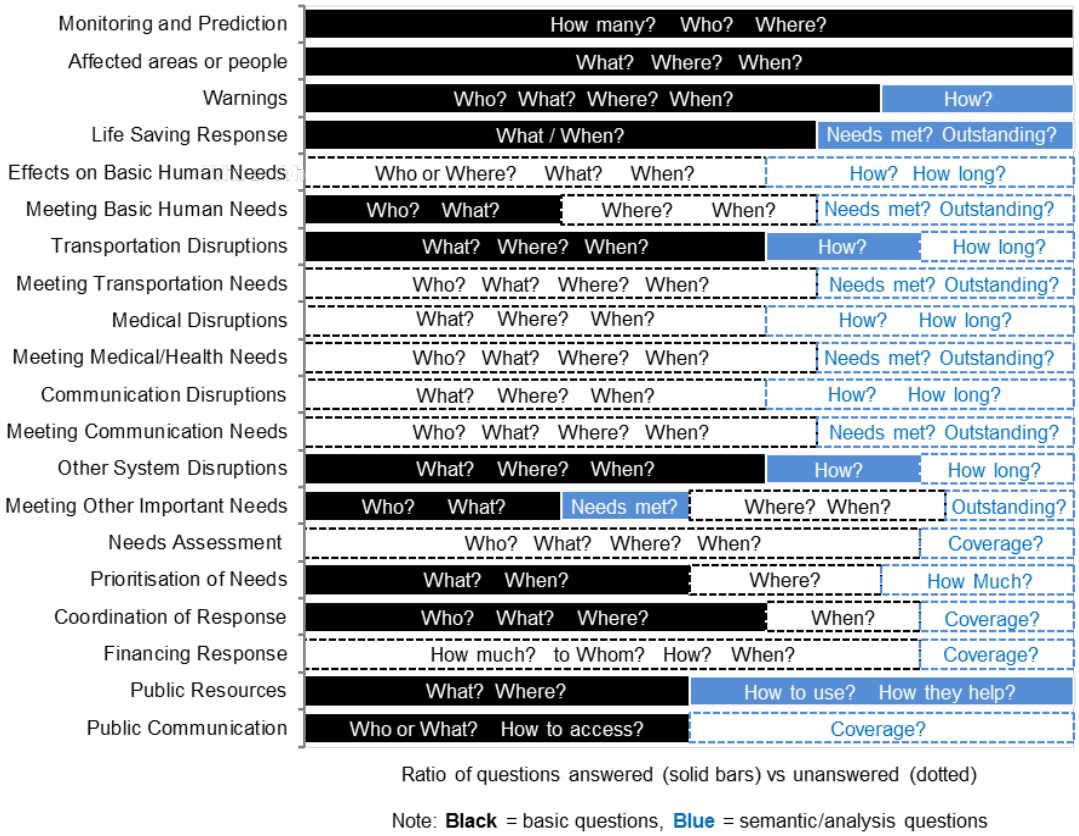

Figure 4.2: Presence/Absence scoring for Typhoon Hagupit - based on information issued before landfall

Gorkha Earthquake

Figure 4.3 identifies the results of the presence/absence scoring completed two days after the Gorkha Earthquake. A total of 13 sources and 272 disaster messages were reviewed, sorted and analyzed. The presence/absence scoring revealed major gaps in information about transportation. In particular, identification of outstanding transportation needs and where and when disruptions would be resolved, were absent. There was also a complete void of information to identify how communication with affected villages was going to be restored. Unlike typical presence/absence scoring results, the information reviewed answered nearly all of the questions pertaining to medical disruptions.

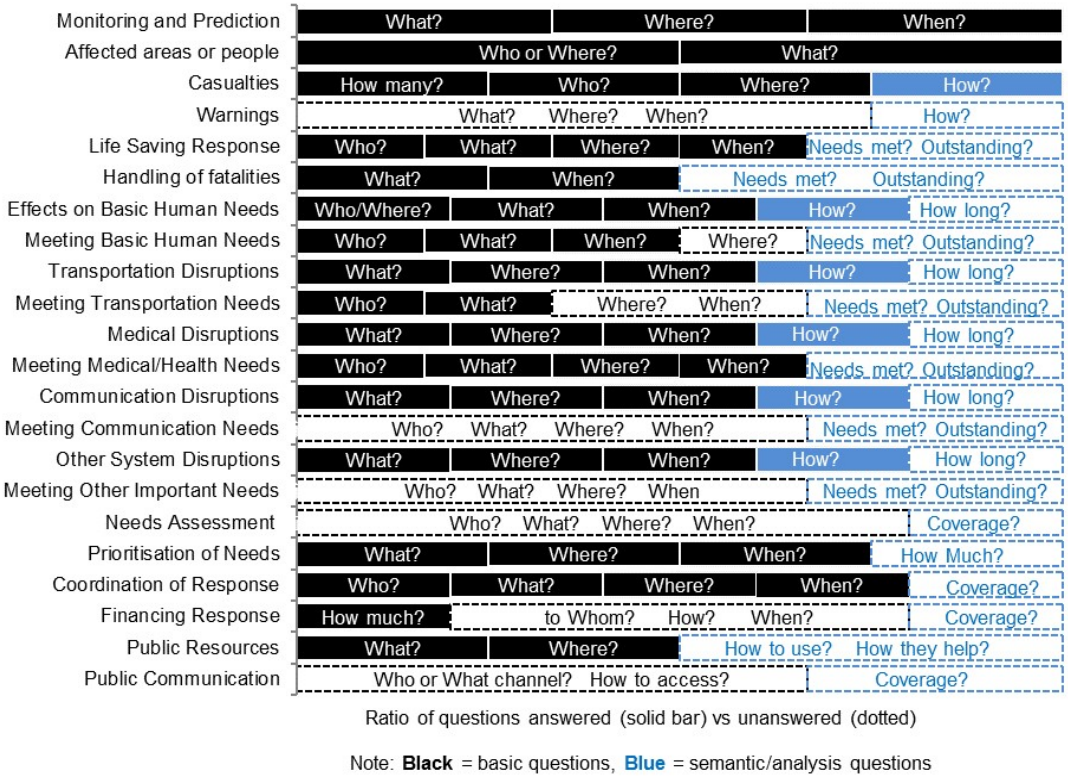

Figure 4.3: Presence/Absence scoring for the Gorkha Earthquake - completed two days after

4.3.2. Comparative analysis

The information gaps illustrated above identify the questions from Table 4.1 that remain unanswered. Further understanding of the information needs of the public can be obtained by carrying out a comparative analysis of the provided information. Two important factors that must be examined are the quality of the information provided and the relevance of the information gaps identified through the presence/absence scoring.

Information quality can be analyzed in terms of the level of detail, coverage, and accuracy. The level of detail refers to the amount of questions answered from Table 4.1 and is therefore revealed through the presence/absence scoring step. The coverage refers to the percentage of actual disaster impacts and subsequently required disaster response activities that are identified. For example, information that focuses on a city may leave out rural areas where disaster impacts have occurred and response activities are therefore required. Issues regarding coverage and accuracy of the information can potentially be identified by comparing the information contained under different thematic categories.

The basic human needs and transportation, medical, and communication system headings have intentionally been split into the themes "disruptions" and "solutions" to facilitate comparison. For instance, the near-real-time analysis completed three days after the 2013 Pakistan Earthquake compared the information provided under basic human needs "disruptions" and "solutions." Although the information provided under "solutions" discussed provision of relief goods, it appeared they did not match the quantities identified under "disruptions." In particular, a UNOCHA (2013b) report issued two days after the earthquake stated that the government had

dispatched 7,600 tents. At the same time, it was reported that 21,000 houses had been destroyed (Saifi 2013) and over 100,000 people made homeless (Agence France-Presse 2013a). This represents a "coverage" issue, as the solutions do not appear to cover the full extent of the disruptions. Further information would therefore be required to explain how the shelter needs will be satisfied for those who cannot be accommodated by the tents. This information would have been useful to those individuals who were still in need of shelter.

Accuracy issues can also potentially be identified if different information sources have conflicting information. For instance, three days after Typhoon Haiyan made landfall in the Philippines the official confirmed death toll was only 255 with 38 missing (NDRRMC 2013); a day earlier a local official estimated the death toll to be 10,000 (Reuters 2013). The substantially higher unofficial estimate could lead one to anticipate that the official death toll would rise in the coming days. Because of the ease at which rumors can spread during a disaster, this analysis refrains from labelling any message as accurate, and instead focuses on those messages that show signs of inaccuracy.

Comparing between themes also helps to establish the relevance of the missing information. In some cases, information gaps do not need to be filled. For example, if there are no medical disruptions then there is no need to identify medical solutions. Conversely, if there are large areas that have experienced communication system failure, then identifying solutions to communicate with populations in the affected areas would be very relevant to the situation. I will now discuss the results of comparative analyses for Typhoon Haiyan, Typhoon Hagupit and the Gorkha Earthquake.

Typhoon Haiyan findings from comparative analysis

Following the initial presence/absence scoring of the NDRRMC reports, I searched elsewhere for the information that was missing. Within 12 days after landfall of Typhoon Haiyan, I found a substantial amount of information to fill some of the gaps identified in Figure 4.1 above. The primary sources of this new information were relief or news agencies. I compared this information to the NDRRMC reports issued within the same time-frame. The following are some of the key findings.

The basic data provided in the NDRRMC reports discussed mainly provision of shelter, food and water. There was limited discussion regarding to what extent the provision of shelter, food and water was meeting the actual demand. Outstanding needs were therefore not fully known; however, the UN calculated that 2.5 million people were still in urgent need of food assistance as of 16 November 2013 (Morella 2013a).

After 12 days, the NDRRMC reports had still not provided any information on damages or disruptions to the medical system. This information was found to be provided by a number of other agencies. Medical disruptions were identified in reports by: International Medical Corps one day after landfall (Aguirre 2013); International Organization for Migration (IOM, 2013) two days after landfall; the World Health Organization (WHO, 2013), UN Population Fund (2013), and UNOCHA (2013c) three days after landfall; and Médecins Sans Frontières (2013) and Agence France-Presse (Morella 2013b) five days after landfall. Most detailed were the lists of medical disruptions and needs provided by Humanity Road (2013) beginning one day after landfall. Hence, the failure of the NDRRMC to detail medical disruptions was greatly compensated by other agencies. While numerous medical activities were identified, there was no

analysis provided to identify to what extent the medical needs of the affected population were being met. Identifying outstanding medical needs was also missing, though the IOM (2013) did identify the need to medically support the 12,000 births expected in November.

Regarding the emergency response, the NDRRMC provided basic data about response activities; however, there was limited analysis to confirm if these actions were meeting the needs of the affected population. To the contrary, it appeared that the emergency activities were not meeting the needs of the affected, since a report by Agence France-Presse (2013b) quoted the Filipino President Benigno Aquino III admitting that "The systems failed…there was a breakdown in terms of government and there was a cascading effect".

The situation reports issued by the NDRRMC (2013) acted as a resource for affected people, however, they mainly identified details of the typhoon, quantified impacts and described the activities of government agencies. Other sources provided information that was substantially more useful to the public. For example, the situation reports issued by Humanity Road (2013) provided a list of useful websites and phone numbers, including telecommunications, utilities, media, social media links, maps and situation reports, link to a list of hospitals, a list of evacuation centers, contacts for the Red Cross, donations, and updates on transportation and infrastructure conditions.

Typhoon Hagupit findings from comparative analysis

Situation Report No.8 marked a change in the NDRRMC report formatting, which appeared to place a greater emphasis on the risk of storm surge. The risk to storm surge was included in the Public Storm Warning Signal (PSWS) section of the update, with each PSWS number associated with a storm surge height. This was also the first time that the risk of storm surge made it to the first page of an NDRRMC situation report for both Typhoon Hagupit and earlier Typhoon Haiyan. The wording was also changed from previous reports. The report stated that "those living along the coast are warned of the occurrence of big waves associated with storm surge which may reach up to 3 meters" (NDRRMC 2014). The term "big waves" was not used during Typhoon Haiyan. The media coverage on Typhoon Hagupit also emphasized the risk to storm surge much more than during Typhoon Haiyan. The risk to storm surge appeared in headlines (GMA News 2014; The Guardian 2014; Ranada 2014). GMA News (2014) provided the local Filipino word for storm surge as "Daluyong".

The NDRRMC reports still did not explain or emphasize the threats. This gap was filled by the media. The most common method of highlighting the danger of storm surge during Typhoon Hagupit was to compare it to the storm surge that occurred a year earlier during Typhoon Haiyan. Appealing to emotions and logic, Larano (2014) referred to the "tragic memories" of Typhoon Haiyan and reminded readers that "Most of the more than 6,300 deaths from Haiyan were due to drowning from 6-meter high walls of water that rushed in to land for hundreds of meters". This description is one of the most vivid used of all of the collected messages that described a storm surge.

Predicted impacts to basic human needs were not identified, even though they appeared obvious. For example, numerous reports confirmed that more than half a million people had fled their homes to seek shelter at evacuation centers (BBC 2014; Guardian 2014; Larano 2014). It was not clear how such individuals would be provided food and water, and the presence or absence of a solution to this problem was not addressed in any reports.

Gorkha Earthquake findings from comparative analysis

Within the first 1.5 days after the Gorkha earthquake, reports on mainstream media were focused on the devastation in Kathmandu and at Mount Everest. The lack of details describing the impacts to districts outside of Kathmandu represented a serious information gap. Social media proved to be a useful source for details of impacts outside of Kathmandu. Humanity Road collected social media posts from individuals from districts that were affected. These details provided unofficial confirmation that a number of districts were heavily impacted, including Lamjung, Gorkha, Dhading, Rasuwa, Nuwakot, Sindhupalchok, Dolakha, Kavrepalenchok, Lalitpur, and Tanahun (Humanity Road 2015). Each of these districts with the exceptions of Lamjung and Tanahun were later added to the official list of 14 "most affected" districts (Ministry of Home Affairs 2015). Other twitter accounts also identified destruction in Parbat and Palpa districts (Twitter 2015a, 2015b). Hence, within two days of the earthquake, reports available on social media of entire villages being wiped out were completely missing from mainstream news.

Two weeks after the earthquake, a second comparison of the available information was completed. The key information that was missing was identification of where relief was either needed or being provided and plans to access or communicate with remote areas.

It was not clear how a district was classified as most affected. For example, the Global Shelter Cluster (2015) described 14 districts as high priority. One of these was Makwanpur, which had only 363 completely damaged homes; however, Solukhumba, Chitwan, Bhojpur, Tanahun, Khotang, Palpa, and Shyanja districts each had over 1,000 houses completely damaged and yet none made the list of "most affected". Relief agencies appeared to be using the list of 14 most affected districts as a guide to collecting information and directing aid. As a result, the variety of reports were limited to discussion about the 14 "most affected" districts, and little if anything was mentioned of other districts. Therefore, the two questions "What areas are affected?" and "How were they affected?", while answered, were identified to be incomplete due to the fact that they were limited to 14 districts at a time when information suggested other districts were also badly affected.

Shelter was identified as a priority, with the United States Agency for International Development (USAID, 2015) reporting that some VDCs in Gorkha and Sindhupalchowk were 90% destroyed and some VDCs in Dhading, Dolakha, Nuwakot and Rasuwa were 80% destroyed. Many organizations identified the aid they had provided to communities. The location of where this aid was distributed was often missing. Identification of outstanding needs was also often missing. Agencies could not confirm what aid was required where, since the status of remote villages was unknown due to lack of communication. The relevance of this information gap was confirmed by the Government of Nepal (2015b) who stated that many affected many districts had not received any aid.

Different organizations identified that they were carrying out physical assessments, but the majority of these only identified the district, and not the specific community. Instead, social media and crowdsourced information appeared to be providing the majority of information needed to assess the specific needs of each community. There was a general lack of information identifying where and when post-disaster needs assessments were planned to take place. The Standby Task Force (2015) created a report documenting 513 organizations responding as of May 6th. Almost all identified who organizations were and what work they were doing. Many

however failed to identify where they were operating and their timeline for delivering aid (i.e., when?). Furthermore, the Center for Excellence in Disaster Management and Humanitarian Assistance (CFE-DMHA, 2015) stated that relief had reached all affected districts. Exactly what aid was provided in what district was not identified. In addition, it was unclear which districts the report referred to, since some organizations referred to 39 affected districts, others referred to 57 affected districts and there was still a list of only 14 "most affected" districts.

In general, mountainous areas were not accessible by road. Many road closures were identified by numerous organizations; however, road clearing activities were not discussed. Numerous reports of helicopter evacuations of injured or vulnerable groups or delivery of aid were observed. The identification of where and when such transports occurred were most often being observed after the fact. Consequently, there was a lack of information which identified what villages would be provided with helicopter transport at what time in the future. In addition, the outstanding transportation needs of the affected population were not described.

Finally, a variety of online tools were created for affected communities with internet access to make aid agencies aware of their needs (GoogleDocs 2015; KLL 2015; Nepal Relief 2015; Resource Nepal 2015). Yet, information was missing regarding how to establish two-way communication with communities that did not have internet access.

4.4. Conclusions

The thematic analysis has resulted in a better understanding of the variety of information that could be useful to the public during a disaster situation. In addition, the thematic analysis led to the development of a classification scheme for disaster response information. The classification scheme serves as a tool to sort disaster response messages so that further analysis can be carried out. A simple presence/absence scoring can help analysts identify the questions that have been answered by the information as well as those questions with information gaps. Comparative analysis can then identify further deficiencies with the information provided as well as gauge the importance of information gaps. Key to this entire approach is that it is designed to be done in near-real-time, i.e., during a disaster situation. In applying this approach to actual disaster events, potential deficiencies were observed at a time when they could still be corrected.

Finally, there are inherent limitations to the results, due to the data collection procedure and the basis for analysis. The disaster response information used for all analyses has been collected from online sources rather than from local sources who could confirm that the information has reached communities. Furthermore, the analysis described above does not factor in the likelihood of whether or not the online disaster response information actually reached and was understood by the public. In Chapters 5 and 6 I discuss the results of quantitative surveys and qualitative interviews carried out in the Philippines and Nepal, respectively. The case studies provide insight into how the disaster response information I have classified above could potentially be disseminated to the public during disaster situations. The case studies will also reveal opportunities to obtain feedback from individuals in communities to confirm if they received the disaster response messages and understood them.

5. Results of the Case Studies in the Philippines

The thematic analysis described in Chapter 4 was limited to analyzing the content of disaster response messages. The objective of the case studies was to examine how disaster response messages could potentially reach disaster affected communities and the challenges along the way. In this chapter I discuss the results of the case studies from the Philippines. Chapter 6 provides the results of the case study in Nepal. I will refer to individuals from communities as "individuals" and barangay government officials as "local officials". When distinguishing between typhoons, I will use the terms Haiyan individuals or local officials and Hagupit individuals or local officials. The term "municipal" refers to municipalities and cities in cases such as Tacloban City and Catbalogan City.

5.1. Purpose of Chapter

The purpose of this chapter is to present the results of the quantitative surveys with individuals and local officials, as well as the qualitative interviews with municipal DRRM officers, from areas affected by typhoons Haiyan (2013) and Hagupit (2014) in the Philippines. This chapter will describe how disaster response information actually reached local populations in the Philippines from either the internet, mass media or local sources. I will describe the respondents' access to information and communication channels and show how that access changed after each typhoon. Results of other comparisons will also be described, such as the sources for disaster warnings compared to the sources for relief information, and the most trusted sources for warnings compared to the anticipated sources. I will also identify how respondents communicated during the disasters and who they communicated with. I will describe the patterns that were observed in the responses, and in particular will identify the differences between the responses of men and women. For a number of cases, I will present the results of statistical tests that confirm if the relation between gender and the dependent variable is significant and not due to chance. A number of questions from the surveys and interviews, once combined, also provide an indication of the overall design of the disaster communication system in the Philippines. Thus, I will discuss the official flow of disaster response information that was observed, and I will describe a few of the key actors involved in the system. Finally, the results will form the basis for the discussion and design of the conceptual model presented in Chapter 7.

5.2. Physical Impacts and Information Needs

Typhoon Haiyan had a greater impact than Typhoon Hagupit. This was witnessed in the damage to homes and the physical needs of communities after landfall, which was confirmed by the respondents. Typhoon Haiyan destroyed or caused major damage to the homes of 70% of individuals, as opposed to 44% of the homes of Hagupit individuals (see Figure 5.1).

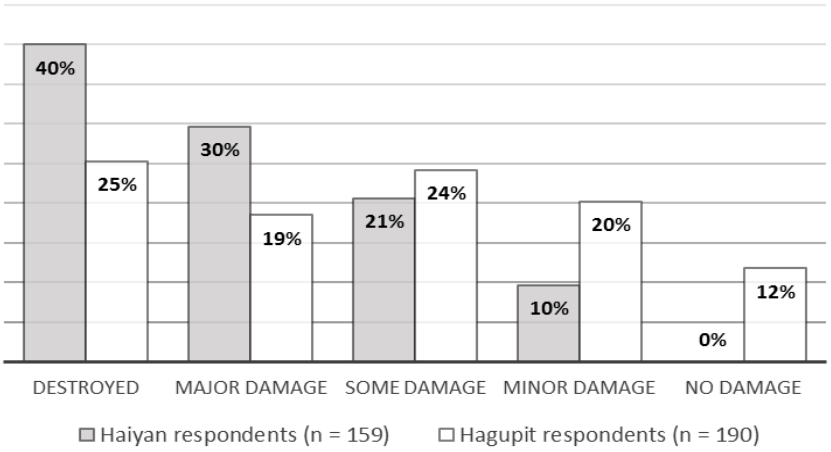

Figure 5.1: Level of damage to homes of individuals

Both typhoons resulted in a high need for food, water and shelter. Medical assistance was required more after Typhoon Haiyan than Hagupit. Respondents were provided the option to identify needs beyond food or water, shelter and medical help. Clothes was the most selected additional need by individuals of both surveys.

Table 5.1: Physical needs identified by individuals in 1st week after landfall

Physical need	Typhoon Haiyan	Typhoon Hagupit
Food or water	98%	89%
Shelter	51%	39%
Medical help	35%	17%
Clothes	19%	11%

We asked individuals what information they needed to help them prepare in the days before the typhoons made landfall and what information they needed to survive in the days after landfall. The question format was open-ended. The entire list of responses was coded into 20 different themes. The top four responses from each respondent group are provided in Table 5.2. Typhoon strength was the most identified information needs in the days before both typhoons. For Hagupit individuals, storm surge details were the next most cited information need, selected by 26% of individuals compared to only 3% of Haiyan individuals. This provides evidence that Hagupit individuals had a greater perception of storm surge risk than Haiyan individuals. After both typhoons, the information needs appeared to align with the physical needs identified above.

Table 5.2: Top four information needs before and after landfall

Haiyan individuals		Hagupit individuals	
Info needs in days before landfall	Info needs in 1st week after landfall	Info needs in days before landfall	Info needs in 1st week after landfall
Typhoon strength (52%)	Aid/relief (69%)	Typhoon strength (35%)	Aid / relief (71%)
General weather (20%)	Food or water (9%)	Storm surge details (26%)	Shelter (11%)
Location of typhoon (13%)	Medical help (6%)	Evacuation details (16%)	Damages (6%)
Evacuation details (12%)	Any help (4%)	Typhoon path (15%)	Food (5%)

5.3. Information and Communication Channels

Access to communication channels for individuals was drastically reduced following Typhoon Haiyan. Access to television dropped from 81% before landfall to only 3% one week after. Likewise, access to radio dropped from 81% before landfall to 14% one week after. Access to two-way communication channels was also badly affected. For example, access to smartphones dropped from 43% before the typhoon, to only 5% in the first week after (see Table 5.3).

Table 5.3: Access to information and communication channels before and after typhoons

		Typhoon Haiyan		Typhoon Hagupit	
		Before typhoon	1-week after	Before typhoon	1-week after
Individuals	Television	81%	3%	78%	37%
Haiyan: N = 159	Radio	81%	14%	50%	26%
Hagupit: N = 190	Smartphone	43%	5%	33%	25%
	Mobile with radio	59%	6%	20%	12%
	Mobile (call-text only)	82%	15%	61%	47%
	Computer with internet	13%	1%	4%	1%
	Computer (no internet)	10%	1%	4%	2%
Local officials	Television	68%	3%	47%	38%
Haiyan: N = 30	Radio	71%	21%	41%	41%
Hagupit: N = 37	Smartphone	41%	6%	9%	9%
	Mobile with radio	35%	6%	6%	6%
	Mobile (call-text only)	50%	6%	29%	27%
	Computer with internet	18%	3%	6%	3%
	Computer (no internet)	50%	6%	32%	24%

Following Typhoon Hagupit, access to information and communication channels was also reduced, but to a lesser extent. As one would expect when individuals leave their home to evacuate, access to television and radio were affected more than access to mobiles. It is also interesting to note the lack of access to two-way communication technology by the Hagupit local officials. Only 9% had access to smartphones and 35% had access to either mobiles with radio, or mobiles with call and text only.

Focusing on access to ICT before the typhoons, there were only a few categories which resulted in a significant variance when disaggregated by gender. For Haiyan individuals, access to mobiles with radio was higher among men (72%) than women (48%), X^2 (1, N = 157) = 8.9, p = 0.003, phi ≈ -0.24. For Hagupit individuals, access to television was higher among men (85%) than women (71%), X^2 (1, N = 190) ≈ 5.3, p ≈ 0.02, phi ≈ -0.17. On the other hand, access to mobiles with call and text only was higher among women (68%) than men (54%) for Hagupit individuals, X^2 (1, N = 190) ≈ 4.1, p ≈ 0.04, phi ≈ -0.15. There was no significant relation between site type (coastal or non-coastal) and access to ICT for Haiyan individuals, and because Hagupit respondents were mostly coastal, a comparison could not be made.

5.3.1. Social Media and Internet

Approx. 57% and 87% of Haiyan and Hagupit individuals, respectively, never used social media before the typhoon, and between 60% and 80% had never used the internet before. When the data is disaggregated by age, it is clear that younger respondents used social media and the internet more than older respondents (see Table 5.4).

Table 5.4: Social media and internet usage before the typhoons disaggregated by age

	Age	Most days	Once a week	Every few weeks	Once a month	Very rarely	Never
Social media	18-24y (N = 26)	38%	23%	12%	4%	4%	19%
	25-34y (N = 38)	18%	5%	8%	3%	11%	55%
	35-44y (N = 72)	15%	4%	8%	0%	6%	67%
	45-54y (N = 71)	7%	3%	6%	0%	1%	83%
	55-64y (N = 77)	1%	4%	5%	1%	4%	84%
	65y+ (N = 52)	2%	4%	2%	0%	0%	92%
Internet	18-24y (N = 26)	27%	15%	12%	12%	12%	23%
	25-34y (N = 38)	18%	0%	3%	3%	21%	55%
	35-44y (N = 72)	13%	3%	3%	0%	8%	74%
	45-54y (N = 71)	7%	4%	4%	0%	4%	80%
	55-64y (N = 77)	1%	1%	1%	0%	9%	87%
	65y+ (N = 52)	2%	4%	2%	0%	0%	92%

5.3.2. Channel preference

Table 5.5 identifies the five most selected channels through which respondents preferred to receive either general disaster warnings (Haiyan respondents) or storm surge warnings (Hagupit respondents). The table combines the respondents' first and second selections. Television and

face-to-face interaction were overall the most preferred channels, and represent one-way and two-way forms of communication, respectively.

Table 5.5: Preference for receiving general disaster warnings for Haiyan respondents and specifically storm surge warnings for Hagupit respondents

Typhoon Haiyan		Typhoon Hagupit	
Individuals	Local officials	Individuals	Local officials
68% TV	70% Face-to-face	53% Face-to-face	39% TV
50% Radio	27% TV	49% TV	38% Face-to-face
35% Face-to-face	27% Radio	30% Megaphone	38% Megaphone
27% Megaphone	27% Megaphone	25% Radio	28% Mobile Call
4% Social media	24% Mobile Call	12% Mobile Call	20% Text

When disaggregated by gender for both typhoon surveys and by site type for Haiyan respondents, there was no significant relation to channel preferences. It is worth noting that for Haiyan individuals, television was selected more often by men (66%) than women (49%), but this difference was not statistically significant.

5.4. Information sources

In almost all four respondent groups, television and radio ranked as the best information sources in the days leading up to the typhoons (see Table 5.6). Next most selected were government officials, with municipal government placing ahead of radio for local officials from Typhoon Hagupit affected areas.

After landfall, the most common answers for individuals were local officials or family and friends. The top responses for local officials were the municipal government followed by family and friends for Typhoon Haiyan, and NGOs/Aid agencies for Typhoon Hagupit. The greatest change was observed in the shift from mass media (television and radio) to actual persons delivering information. This also marked a shift in reliance on one-way forms of communication to sources with the potential to engage in two-way communication.

Table 5.6: Shift in top information sources from days before to one week after typhoons

Typhoon	Respondent group	Days before (% of responses)	One week after (% of responses)
Haiyan (2013)	Individuals (N = 159)	82% television	62% local officials
		59% radio	57% family/friends
		19% local officials	19% radio
		13% family/friends	15% city/municipal gov.
	Local officials (N = 30)	86% television	73% city/municipality
		57% radio	37% family/friends
		48% city/municipal gov.	29% NGO/aid agency
		3% Family or friends	28% radio
Hagupit (2014)	Individuals (N = 190)	82% television	66% family/friends
		41% radio	46% local officials
		23% local officials	20% city/municipal gov.
		22% family / friends	18% radio
	Local officials (N = 37)	88% television	75% city/municipality
		55% city/municipality	43% NGO/aid agency
		50% radio	30% radio
		3% PAGASA	12% Family/friends

5.4.1. Trusted and anticipated information sources

The same four agencies were identified by individuals from Haiyan and Hagupit surveys as the most trusted agencies to provide general (Haiyan) or storm surge (Hagupit) warnings and as the agencies anticipated to deliver storm surge warnings in the future. The top selected agencies were PAGASA, local officials, municipal officials, and news agencies. In both cases, more than one third of respondents identified more than one source who would warn them of storm surges in the future.

Table 5.7: Trusted and anticipated sources for disaster warnings

	Haiyan Individuals		Hagupit Individuals	
Agency	Most trusted agency for disaster warnings	Anticipated source for storm surge warnings	Most trusted agency for storm surge warnings	Anticipate source for storm surge warnings
PAGASA	39%	44%	25%	18%
Local officials	28%	57%	16%	40%
Municipal officials	17%	32%	20%	37%
News agency	7%	18%	20%	20%
Others	9%	20%	19%	13%

For Haiyan surveys, there was a significant relation between gender and selection of most trusted information source, X^2 (4, N = 155) = 17.1, p = 0.002, Cramer's V = 0.33. The differences which contributed the most to the relation were the selection of PAGASA and municipal officials. PAGASA was selected by 53% of men and 29% of women, with standardized residuals of 1.7 and -1.6, respectively. Municipal officials, which contributed even more to the relation, were selected by 6% of men and 28% of women, with standardized residuals of -2.4 and 2.4, respectively. The selection of local officials, news agencies or other selections were similar for men and women. For Hagupit individuals, there was also a significant relation between gender and selection of the most trusted information source, X^2 (4, N = 182) = 18.3, p = 0.001, Cramer's V = 0.32. Similar to the results for Haiyan surveys, the Hagupit surveys revealed a difference in the selection of PAGASA (men = 37%, women = 17%), and municipal officials (men = 17%, women = 25%). The difference in the selection of PAGASA contributed the most to the relation, with standardized residuals of 2 and -1.9 for men and women, respectively.

5.5. Challenges

A majority of Haiyan respondents (52%) stated that there were no challenges to obtaining sufficient information to help them prepare in the days before landfall. Of those that experienced challenges in finding information, 47% stated that they did not understand the information they received. Similarly, of the 15 Haiyan local officials who experienced challenges in obtaining disaster response information before landfall, 60% confirmed that they did not understand the information received. After landfall, only 5% of individuals stated that there were no challenges to obtaining sufficient information to help them access relief. The main challenges after landfall were associated with lack of access to channels such as television, cellphones, and radio (see Table 5.8).

For Typhoon Hagupit, 69% of respondents stated that there were no challenges in finding information to help them prepare in the days before landfall. Of those that experienced challenges in finding information, only 9% stated that they did not understand the information they received. After landfall, only 16% of respondents stated that there were no challenges to obtaining sufficient information to help them access relief. The main challenges after landfall were that they did not have access to communication channels (see Table 5.8).

Table 5.8: Challenges for individuals to obtain disaster information before and after typhoons

Theme	Challenge	Haiyan		Hagupit	
		Days before (N = 74)	1 week after (N = 143)	Days before (N = 57)	1 week after (N = 159)
Channel	No access to television	5%	62%	12%	41%
	No access to cellphone	5%	59%	14%	31%
	No access to radio	3%	58%	9%	21%
	No access to internet	7%	15%	7%	3%
	No Electricity	0%	15%	16%	32%
	No means of asking for information	12%	8%	19%	8%
Content	No information available	0%	18%	5%	6%
	Information available was bad quality	14%	8%	4%	3%
Knowledge	Didn't know where to find the info	31%	11%	16%	8%
	Didn't know what info was available	14%	8%	11%	7%
Understanding	Didn't understand the information	47%	1%	9%	1%

5.6. Situational Awareness

The following set of questions reveals to some extent, the respondents' situational awareness in the days before landfall of each typhoon (see Table 5.9). In every category, the situational awareness during the days preceding landfall of Typhoon Hagupit was higher than the days preceding landfall of Typhoon Haiyan. As one might expect, the situational awareness of the local officials was higher than that of the individuals in both cases. The awareness of the potential for a storm surge, and the understanding of how dangerous the storm surge could be, were notably the categories with the lowest percentage for Haiyan respondents. These same two categories were higher among Hagupit individuals. Despite the fact that a majority (53%) of Haiyan respondents did not evacuate prior to landfall, most confirmed that their area was advised to do so and that they knew to where they could evacuate. For both Haiyan and Hagupit individuals, there was no significant relation between gender and any of the situational awareness items identified in Table 5.9.

Table 5.9: Situational awareness in days before landfall of both typhoons

	Typhoon Haiyan		Typhoon Hagupit	
	Individuals (n = 159)	Local officials (n = 30)	Individuals (n = 190)	Local officials (n = 37)
Aware of most of typhoon details: wind speed, size, location, predicted path & timing	20%	41%	41%	72%
Understood barangay could be badly affected	68%	77%	91%	95%
Aware of the public storm warning signals issued in area	86%	91%	89%	97%
Understood how dangerous the winds could be	67%	77%	96%	97%
Aware of the potential for a storm surge in area	34%	50%	88%	95%
Understood how dangerous the storm surge could be	34%	41%	94%	100%
Area advised to evacuate	85%	85%	91%	95%
Aware of where people in barangay can evacuate to	85%	94%	94%	97%

5.6.1. Reasons for and against evacuating

For Haiyan individuals, there was a significant relation between gender and evacuation, as 54% of women evacuated compared to 38% of men, X^2 (1, N = 157) = 3.9, p = 0.048, phi = -0.16. While 50% of Haiyan coastal area individuals evacuated and 41% of non-coastal area individuals evacuated, this difference was not statistically significant.

A minority (47%) of Haiyan individuals evacuated prior to landfall compared to a large majority (77%) of Hagupit individuals. One reason could be that Hagupit individuals were mostly from coastal communities. Coastal communities may be either more used to evacuating or felt more threatened by the typhoon and storm surge. The individuals were asked in an open-response format, why they did or did not evacuate. While not in the same order, individuals from both typhoons listed the same top three reasons as: their house was unsafe; the threat of a storm surge; and a fear for safety. Conversely, the top reasons for not evacuating were also the same for both typhoons and even in the same order. They were identified as: their house was safe enough; they did not expect major impacts; and to secure property (see Table 5.10).

Table 5.10: Reasons for and against evacuating prior to landfall of both typhoons

Haiyan Individuals				Hagupit Individuals			
Reasons for evacuating (N = 62)		Reasons against evacuating (N = 79)		Reasons for evacuating (N = 145)		Reasons against evacuating (N = 38)	
34%	Thought house was unsafe	49%	Thought house was safe	27%	Fear for safety	28%	Thought house was safe
18%	Storm surge	24%	Did not expect major impacts	26%	Storm surge	19%	Did not expect major impacts
18%	Fear for safety	8%	To secure property	17%	Thought house was unsafe	19%	To secure property

Of those who did not evacuate, 55 (or 70%) Haiyan individuals and 16 (or 42%) Hagupit individuals, thought they should have in hindsight. The 55 Haiyan individuals were asked to explain why the disaster warnings failed to convince them to evacuate. The most selected reasons were that threats were neither explained (67%) nor emphasized (57%). The next most selected responses were that individuals did not receive the warnings (12%), the warnings did not contain enough instructions (6%) and that the warnings came too late (4%). The question was multiple choice, allowed for multiple answers and included an open-ended response option. The complete set of options for answers are provided in Appendix B. While response bias can sometimes favor the first items on a list of choices, the two most selected answers shown in Figure 5.2 were third and fourth on a list of seven items.

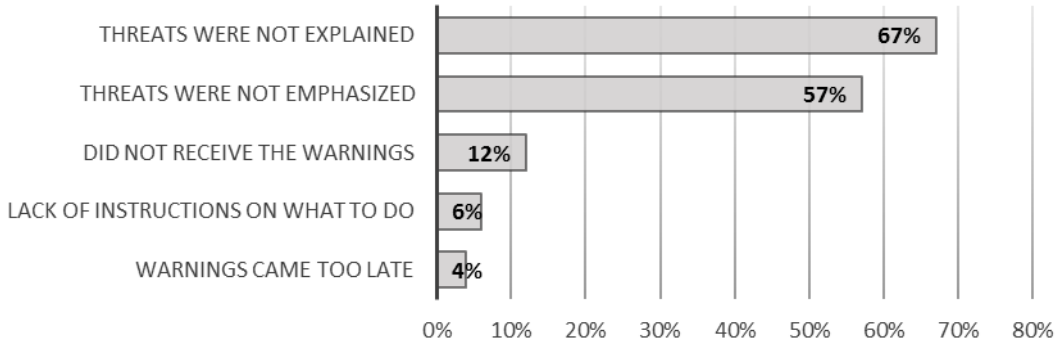

Figure 5.2: Why warnings were unsuccessful in convincing respondents to evacuate prior to landfall of Typhoon Haiyan (N = 55)

Answers from Haiyan local officials appeared to validate the responses by the individuals. Haiyan local officials (N = 30) confirmed that the warnings were unsuccessful in getting people to evacuate because the warnings were neither emphasized (60%) nor explained (40%).

5.7. Communication

Fewer individuals were able to contact family members who were not with them in the first week after Typhoon Haiyan (49%) than after Typhoon Hagupit (71%). In the first week after Typhoon Haiyan, individuals who were able to communicate with their family or friends did so

mostly through face-to-face interaction. Typhoon Hagupit individuals showed a greater variety in their use of communication channels, with similar percentages of respondents selecting text message, face-to-face interaction, and mobile calls (see Figure 5.3). Hagupit respondents also had greater access to these channels compared to Haiyan respondents as discussed in Section 5.3. Social media, on the other hand, was hardly used to connect with family or friends for both Haiyan and Hagupit surveys. There was no significant relation between gender and the use of channels to contact friends and family in the first week after both typhoons.

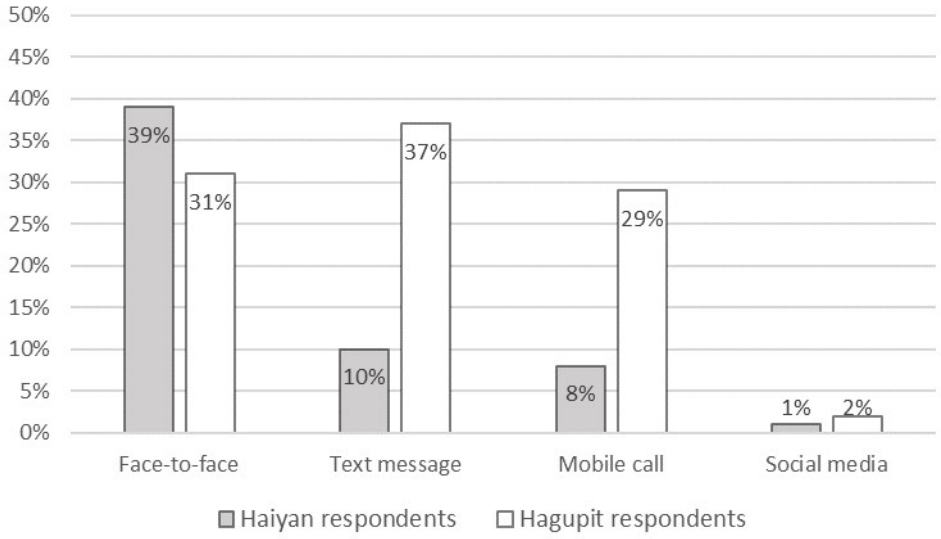

Figure 5.3: How individuals contacted family and friends (who were not with them at the time of the typhoon) in the first week after landfall

Many individuals also communicated with government or other agencies in the first week after landfall. The agencies which individuals communicated with the most were the government organizations responsible for their area: 60% of Haiyan and 62% of Hagupit individuals communicated with their local officials. Thus, the official structure of disaster information dissemination appears to support two-way communication. Similarly, 76% of Haiyan and 67% of Hagupit local officials communicated with their municipal government (see Table 5.11). More Typhoon Hagupit individuals did not communicate at all with government or other agencies than Typhoon Haiyan individuals. This is potentially a result of individuals being less impacted by Typhoon Hagupit and having fewer needs than those impacted by Typhoon Haiyan. Hagupit local officials also communicated less with other agencies than Haiyan local officials; however, the difference was minimal. Furthermore, Hagupit local officials communicated with more agencies compared to Haiyan local officials. This suggests that these additional agencies (DSWD, NGOs, and DILG) either became more involved in disaster response activities since Typhoon Haiyan, or were able to communicate with local officials quicker after Typhoon Hagupit (i.e., in the first week) than Typhoon Haiyan.

Table 5.11: Communication with agencies by individuals (left) and local officials (right) in the first week after each typhoon

Agency	Haiyan individuals (n = 159)	Hagupit individuals (n = 190)	Haiyan local officials (N = 30)	Hagupit local officials (N = 37)
Local officials	60%	30%	-	-
City/municipal govern.	12%	15%	76%	67%
NGO/ aid agency	9%	9%	14%	28%
DSWD	4%	9%	14%	49%
Police or army	1%	1%	-	-
DILG	1%	5%	-	13%
News agency	-	1%	-	3%
Provincial government	-	-	-	3%
Did not communicate with any agencies	26%	44%	5%	10%

For Haiyan individuals, 78% of men communicated with government or other agencies, compared to 69% of women; however, this difference was not statistically significant. The difference was even less noticeable for Hagupit individuals, where 54% of men communicated with government or other agencies compared to 58% of women. Overall, this suggests that the majority of Filipinos in the areas surveyed have access to government officials in emergency situations.

In general, the most common method of communication with government or other agencies in the first week after landfall was face-to-face interaction (see Table 5.12). All of Haiyan and most of Hagupit (93%) individuals' communication with agencies was through face-to-face interaction. Approx. 92% of Haiyan and 81% of Hagupit local officials' communication with other agencies was also through face-to-face interaction. No communication was through social media or any other form of internet based technology.

Table 5.12: Channels used to communicate with agencies by individuals (left) and local officials (right) in the first week after each typhoon

Channel	Haiyan individuals (N = 159)	Hagupit individuals (N = 190)	Haiyan local officials (N = 30)	Hagupit local officials (N = 37)
Face-to-face	100%	93%	92%	81%
Text message	-	3%	3%	10%
Call	-	4%	3%	5%
Other	-	-	2%	4%

The main reasons for not communicating with agencies in the first week after landfall was that the respondents either had no means of communication, relied on officials sending messages, did

not know who to communicate with, or because there were no agencies to communicate with. These results combine the responses from 23 and 73 individuals from Typhoon Haiyan and Hagupit individuals, respectively, who did not communicate with any agencies.

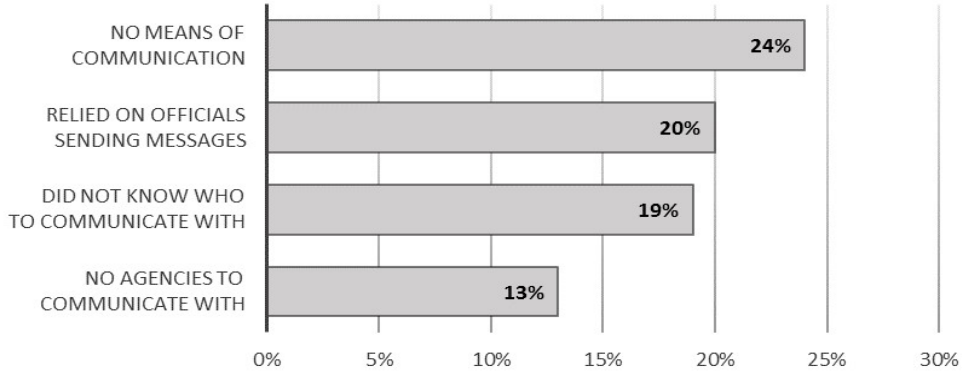

Figure 5.4: Main reasons for individuals not communicating with agencies

5.8. Official Flow of Storm Surge Warnings

We now turn our focus to storm surge warnings issued prior to landfall of Typhoon Hagupit. Hagupit individuals were asked how they received storm surge warnings. Not a single one of the 190 individuals was advised of the storm surge by NOAH directly. In fact, 89% of individuals did not know who or what NOAH was. This issue was not limited to individuals, as 82% of local officials also did not know who or what NOAH was. Nonetheless, storm surge warnings reached 88% of Hagupit individuals and 95% of Hagupit local officials before landfall.

The top four sources for storm surge warnings for individuals leading up to Typhoon Hagupit, were local officials, news agencies, municipal government, and family and friends (see Table 5.13). Those respondents selecting government officials received storm surge warnings primarily by megaphone (56%) and face-to-face interaction (26%). Those respondents who selected news agencies received storm surge warnings through television (100%) or radio (31%). Hagupit local officials primarily received storm surge warnings from the municipal DRRM officer, who in turn, received storm surge warnings from the provincial DRRM officer. As Table 5.13 illustrates, an official flow of disaster response information was clearly visible in the case of distributing storm surge warnings during Typhoon Hagupit. Storm surge warnings travelled from the provincial DRRM officer to the municipal DRRM officer, to the local officials, and finally to the individuals. Furthermore, the respondents themselves each identified the actor above them in the chain to be more informative than other sources.

Table 5.13: Information sources for storm surge warnings prior to Typhoon Hagupit

Individuals (n = 190)	Local officials (n = 37)	Municipal DRRM officer (n = 7)
42% Local officials	66% Municipal DRRM officer	100% Provincial DRRM officer
29% News agency	47% News agency	86% OCD
28% Municipal government	13% NOAH website	86% DILG
11% Family and friends	8% PAGASA	71% NOAH website

There was a clear preference for sending storm surge warnings by text message at the provincial and municipal government levels. All provincial and municipal DDRM officers interviewed sent storm surge warnings to the next lowest level of government authority by text message. In addition to text message, five out of seven municipal DRRM officers also used megaphone to warn barangay captains and individuals. Hence, there was a shift in the channels of communication from text message to megaphone or face-to-face interaction which occurred at both the municipal and local level (see Table 5.14).

Table 5.14: Channels used by provincial, municipal and local officials to disseminate storm surge warnings to those in the chain below them during Typhoon Hagupit

Agency	Text	Mega-phone	Face-to-face	Bell or siren	Call	Letter	2-way radio	Email
Provincial DRRM officers (n = 3)	100%	-	-	-	33%	33%	33%	33%
Municipal DRRM officers (n = 7)	100%	71%	29%	-	14%	14%	-	-
Local officials (n = 37)	8%	70%	54%	5%	-	-	-	-

All three provincial DRRM officers confirmed to have received typhoon information from PAGASA, and two of the three confirmed to have used NOAH's website to view storm surge inundation maps. Five of the seven municipal DRRM officers also confirmed to have accessed NOAH's website to view storm surge inundation maps. However, none of the local officials accessed NOAH's website. Hence, NOAH's storm surge information reached local officials, and subsequently individuals, indirectly through municipal DRRM officers who either accessed the online information themselves, or were provided some of the information through the provincial DRRM officer. Furthermore, the provincial and municipal DRRM officers were not sent storm surge warnings from NOAH. Instead, the officers actively searched for the information online. The information was then converted, first from hazard maps and lists of localities at risk to text message, then from text message to verbal communication over megaphone or face-to-face interaction.

5.9. Key Actors

This section discusses a few key actors in delivering disaster response information to the public. The key actors identified were the municipal DRRM officers, local officials, and scientific agencies. The results from the survey are complemented with the findings from the qualitative interviews with municipal and provincial DRRM officers, as well as a representative from NOAH.

5.9.1. Municipal DRRM officers and local officials

The municipal DRRM officers received storm surge warnings from a number of sources and through a variety of channels. Many municipal DRRM officers also actively searched for further information by accessing online websites, including NOAH's hazard website. Municipal DRRM officers then sent that information by text or megaphone to barangay captains who in turn

informed the community via megaphone or face-to-face interaction. Figure 5.5 identifies the flow of critical storm surge information leading up to landfall of Typhoon Hagupit, as confirmed through the semi-structured qualitative interviews with municipal DRRM officers. The number of times each of the seven municipal DRRM officers identified how they received or disseminated warnings is labelled in brackets.

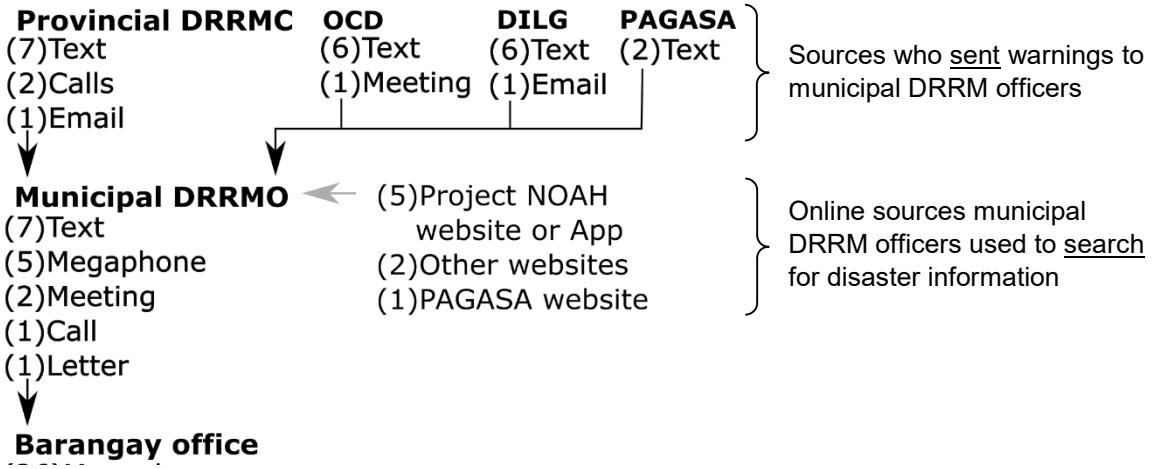

Figure 5.5: Critical Storm Surge Information Flow for Typhoon Hagupit (N = 7)

Most municipal DRRM officers converted the typhoon and storm surge warnings they received from text messages to spoken announcements over megaphone. The majority, but not all also targeted certain audiences, such as coastal barangays and landslide prone barangays. Finally, most municipal DDRM officers also sought feedback by text message, or in person by sending personnel to those barangays that were at high risk (coastal) or those barangays which did not communicate feedback through text message or calls.

5.9.2. Scientific agencies

Prior to landfall of Typhoon Hagupit, the Nationwide Operational Assessment of Hazards (NOAH) produced storm surge hazard maps showing the heights of predicted storm surges in many of the coastal areas of Leyte, Samar, and Eastern Samar. NOAH also provided a long list of localities with the greatest risk to storm surge. NOAH is a key actor because the hazard information it produces is critical to the public achieving situational awareness in a disaster. Yet, as discussed in Section 5.7, not one of the Hagupit survey respondents received storm surge information from NOAH directly. Even the municipal DDRM officers were not sent information by NOAH, but rather accessed it themselves online. I met with a NOAH representative who confirmed that it was not part of NOAH's mandate to actively send any hazard information to any agency. Instead, NOAH was only mandated to produce the hazard maps and the website to access the maps.

The Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) was also observed to be a key actor because of the hazard and general weather information they produce. PAGASA was a critical source for typhoon and general weather updates. PAGASA even actively sent storm surge warnings to some municipal DRRM officers by text message (see

Figure 5.5). PAGASA was also the most trusted agency to deliver general disaster warnings (Haiyan surveys) and storm surge warnings (Hagupit surveys) to individuals.

5.10. Comparison to thematic analyses

In this section I will compare some of the findings from the surveys and interviews to the presence/absence scoring and comparative analysis described in Sections 4.3.1 and 4.3.2. The purpose of this comparison is to observe if the responses to the surveys can validate the near-real-time analysis. In addition, viewing the results of both research approaches side-by-side can provide a deeper understanding of the communication problem.

In the presence/absence scoring for Typhoon Haiyan, the thematic category "medical disruptions" did not have any questions answered in the first five days by the NDRRMC reports. Yet, the surveys revealed that 35% of individuals needed medical help. In addition, the majority of those who needed medical help did not receive it because it was unavailable. Part of the reason for identifying medical disruptions is that it is the first step in identifying medical solutions. If individuals could have been advised of how they could access medical attention, potentially more would have received medical assistance sooner.

Overall, the type of information that was most frequently missing from NDRRMC reports was semantic/analysis information. Starting with the days before landfall, analyses of the NDRRMC warnings revealed that the details provided regarding the potential strong winds, rains, flooding and storm surge did not answer the semantic question: "how do the details equal a threat to human life?". The Haiyan surveys confirmed that individuals had problems understanding the warnings. As a result, many did not evacuate, who in hindsight believed that they should have. When asked why the warnings were unsuccessful in convincing people to evacuate, the top two reasons selected by both individuals and local officials were that the threats were not explained or emphasized. This same failure on the part of the NDRRMC was also highlighted by an after-action review (Neussner 2014). What this example illustrates, is that the classification scheme and information gap analysis methodology could have identified this same issue before landfall.

For Typhoon Hagupit, the semantic question "how do the details equal a threat" was answered; however, the information to answer this question came from news agencies rather than the NDRRMC official warnings. Fortunately, individuals received the majority of their information from news media, considering television and radio were the top selected information sources before landfall. This time, individuals from the survey understood the warnings and a greater percentage of individuals evacuated. This example highlights the importance of seeking alternative information sources when there are deficiencies with the information from the main source.

For both typhoons, the NDRRMC focused on the details of the typhoon such as the strength, location and path. Such details were confirmed by the individuals as information that was important to them before the typhoon made landfall. However, in both Haiyan and Hagupit surveys, individuals stated that receiving evacuation details was also important to them before landfall. The NDRRMC reports neither provided information advising the public if they should evacuate nor details describing how they should evacuate. After both typhoons the most important information that approx. 70% of individuals stated they searched for was information about aid/relief. Yet, the NDRRMC situation reports focused on identifying damages, affected

populations, financial losses, critical system disruptions, and actions by government agencies. Such information is not very useful for someone searching for aid.

5.11. Conclusions

The two case studies from the Philippines demonstrate that although the system for distributing disaster response information is complex, with multiple intermediaries and communication channels, patterns of information sources and channels were observed. For instance, online storm surge warnings were accessed by upper levels of government, texted to lower levels, and communicated verbally to the community. For both typhoons, a clear shift was observed in the information sources used before the typhoon to afterward. Many of those who previously turned to television and radio for typhoon warnings before landfall, began relying on local officials, family and friends for relief information after landfall. The challenges to obtaining disaster response information before typhoon Haiyan were largely identified as semantic challenges, as nearly half of individuals and over half of local officials who experienced challenges confirmed that they did not understand the information they received. In contrast, challenges to obtaining disaster response information after both typhoons were largely identified as being technical challenges.

The majority of individuals and local officials communicated with government agencies in the first week after the typhoons. Furthermore, the method of communication with agencies was overwhelmingly face-to-face interaction. The overall disaster communication system was also found to be reliant on government officials communicating at the local level through either face-to-face interaction or megaphone. In contrast, almost no communication was conducted by social media, and very little disaster response information was obtained via social media. The case studies also revealed that some channels of communication were more vulnerable to disaster impacts than others. The larger Typhoon Haiyan badly affected all communication channels. The smaller Typhoon Hagupit on the other hand, affected access to some channels such as television, more than others like mobile phones and smartphones.

Finally, statistical tests confirmed a significant relation between gender and access to some communication channels. For example, for Typhoon Haiyan respondents, men had greater access to television than women. While this result is statistically significant, given the circumstances, it holds little practical significance for a sender deciding to use television or not to distribute information to women. The Hagupit survey showed that 85% of men had access to television before the earthquake compared to 71% of women; however, television was still the channel that women had the greatest access to. If targeting women, the sender would still decide to use television. Where the results do have practical significance, is the identification of the quantity of individuals who will not be reached by television, which are only 15% of men compared to 29% of women. Viewed in this perspective, the results reveal that if only television were used to disseminate disaster response information, roughly twice as many women than men would not have access to that information. Alternative channels could be sought to reach those who do not have access to television, keeping in mind that more of them are likely to be women.

The same line of argument could be followed to assess who will not receive information sent via social media. The answer is overwhelmingly older generations, with 92% of those 65 years of age or older having never used social media before the typhoons. In fact, 55% of those 25 years of age or older never used social media before the typhoons struck. Again, the argument is not to argue for or against using social media, since it is believed that every additional channel used can

contribute. The point is to understand who is not reached by the channels that the sender has selected to use, so that those groups of individuals can be included in the target audience for messages delivered through alternative channels.

The test for statistical significance also revealed that men are more likely than women to trust PAGASA, and women are more likely to trust municipal DRRM officials. Hence, targeting women by distributing information through municipal DRRM officials is another option for reaching a female target audience.

6. Results of the Case Study in Nepal

A number of quantitative surveys and qualitative interviews were carried out in Nepal. In referring to respondents from the different surveys and interviews, I will use the terms "individuals", "local officials", "key informants" and "shelter survey respondents". Individuals include members of the public who took part in the main survey with 401 participants. Local officials encompass ward and VDC government officials who took part in the survey with 20 participants. Key informants refers to district level agencies who took part in a survey with 25 participants. Qualitative interviews were also conducted with half of the key informants. Shelter survey respondents refer to those households who participated in the shelter survey which included 284 households, with 32 also taking part in qualitative interviews.

6.1. Purpose of Chapter

The main purpose of this chapter is to present the findings of the quantitative surveys with individuals from communities in eight districts that were among the worst affected by the 25 April 2016 Gorkha Earthquake in Nepal. I will also present the findings from the surveys with local officials, as well as the surveys and qualitative interviews with key informants. The results will reveal patterns in the information seeking and communication behavior of local communities in response to this sudden major earthquake. I have selected two groups which could realistically be targeted to receive disaster response information. Communities living in rural areas and women in general represent location and gender specific targeting, respectively. I will demonstrate how the information and communication channels available to these groups can differ from their counterparts (i.e., urban vs. rural and men vs. women).

6.2. Physical impacts and Information Needs

The physical needs of the respondents were the direct result of the damages caused by the earthquake. More than three quarters of individuals confirmed that their homes were either destroyed or suffered major damage (see Figure 6.1).

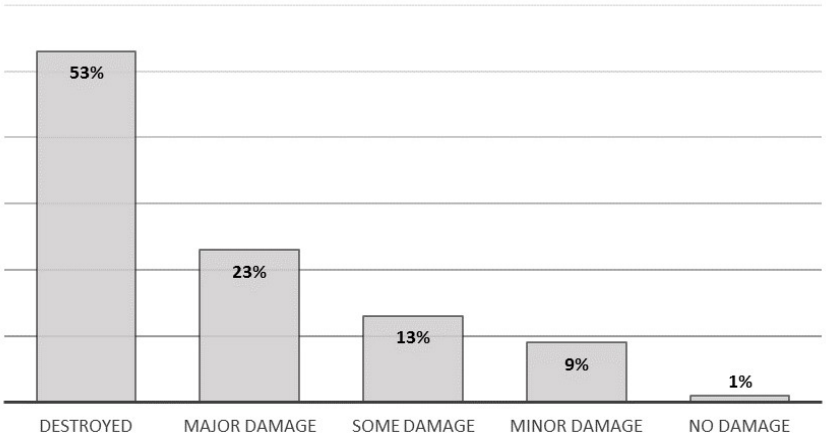

Figure 6.1: Level of damage to homes of individuals (n = 401)

The earthquake also left nearly all individuals without electricity, and caused the loss of many basic human needs, crops, and livestock (see Figure 6.2). Only three individuals out of 401 reported no impacts.

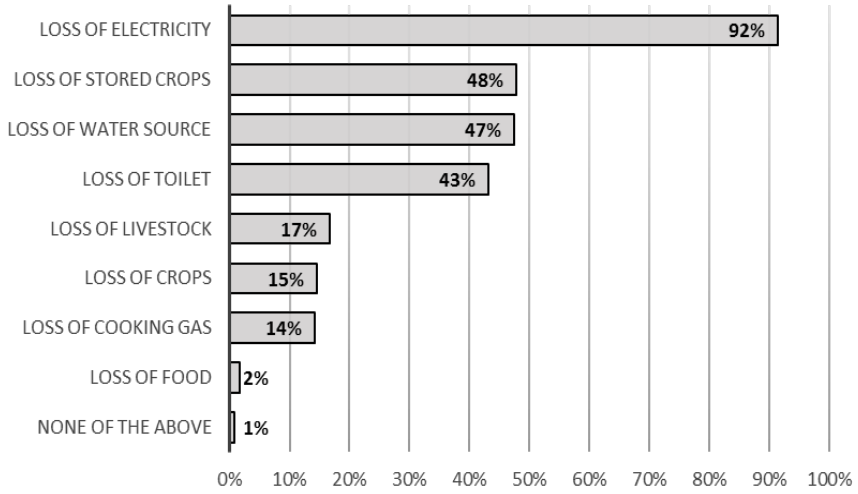

Figure 6.2: Additional impacts to individuals caused by the earthquake

Almost all individuals confirmed to have needed shelter, most needed food or water and about one third needed medical assistance (see Table 6.1). These three critical needs were also confirmed by local officials.

Table 6.1: Critical needs in the first week after the earthquake

Individuals (n = 401)	Local officials (n = 20)
95% Shelter	100% Shelter
77% Food or water	95% Food or water
32% Medical assistance	85% Medical assistance

The individuals were asked the open-ended question of what information they looked for during the first week after the earthquake when they were trying to survive or decide what to do. Themes were developed from the variety of responses. The information needs appeared to match the physical needs. One item which was not observed to such a large extent in the Philippines, was that 21% of individuals in Nepal identified the need for information about the status of family and friends. The top four information needs in the first week after the earthquake were information regarding shelter, the state of family or friends, aid distribution, and food or water. Figure 6.3 depicts those themes that were identified by more than 10 individuals. In total, the information identified by individuals could be coded into 29 categories. There were no statistically significant variances between the information needs of men and women.

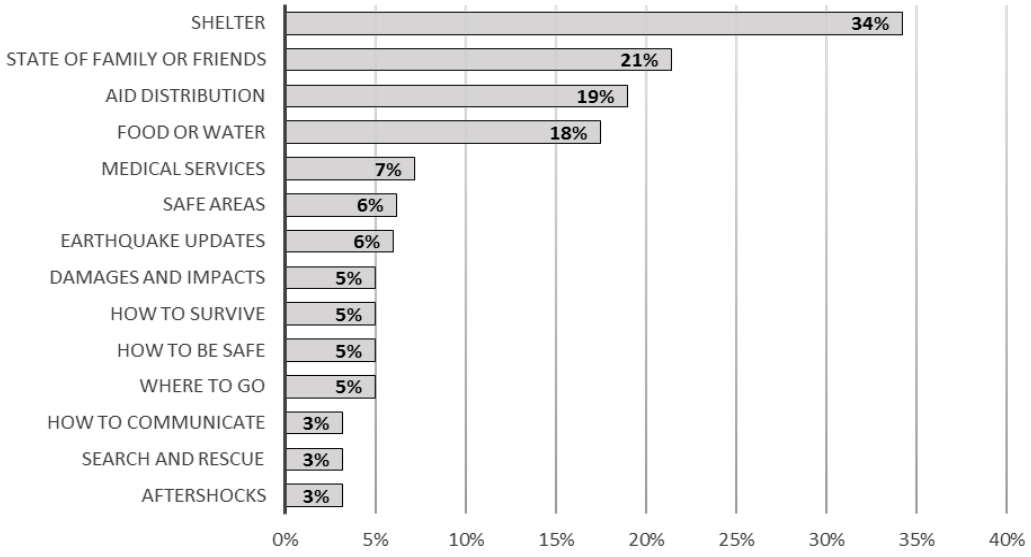

Figure 6.3: Top information individuals sought in the first week after the earthquake by (N = 401)

6.3. Information and Communication channels

The survey revealed that affected populations have different access to technology based on their gender and location (urban vs. rural). There was a significant association between gender and access to most of the communication channels listed in Table 6.2. In general, men had greater access to smartphones and computers with internet than women. Women were more likely to have mobiles with radio. Access to radios, however, is difficult to measure. While men had greater access to stand-alone radios, women had greater access to mobiles with radio capabilities. On the other hand, men also had greater access to smartphones, many of which may have had radio capabilities.

Table 6.2: Relation between gender and access to ICT before the earthquake

ICT	Male (n = 218)	Female (n = 183)	Statistically significant (Chi-square test: significant if $p < 0.05$)	Effect size (phi coefficient)
TV	78%	81%	No (x^2 (1)=0.55, p=0.46)	None to small (0.04)
Radio	76%	66%	Yes (x^2 (1)=4.45, p=0.04)	Small (-0.11)
Smartphone	48%	32%	Yes (x^2 (1)=11.19, p=0.001)	Small to medium (-0.17)
Mobile with radio	17%	29%	Yes (x^2 (1)=8.22, p=0.004)	Small (0.14)
Mobile with call and text only	22%	25%	No (x^2 (1)=0.54, p=0.46)	None to small (0.04)
Computer with internet	22%	13%	Yes (x^2 (1)=5.35, p=0.02)	Small (-0.12)
Computer without internet	10%	15%	No (x^2 (1)=2.47, p=0.12)	Small (0.08)

There were even greater differences when disaggregated by site type. For all but mobiles with radios, there was a significant association between site type and access to the various channels

identified in Table 6.3. Individuals from rural areas were statistically less likely to have televisions, smartphones or computers than individuals from urban areas, and more likely to have mobiles with call and text only. Considering the different types of mobiles, it appears that the further away a target audience resides from urban areas, the more likely they are to have a mobile with reduced technical capabilities. One peculiar relation is semi-urban access to radio. In every other category semi-urban sites are in between urban and rural as one would expect; however, semi-urban sites have significantly less access to radio than both urban and rural sites. The relation is also significant, and therefore cannot be explained by chance. The reason for the different pattern is likely explained by the high access to radios in rural areas. For a number of reasons such as reduced income, cable and electricity, those in rural areas are more likely to rely on battery powered radios than television for their entertainment and news.

Table 6.3: Relation between site type and access to ICT before the earthquake

ICT	Urban N=125	Semi-urban N=186	Rural N=90	Statistically significant (Chi-square test: significant if $p < 0.05$)	Effect size (Cramer's V test)
TV	100%	74%	63%	Yes (x^2 (2)=50.4, $p<0.001$)	Medium (0.36)
Radio	78%	60%	87%	Yes (x^2 (2)=25.1, $p<0.001$)	Medium (0.25)
Smartphone	62%	39%	13%	Yes (x^2 (2)=52.5, $p<0.001$)	Medium (0.36)
Mobile with radio	18%	22%	30%	No (x^2 (2)=4.2, $p\approx0.12$)	Small (0.10)
Mobile with call and text only	15%	20%	41%	Yes (x^2 (2)=21.3, $p<0.001$)	Small to Medium (0.23)
Computer with internet	34%	15%	1%	Yes (x^2 (2)=41.3, $p<0.001$)	Medium (0.32)
Computer without internet	24%	9%	3%	Yes (x^2 (2)=24, $p<0.001$)	Medium (0.25)

Overall, access to smartphones and mobile phones were the least impacted, with only a 2 - 4% decrease in the first week after the earthquake. Access to television was most impacted, with a decrease of 53% (see Table 6.4). Men and women's access to information and communication channels were both reduced because of the impacts from the earthquake, but there was no statistically significant difference in the percentage of reduction between men and women.

Table 6.4: Access to information and communication channels before and after the earthquake

	Before earthquake	1 week after earthquake
TV	80%	27%
Radio	71%	52%
Smartphone	41%	38%
Mobile with radio	22%	19%
Mobile with call and text only	23%	20%
Computer with internet	18%	6%
Computer without internet	12%	5%

6.3.1. Social Media and Internet

Urban areas have a higher potential to utilize social media and the internet in general because they had greater access to smartphones and computers with internet (see Table 6.3 above). To confirm this, individuals were asked how often they used social media or the internet in general before the earthquake. Approx. 50% of individuals from urban and semi-urban areas used social media once a week or more, as opposed to less than 15% of rural individuals. Over 85% of individuals from rural areas confirmed that they never use social media or the internet (see Figure 6.4).

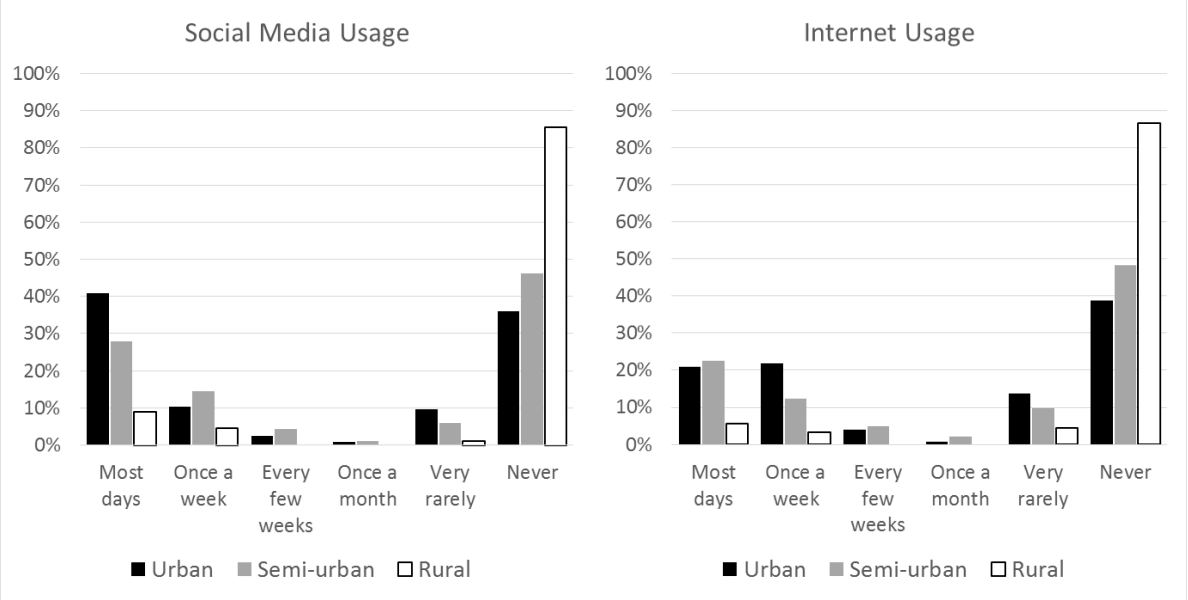

Figure 6.4: Use of social media and internet before the earthquake disaggregated by site type

Social media was also informative for those that had access to it immediately after the earthquake, being selected as the first or second best source of critical information by 30% of urban site individuals and 10% of semi-urban individuals. Only 4% of rural individuals identified social media as a main source of information, highlighting the lack of penetration of social media into rural areas.

Disaggregating by age reveals that the younger generation of Nepalis actually uses social media quite frequently (see Table 6.5). Of those 18 to 24 years of age, 71% used social media most days before the earthquake, and another 12% used social media once a week. Across all age groups, less people browsed the internet than used social media. One reason to explain this difference is derived from the fact that Nepalis in general access social media and the internet with their mobile phones. Feature phones, which are widely used in Nepal, have limited capabilities but provide access to Facebook or other social networking sites through mobile applications. This can make social networking easier than browsing internet websites. Furthermore, poor internet connectivity throughout Nepal greatly slows down internet browsing, whereas smartphone applications for using Facebook or other social networking websites are not as badly affected.

Table 6.5: Use of social media and internet before the earthquake disaggregated by age

	Age	Most days	Once a week	Every few weeks	Once a month	Very rarely	Never
Social media	18-24y (N = 83)	71%	12%	1%	0%	2%	13%
	25-34y (N = 109)	37%	21%	3%	1%	9%	29%
	35-44y (N = 85)	8%	11%	8%	2%	11%	60%
	45-54y (N = 51)	10%	4%	0%	0%	4%	82%
	55-64y (N = 34)	0%	0%	0%	0%	0%	100%
	65y+ (N = 39)	0%	0%	0%	0%	3%	97%
Internet	18-24y (N = 83)	38%	27%	2%	0%	16%	17%
	25-34y (N = 109)	29%	20%	6%	3%	10%	32%
	35-44y (N = 85)	8%	7%	7%	2%	14%	61%
	45-54y (N = 51)	6%	6%	0%	0%	6%	82%
	55-64y (N = 34)	0%	0%	0%	0%	0%	100%
	65y+ (N = 39)	0%	0%	0%	0%	0%	100%

Use of social media by local officials was similar to the young generation of 18 – 24 year olds, with 65% of local officials using social media most days, and 40% using internet most days. The higher rates among local officials are likely because officials work in offices which ought to have more resources than a typical family, and because the offices are more likely to be located in urban or semi-urban areas than rural areas. Offices in urban areas are often responsible for rural areas.

6.3.2. Channel preference

Figure 6.5 identifies the top two channels selected by individuals for how they prefer to receive disaster updates and aid information. By disaggregating the responses according to site type, large differences in channel preferences were observed. Face-to-face communication and radio were preferred by rural area individuals, and urban areas preferred television. Megaphone proved to be almost equally important across all site types. Social media was also preferred by 26% of individuals in urban sites.

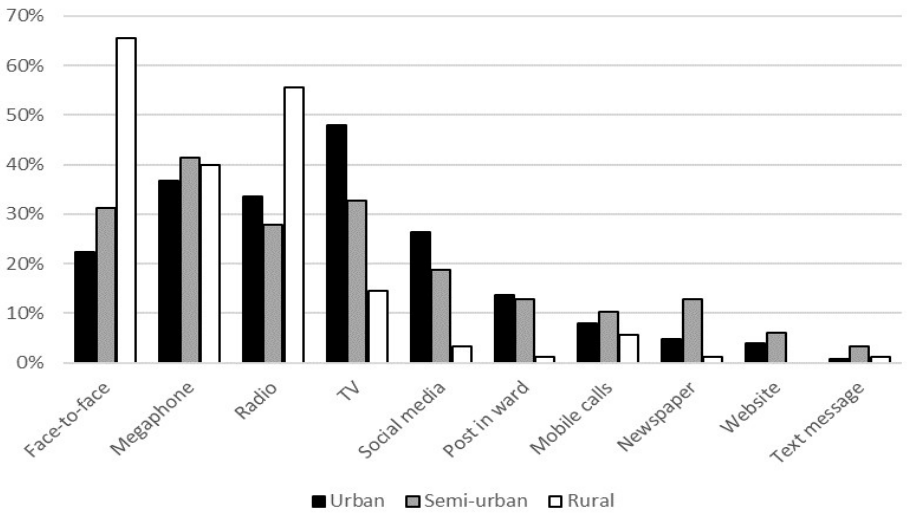

Figure 6.5: Individuals' preference for receiving disaster updates and aid information disaggregated by site type

The relation between gender and preferred channels was not statistically significant. Megaphone, face-to-face interaction, radio and television were the top four selected channels by men and women. Women in general preferred information to be posted in the community more than men did. Women also selected television more than men, and men selected radio and newspaper more than women.

There was no clear channel preference for local government officials. Instead, preference for receiving disaster updates and aid information was widely distributed across a variety of channels (see Figure 6.6).

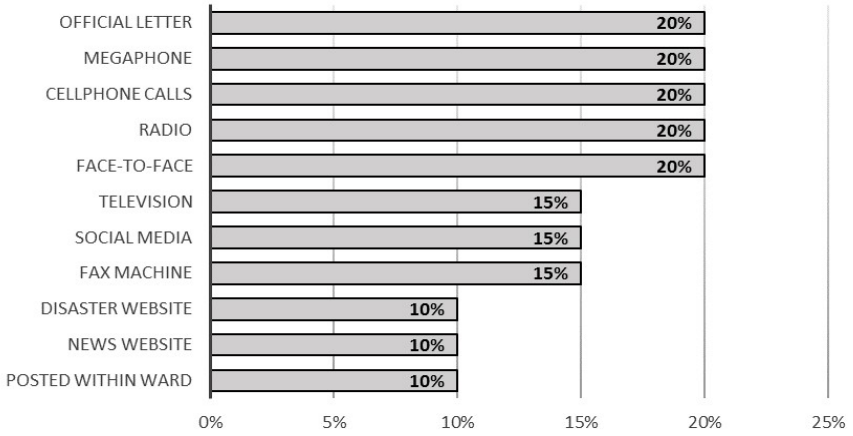

Figure 6.6: Local officials' preference for receiving disaster updates and aid information (showing only those channels selected by at least two officials)

6.4. Information Sources

The top information sources selected by individuals for three different types of information are identified in Figure 6.7. The three types of information represent a progression in time, beginning with general news before the earthquake, critical information to survive in the first

week after the earthquake, and longer term information about accessing aid in the weeks to months after the earthquake. A shift was observed from relying on one-way mass media (television and radio) to two-way forms of communication with family and friends and local government officials. That being said, in the first week after the earthquake, radio became the most informative source for critical disaster response information. Radio was eventually replaced by local officials as the top source for information about aid.

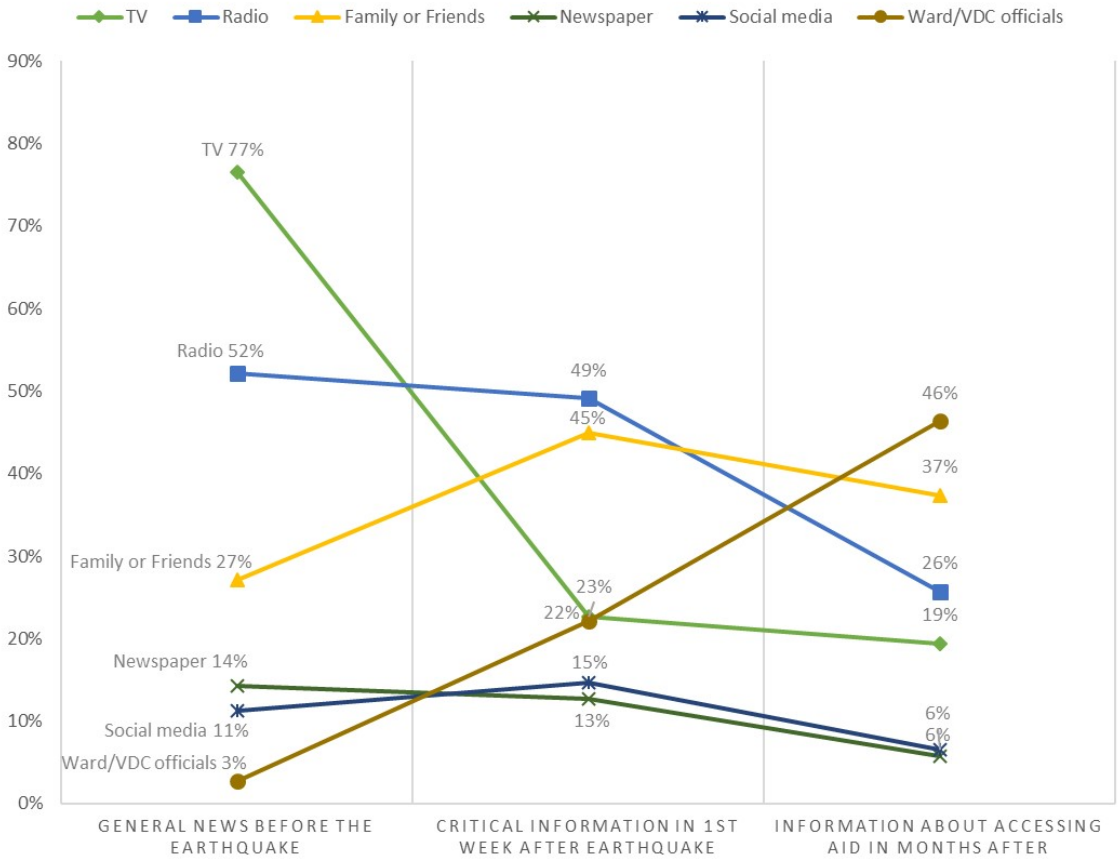

Figure 6.7: Shift in top information sources over time and type of information

When disaggregated by site type, it is clear that in the first week after the earthquake, radio was better at reaching rural areas than urban and semi-urban areas (see Figure 6.8). On the other hand, social media was better at reaching urban areas than semi-urban or rural areas. In urban areas, social media became a better information source than television for the first week after the earthquake.

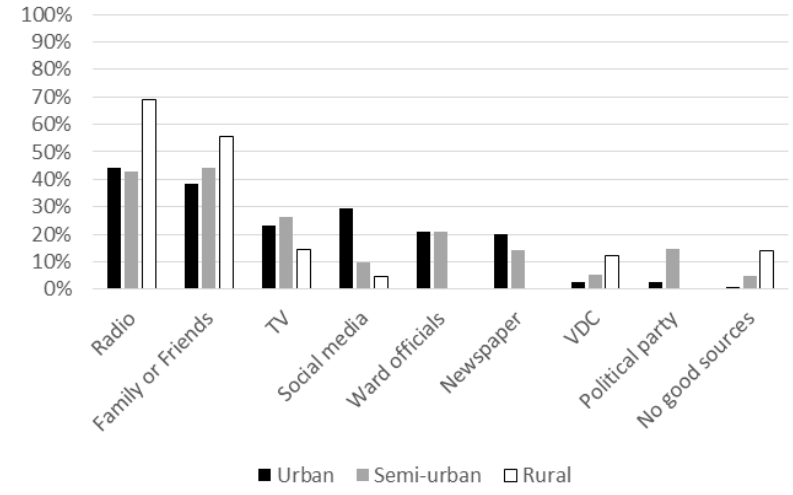

Figure 6.8: Best sources for critical information in the first week after the earthquake disaggregated by site type

6.4.1. Trusted sources

Figure 6.9 identifies the top two trusted sources selected by individuals to provide them with accurate disaster relief information. Besides family or friends, individuals trusted local officials from ward or VDC government offices, followed by radio stations (see Figure 6.9). Urban areas selected ward officials at a much higher rate than VDC officials, and rural areas selected VDC officials much more than ward officials. The top trusted sources among local officials were identified as the DDRC, the CDO, ward or VDC experts, and political parties. Hence, both individuals and local government officials placed their trust in government agencies. The only notable difference in selections between men and women were in trust in family or friends (men = 28%, women =42%) and trust in political parties (men = 17%, women = 6%).

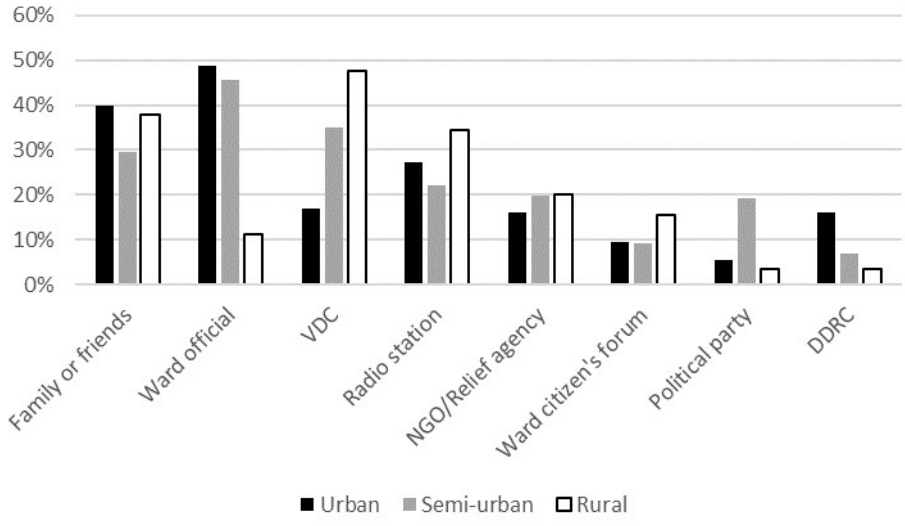

Figure 6.9: Agencies most trusted by individuals to provide accurate disaster relief information disaggregated by site type

6.4.2. Anticipated information sources

Finally, individuals were asked who should advise them of the risk of their area to future earthquakes or landslides. Only 1% of individuals identified experts such as engineers or geologists. Instead, local officials and news agencies were identified (Table 6.6). The most selected method of communication was face-to-face, followed by megaphone and social media. Most individuals selected more than one person or agency, meaning that they expect information to be disseminated through multiple sources.

Table 6.6: Anticipated sources to advise individuals about the risk of their area to future earthquakes and landslides

Information source	Count N=401	% of cases	Channel of communication count (below) and % of total (top)						
			Face-to-face	Mega-phone	Social media	Call	TV	Radio	Other
			43%	**16%**	**14%**	**7%**	**6%**	**6%**	**8%**
Ward officials	163	**41%**	98	42	5	16	-	-	11
VDC officials	143	**36%**	77	36	4	8	-	-	1
News agency	132	**33%**	7	5	62	-	43	39	19
NGO or relief agency	55	**14%**	27	10	8	1	-	-	9
CDO officials	52	**13%**	30	7	5	5	1	1	10
Ward citizen's forum	50	**13%**	38	5	1	11	-	-	2
DDRC	46	**12%**	14	7	16	10	-	-	7
Police or army	10	**3%**	9	-	-	-	-	-	-
Others	20	**5%**	9	2	2	-	-	2	1

The majority of government officials expected the DDRC to advise them of the risk of their area to future earthquakes and landslides, followed by news agencies, the CDO, Ward/VDC experts and NGOs (see Table 6.7). The most selected channels through which local officials expect to receive risk information were face-to-face interaction, phone calls, and letters.

Table 6.7: Anticipated sources to advise local officials about the risk of their area to future earthquakes and landslides

Agency	Count N = 20	% of cases	Channel of communication count (below) and % of total (top)						
			F2F	call	letter	social media	text	email	Other
			26%	**21%**	**21%**	**9%**	**6%**	**6%**	**10%**
DDRC	11	**55%**	4	3	6	1	-	1	-
News agency	10	**50%**	2	5	-	3	-	1	5
CDO	8	**40%**	3	2	5	1	-	1	-
Ward/VDC experts	6	**30%**	5	-	2	1	4	-	1
NGO	4	**20%**	2	3	1	-	-	1	1
Other	3	**15%**	2	1	-	-	-	-	1

6.4.3. Rumors

Rumors were frequently observed after the earthquake, as evidenced by the multiple reports produced by Open Mic Nepal (2015). Open Mic Nepal's reports tracked rumors and false perceptions, and reported the facts to counter those rumors. The reports were valuable to anyone in the community and were issued in Nepali and English; however, they were only issued online. I asked individuals how they validated rumors to learn from their responses but also to confirm if anyone made use of this valuable online resource. Less than 2% of individuals used any form of internet or social media to validate rumors and none used the Open Mic Nepal website. Instead, individuals either sought the knowledge of persons in their community or turned to news media (see Figure 6.10).

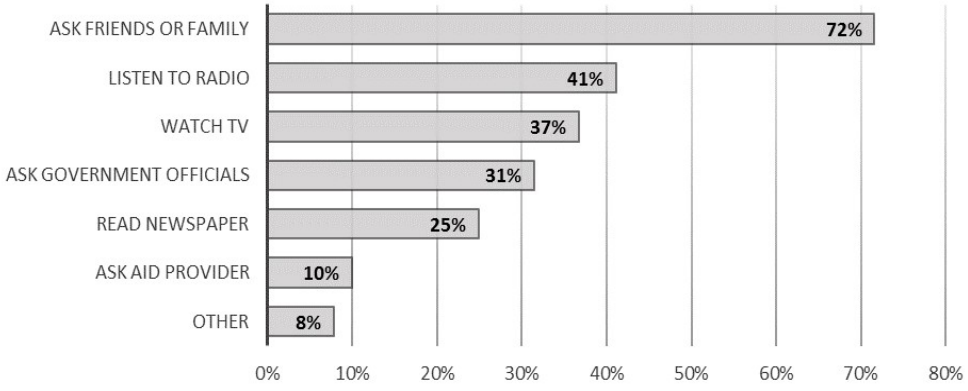

Figure 6.10: How individuals validate rumors (N = 401)

6.4.4. Local knowledge of increased landslide risk

Approx. 21% of individuals stated that their home was in an area at risk to landslides at the time of the surveys (Nov 2015), and 14% confirmed that a landslide had occurred in their area during the latest monsoon (June – Sept. 2015). This matched with government officials, as 25% confirmed their areas of responsibility were prone to landslides and 20% confirmed a landslide occurred during the monsoon. Most individuals (65%) were aware that the earthquake may have caused an increased risk of landslide during the monsoon in landslide prone areas; this is compared to 80% of government officials. Furthermore, of those individuals that were aware of the increased risk to landslides, 45% changed their behavior during the monsoon as a result of the increased risk perception; they either took precautions or were extra careful during heavy rainfall.

Those individuals and government officials who were aware of the increased risk to landslides were asked where they obtained this knowledge. Surprisingly, the most frequent response did not match any of the options on the multiple choice list, and so filled the open-ended option. Of the 260 individuals who were aware of the increased landslide risk, 37% stated that they developed this increased risk perception on their own. The most common terms used by the individuals, once translated from Nepali to English, were "self-analysis", "own observations", and "experience". Thus, one of the key sources of information were the local individuals themselves. Responses by local officials were quite different, as 75% of officials acquired their increased risk perception from news agencies.

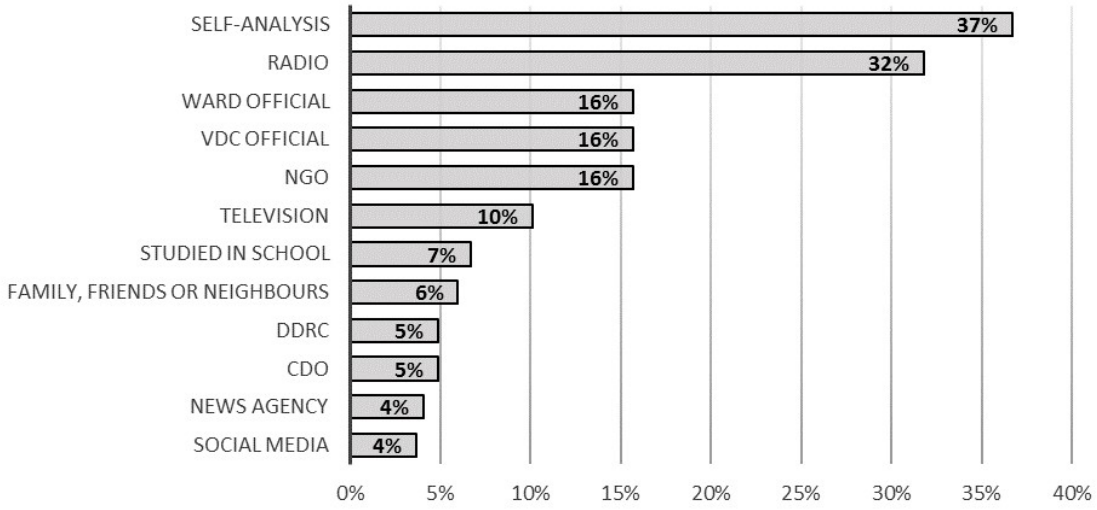

Figure 6.11: How individuals became aware of increased landslide risk during monsoon (n = 267)

6.5. Challenges

Individuals were asked what the greatest challenges were to acquiring the information they needed. Different types of challenges were presented for individuals to select from, with the option of an open-ended response. The different challenges fall under four themes: channel issues, content issues, lack of knowledge and lack of understanding. Channel issues such as lack of access to television and radio, were the most selected responses. Content issues were also cited often, as were lack of knowledge about what information one could access and how to access it. While failure to understand the information was only identified by 10% of individuals, one must consider that the other challenges may have prevented individuals from receiving information in the first place. Only 12% stated that there were no challenges and that disaster response information was easy to find in the first week after the earthquake.

Table 6.8: Challenges for individuals to obtain disaster response information in the first week after the earthquake

Theme	Challenge	Count	% of cases (n = 349)
Channels	No access to television	157	45%
	No access to radio	66	19%
	No means of asking for information	59	17%
	No access to internet	56	16%
	No access to mobile	46	13%
	No electricity (other)	26	7%
Content	Info available was bad quality	120	34%
	No information available	66	19%
Knowledge	Didn't know what info was available	67	19%
	Didn't know who to ask	67	19%
	Didn't know where to find information	57	16%
Understanding	Didn't understand the information	35	10%

For key informants, the greatest challenge to knowing about the impacts and relief efforts or aid was surprisingly blocked roads (see Table 6.9). "Blocked roads" was not among the identified choices, but was instead filled into the open-response option. This provides evidence of the importance of both the road network and of face-to-face communication which relies on travel over mountainous terrain.

Table 6.9: Top three challenges for key informants to obtain information about impacts (left) and relief efforts (right)

Information about Impacts (N = 24)		Information about Relief Efforts (N = 17)	
46%	Blocked roads	53%	Blocked roads
46%	No phone network	35%	No phone network
29%	No electricity	12%	No electricity

English was the main language used for disaster updates online. The survey found that 41% of men spoke English as opposed to only 26% of women. Hence, any communication concerning the delivery of aid in Nepal that is conducted in English, is favoring men over women, unless the communication specifically targets women. Approx. 75% of local government officials spoke English. Nepal has a number of different languages spoken, and not everyone speaks Nepali. This leads to communication issues, as confirmed by the fact that 25% of local officials stated that there were issues communicating with people in their ward or VDC due to language barriers.

6.6. Communication

In the first week after the earthquake individuals needed to communicate with their family and friends to confirm their safety, and request or offer help. Individuals also needed to communicate with government or other agencies to advise of impacts, request emergency assistance or inquire about aid. Government officials also needed to communicate with each other to inform and become informed of impacts and needs, as well as to plan relief efforts. The respondents were asked how they communicated which each other, and which government or other agencies they communicate with.

6.6.1. Communication with family and friends

Figure 6.12 identifies how individuals contacted their family or friends in the first week after the earthquake. Mobile call was the most identified form of communication between family and friends.

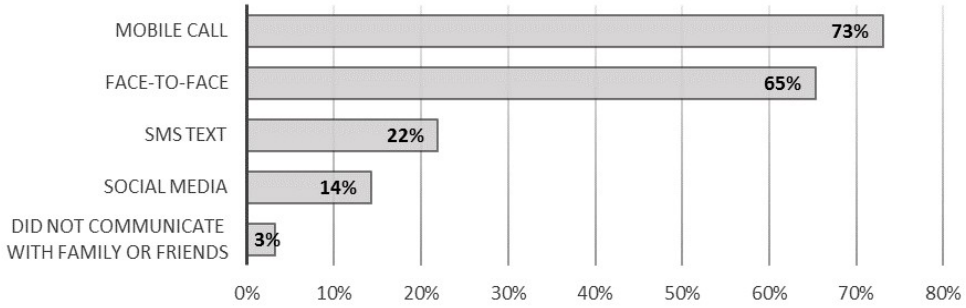

Figure 6.12: How individuals communicated with family or friends in the first week after the earthquake

The majority of individuals from all three site types used both mobile calls and face-to-face interaction to communicate with family and friends. Aside from face-to-face interaction, statistically significant variances were observed in the various channels used by urban, semi-urban and rural individuals to contact family or friends in the first week after the earthquake (see Table 6.10). Urban individuals were most likely (87%) to use mobile calls, followed by rural individuals (71%) and semi-urban individuals (65%). Individuals from rural sites were least likely to use SMS text (6%) and social media (3%). The low use of social media is understandable considering that over 85% of individuals from rural sites did not use social media before the earthquake. In contrast, over one quarter of urban individuals communicated with family or friends by social media in the first week after the earthquake. Hence, half of those in urban areas who were regularly using social media before the earthquake were able to continue using it afterwards to contact family and friends. There was no statistical significance in the variances observed between the responses of men and women.

Table 6.10: How individuals contacted family and friends in the first week after the earthquake disaggregated by site type

Channel	Urban (n=125)	Semi-urban (n=186)	Rural (n=90)	Statistically significant (significant if p<0.05)	Effect size (Cramer's V test)
Mobile call	87%	65%	71%	Yes (x^2 (2)=19.8, p<0.001)	Small to Medium (0.22)
Face-to-face	66%	69%	57%	No (x^2 (2)=4.04, p≈0.13)	Small (0.10)
SMS text	33%	23%	6%	Yes (x^2 (2)=22.8, p<0.001)	Near Medium (0.24)
Social media	26%	12%	3%	Yes (x^2 (2)=22.9, p<0.001)	Near Medium (0.24)
Did not communicate	1%	3%	7%	No (x^2 (2)=5.74, p≈0.06)	Small (0.12)

6.6.2. Communication with agencies

Many individuals also communicated with government or other agencies in the first week after the earthquake. As identified in Figure 6.13, ward officials were the main agency that individuals communicated with, followed by the police/army, and the VDC.

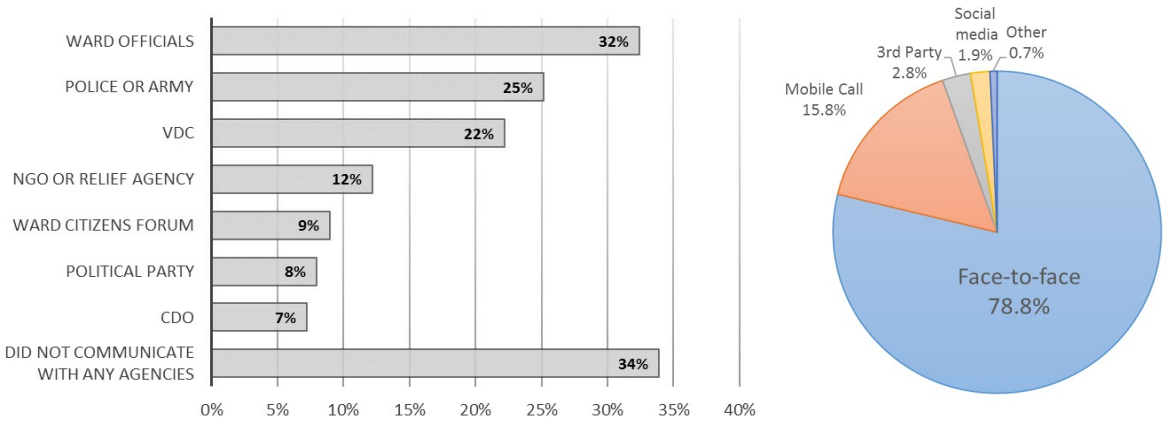

Figure 6.13: Agencies (left) individuals communicated with in the first week after the earthquake and methods of communication (right), N = 401

The primary form of communication was face-to-face, which accounted for 79% of communication instances, followed by phone calls at 16%. Approx. 52% of rural individuals did not communicate with agencies in the first week after the earthquake, as opposed to 35% of urban and 24% of semi-urban individuals. The relation between site type and communication with the majority of agencies described was significant (see Table 6.11). Ward offices appeared to be the local government agency who communicated with individuals in urban and semi-urban areas and VDC offices communicated with individuals in semi-urban and rural areas. Police also appeared to be more accessible in urban and semi-urban areas than rural areas.

Table 6.11: Relations between site type and agencies individuals communicated with

Channel	Urban (n=125)	Semi-urban (n=186)	Rural (n=90)	Statistically significant (significant if $p<0.05$) N = 401	Effect size (Cramer's V test)
Ward officials	34%	46%	2%	Yes (X^2 (2)=50.7, $p<0.001$)	Above Medium (0.36)
Police or army	32%	27%	12%	Yes (X^2 (2)=11.4, $p=0.003$)	Small to Medium (0.17)
VDC	10%	26%	30%	Yes (X^2 (2)=15.1, $p=0.001$)	Small to Medium (0.19)
NGO / aid agency	17%	12%	7%	No (X^2 (2)=0.87, $p=0.08$)	Small (0.11)
Ward citizens forum	6%	10%	11%	No (X^2 (2)=1.63, $p=0.44$)	None to Small (0.06)
CDO	13%	4%	7%	Yes (X^2 (2)=9.2, $p=0.01$)	Small (0.15)
Political parties	4%	13%	2%	Yes (X^2 (2)=14.3, $p=0.001$)	Small to Medium (0.19)
Did not communicate	35%	24%	52%	Yes (X^2 (2)=21.4, $p<0.001$)	Small to Medium (0.23)

In an open-ended question format, the individuals who did not communicate with any agencies were asked to explain why. Approx. 20% of these individuals explained that they had no need to communicate with any agencies. For the remaining 66 individuals, the most cited explanation was that they did not know who to communicate with or how (33%). Another 15% stated that they were too busy to be concerned with contacting agencies, and 12% lacked the means to communicate with agencies. A number of individuals could not explain why they did not communicate with government or other agencies (28%).

There was no significant difference in the channels used by women and men to communicate with the various agencies. Men were more likely to communicate with police/army than women; however, the relation was not statistically significant, X^2 (1) = 3.49, $p=0.62$, phi = 0.09. Although there were cases in which men or women communicated with a certain agency more or less, overall, the percentage of men and women who communicated with some agency was almost the same (between 33% and 34%).

All 20 local officials were in communication with other agencies within the first week after the earthquake. The majority of communication was either face-to-face (45%) or mobile calls (41%). Only 6% of communication was through letter, 4% through megaphone, and 4% through email. Local government agencies did not use text message or social media at all to communicate with other agencies.

6.6.3. Communicating complaints

Approx. 44% of individuals confirmed that they had witnessed unfair distribution of aid, with another 20% being unsure whether they had or not. Just over half of those who witnessed unfair distribution of aid did not report it. A number of reasons were provided to the open ended question of why individuals did not report unfair distribution of aid. The most cited reason, which was provided by 16% of individuals (N = 95), was that they did not know who to complain to or how.

When asked to whom individuals can submit complaints regarding discrepancies with aid, unfair distribution or issues getting aid, the main agencies identified were the police/army, ward officials, VDC officials, and CDOs (see Figure 6.14). Of the 401 individuals, 14% did not know

who they could submits complaints to regarding issues with the distribution of aid. In addition, local officials were asked what they do when they receive complaints about the provision of aid. For those local officials that received complaints, 70% forwarded those complaints to the next level of government, police, aid agencies or the DDRC, with the remaining 30% stating they did nothing.

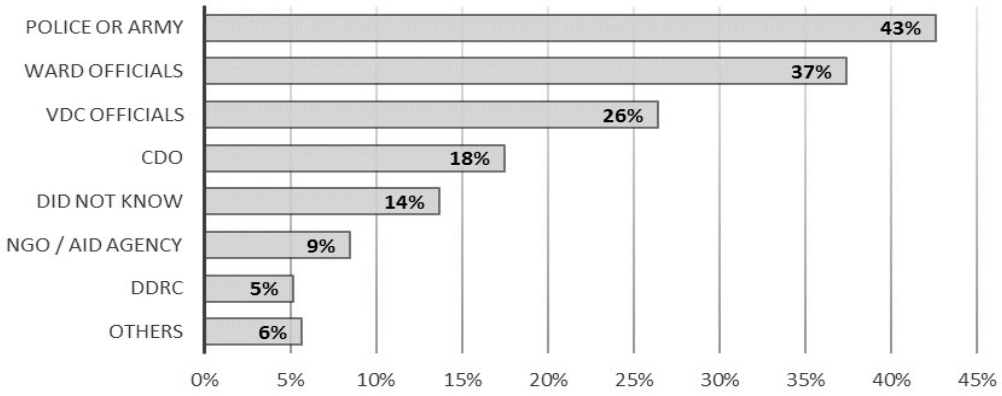

Figure 6.14: To whom individuals believe they can submit complaints regarding unfair distribution of aid (N = 401)

For the shelter survey completed in June 2015, a total of 67% of the 284 households described issues with services at their shelter site. It was found that 30% of those that had shelter issues and had a camp management in place, did discuss shelter issues with their camp managers. For general issues not limited to the shelter site, 23% of households confirmed that they contacted someone from the government or an aid agency to discuss their needs or make complaints. A large majority of households (67%) contacted government offices at either the ward, VDC, municipality or district level, but only 6% contacted aid agencies. Almost all communication with government or aid agencies was in person rather than over the phone, by text or online (see Figure 6.15). Only 19% of people sheltering in urban areas contacted government or other agencies, compared to 31% of people sheltering in rural areas. This suggests that either agencies in rural areas are more accessible or households in rural areas had a greater need to contact agencies. It should also be noted that none of the 19 households from rural areas that had relocated to urban shelter sites contacted government or other agencies.

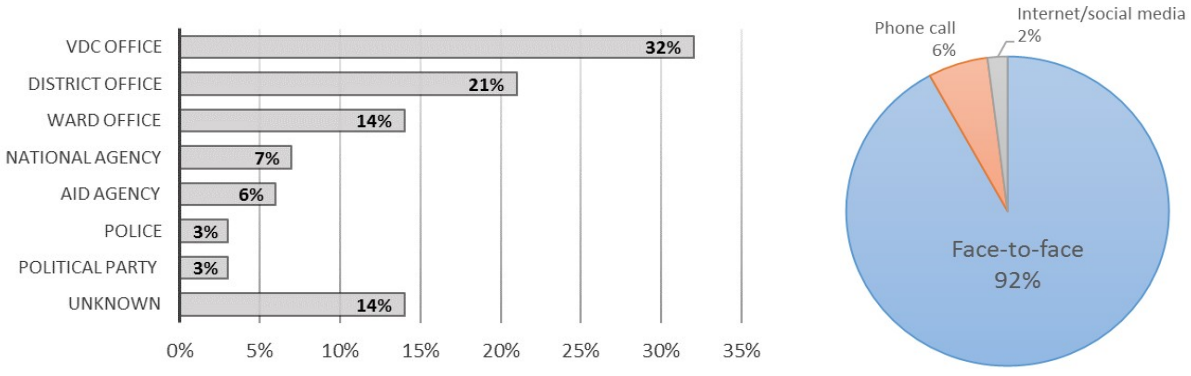

Figure 6.15: Agencies (left) that shelter survey respondents communicated with in the first week after the earthquake and the methods of communication (right), N = 191

Through the qualitative follow-up interviews it was found that many shelter sites had created camp management committees to represent the households staying at the shelter sites when speaking to officials and other agencies. These committees became a source of information as well as a conduit to have issues heard and potentially resolved.

6.7. Official Flow of Information

The official flow of disaster response information was evident in the communication of information about how to access aid (see Table 6.12). Half of the individuals received aid information from the local government. The majority of the local government received aid information from the district government (CDO or DDRC). The district government then received aid information from international or local NGOs and the national Home Ministry, among others.

Table 6.12: Top information sources for accessing aid

Individuals (n = 401)	Local government (n = 20)	District Government (n = 6)
50% Local government	45% Chief District Officer	33% I/NGOs
38% Family or friends	35% DDRC	33% Home ministry
26% Radio	35% Ward/VDC experts	17% Community
20% Television	25% Political party	17% VDCs

Surveys with key informants provided a more complete picture of the flow of disaster response information after the earthquake. Police and the public were the most cited sources of information about disaster impacts, followed by the VDCs, the DDRC and the Army (see Table 6.13). Information about relief efforts and available aid were mostly received from either I/NGOs or the DDRC. The most common channel used to receive information were through two-way communication, with 36% via mobile call and 23% via face-to-face interaction.

Table 6.13: Who sent key informants information regarding impacts (left) and relief efforts or aid (right) in the first week (n = 25)

Impacts		Relief efforts or aid	
Agency	% of cases	Agency	% of cases
Police	68%	I/NGOs	44%
The public	68%	DDRC	40%
VDC offices	24%	CDO/DAO	16%
DDRC	24%	Police	12%
Army	24%	Home ministry	12%

Key informants communicated the most with police, followed by the DDRC, the Army and the DAO (see Table 6.14). The majority of contact between key informants and other agencies was through two-way communication, with 43% through mobile calls and 22% through face-to-face interaction.

Table 6.14: Agencies that key informants communicated with in the first week after the earthquake

Agency	% of cases (n = 25)
Police	64%
DDRC	52%
Army	36%
CDO/DAO	36%

Finally, the most common channels through which local officials distributed disaster response information to the communities were face-to-face interaction and mobile calls (see Figure 6.16). Both channels allow for two-way communication. Furthermore, a majority of officials sent information through more than one channel.

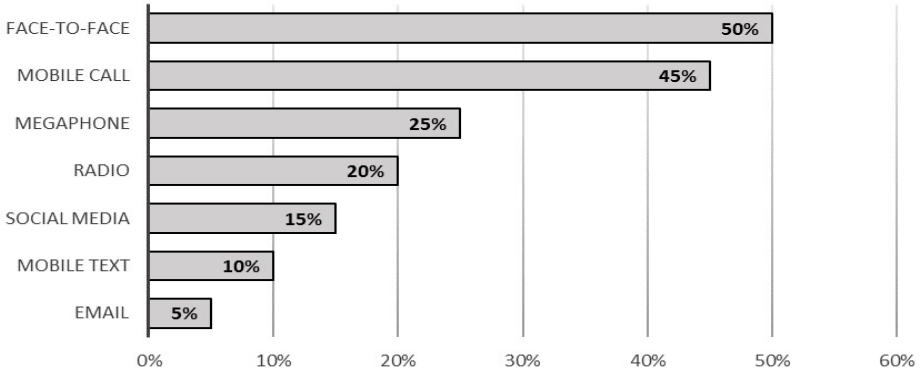

Figure 6.16: How local officials disseminated disaster response information to the community

6.8. Key Actors

This section discusses a few key actors in delivering disaster response information to the public in Nepal. The key actors identified were the police, the DDRC, radio stations and emergent groups. The following is based on both results from key informant surveys and qualitative interviews.

6.8.1. Police

The surveys with key informants illustrated that the police play a key role in the disaster communication system. The Nepal police were identified by key informants as both the top source for information about impacts (see Table 6.13) as well as the agency that key informants communicated with the most in the first week after the earthquake (see Table 6.14). A qualitative

interview was conducted with Dr. Rajib Subba, Deputy Inspector General and Director of the Communication Directorate, Nepal Police Headquarters in Kathmandu. The following account is mostly derived from the qualitative interview with Dr. Subba, as well as discussions with police superintendents from Dhading, Dolakha, Kathmandu, Nuwakot, Rasuwa and Sindhupalchok district police headquarters, as well as with the Senior Superintendent of Police from the Disaster Management Division in Kathmandu.

The Nepal police are well positioned throughout the country, with more than 1000 police units and extensive resources. After the earthquake, each district police headquarters collected information about impacts and relief needs from police units covering every village throughout their district, and forwarded this information to Zone and National Police headquarters. There are more than 3,700 police communications staff alone. The main communication system employed is a two-way radio network which links every police unit in the country. When there is a disaster, police are mandated to assess damage and report back by radio up the chain to central headquarters. Headquarters informs the Ministry of Home Affairs.

The police are a key actor because of their vast resources, as well as their ability to adapt to the communication needs of a variety of emergency situations. After the earthquake, the police headquarters requested the public to send messages to the police through their Facebook page, which they have had since 2013. Approximately 65 out of 75 district headquarters have internet connections and social media accounts. The same night as the earthquake, police central headquarters also started an SMS text message service for the public to send information about damage and other impacts. Police received more than 6,000 texts in the first four months. The day after the earthquake, the police also started using twitter to send disaster response information to the public in addition to Facebook.

In order to manage the high volume of reports that were being received after the earthquake by social media and text messaging, the police needed to integrate the social media and texting program with the greater police network. The police established a communication team at the central headquarters in Kathmandu that consisted of a "fusion of radio and social media", as described by Dr. Subba. The team was composed of six two-way radio units operated by staff on six hour shifts, and ten social media and text messaging staff. The team was housed on either side of one room. The social media staff would monitor social media and simply turn around to advise the radio staff of reported incidents. Examples of incidents included physical impacts to communities, delivery of aid and illegal activities. The radio operators would then radio the appropriate police units in the area to validate or take action on the information.

While police units were the main actor collecting information about impacts and relief needs at the village level, they were not officially responsible for disseminating relief information back to villages. Instead, all disaster response information went through the DDRC and local government and political leaders were tasked with disseminating relief information to communities (see Figure 6.17).

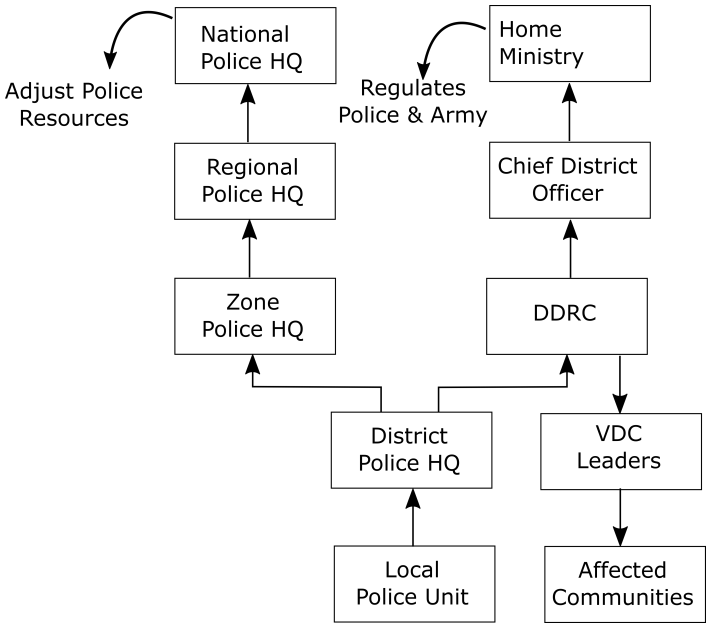

Figure 6.17: Circular flow of information collected by police

6.8.2. DDRC

The District Disaster Relief Committee (DDRC) was by far the main agency that key informants sent information to regarding disaster impacts and relief efforts or aid (see Table 6.15). Within the first week, 60% and 56% of key informants sent information to the DDRC about impacts and relief efforts, respectively. The top two channels used to communicate this information was face-to-face interaction (30%) and mobile call (30%). Thus, the DDRC played a major role in compiling disaster response information from various sources and disseminating to other actors.

Table 6.15: To whom key informants sent information regarding impacts (left) and relief efforts or aid (right) in the first week (N = 25)

Impacts		Relief efforts or aid	
Agency	% of cases	Agency	% of cases
DDRC	60%	DDRC	56%
Home Ministry	20%	Police	24%
Police	20%	VDCs	20%
CDO/DAO	16%	Home ministry	16%

I met with representatives from the DDRC in Dhading, Dolakha, Nuwakot, Sindhupalchok and Rasuwa in April 2016. In the days and weeks after the earthquake, the DDRC had multiple meetings daily. They called upon one political leader from each political party in every VDC to come in person to the DDRC to advise of impacts and to communicate messages back to the community. Simultaneously, the DDRC acted as the coordinating agency for all relief goods within each district. As a result, community leaders needed to travel to the district headquarters

to meet with the DDRC to retrieve information, although communities were accessible by police. For some VDC and political leaders, traveling to district headquarters took days.

6.8.3. Radio Stations

Radio stations were key actors due to their ability to reach a wide audience after the earthquake, despite being impacted themselves. I met with radio stations in Dhading, Dolakha, Nuwakot, Rasuwa, and Sindhupalchok, as well as a representative of the national Association of Community Radio Broadcasters (ACORAB) in Kathmandu. The earthquake damaged a number of radio transmitting towers and equipment. Yet all of the radio stations visited were able to broadcast within days of the earthquake. Those that were knocked off the air due to damaged towers or equipment were able to set up temporary transmission solutions quickly. Radio stations were a critical partner used by many of the key informants to disseminate information regarding relief efforts and aid.

Radio stations also received information from communities. In addition, they sent reporters to affected areas to investigate impacts and relief needs. Furthermore, many radio stations have what they refer to as trained volunteer reporters who represent different communities. In normal times (i.e., before the earthquake), these volunteer reporters would relay information to the radio station about events occurring in the community, such as business news, monsoon impacts, and protests ("bandh"). In the aftermath of the earthquake, these same volunteer reporters were often the first point of contact between the radio station and many of the communities, typically through mobile calls.

Individuals from affected communities also contacted radio stations to advise of impacts, request assistance, or to raise issues regarding the relief effort. A number of incidents were reported in which individuals were able to obtain rescue through calling radio stations. For example, 10 students trapped behind a landslide in Sindhupalchok managed to call Sindhu FM radio station in Chautara, Sindhupalchok. The call was broadcast live on the air. A police officer listening to the program in the vicinity travelled to the area and rescued the students. In another incident, a community in remote Northeast Sindhupalchok was heavily impacted by the earthquake and landslides blocked the route out of the village towards the district headquarters. Communications did not work whatsoever. Some in the community crossed into China and contacted Sindhu FM radio station by using a Chinese mobile. Sindhu FM then reported this information to the DDRC who arranged the rescue of 79 villagers by helicopter. Similar stories emerged from other radio stations.

ACORAB consists of more than 200 radio station members across 74 (of 75) districts of Nepal. Over the weeks and months after the earthquake, ACORAB and radio stations worked together to address the issues that emerged as a result of the earthquake's impacts and the difficulties of administering aid fairly. Radio stations gained understanding of community issues through face-to-face interviews with individuals or through call in programs. Radio stations relayed this information to ACORAB, who in turn designed and recorded community radio programs to be broadcast by all of its member radio stations in the affected districts. For example, some programs discussed sanitary issues, countered rumors or advised listeners how they could obtain victim identification cards.

6.8.4. Emergent Groups

I met with Kathmandu Living Labs (KLL) founder and executive director, Dr. Nama Raj Budhathoki on two occasions. KLL launched QuakeMap a day after the earthquake. QuakeMap was a platform for affected communities to identify their needs through social media, mobile calls or text and have their requests for aid relayed to organizations that could potentially help. KLL communicated with local actors to confirm the needs reported by communities. They also followed up with humanitarian agencies to ensure needs reports were matched to agencies with the capacity to respond. KLL obtained feedback online or by calling local actors with the intention to then "close" reports. Government responders, such as the Nepalese Army, also used the QuakeMap reports and maps to coordinate relief efforts.

KLL eventually became the lead agency who supplied the software, training and data management for the 1,500 engineers who conducted the re-assessment of damages to homes. This emergent group now has a stable role in the disaster management system and is therefore likely to take a lead role in response to future disasters.

6.9. Comparison to thematic analysis

The presence/absence scoring in Section 4.3.1 revealed that there was no information in the first two days to answer any of the questions within the thematic category "warnings". Though the earthquake could not have been predicted, this theme includes warnings for threats resulting after the initial impact. In the context of the Gorkha Earthquake, the most critical information for many individuals was to know more about aftershocks and landslides. This was confirmed in the shelter survey.

The comparative analysis revealed that the first few days of media coverage were focused on Kathmandu and mount Everest. The information gap analysis documented the fact that an extensive amount of information about affected areas and needs was being posted on social media. Some agencies, such as Humanity Road were including this information in reports, resulting in their reports containing more details than international news and relief agencies. KLL also took full advantage of the information found on social media. The Nepal Police incorporated social media into their information collection and dissemination plans as well. Furthermore, the surveys found that half of those individuals who used social media before the earthquake also listed it as one of their top two sources for information after the earthquake. Roughly the same amount of individuals also used social media to communicate with family and friends after the earthquake. The utility of social media as an information source was greater after the Gorkha Earthquake than it was during either of the two typhoons in the Philippines.

The information gap analysis completed only two days after the earthquake had already highlighted the importance of social media to gather information on affected areas and needs. This finding provided an additional incentive for applying the information gap methodology during disasters that went beyond the original intent of the methodology. The original intent of the presence/absence scoring and the comparative analysis was to critically analyze the information available, so that recommendations could be made about further information requirements. However, in an attempt to find information to fill the gaps, useful sources were discovered. The same occurred with Typhoon Haiyan, when relief agencies were found to have better information on medical needs than the NDRRMC official warnings, and again with Typhoon Hagupit, when news agencies were found to have better information about storm

surges. This identification of information sources to either fill particular information needs or as useful sources in general is beneficial not only to the public but to those in the disaster management system who strive to inform that public. The value of the information gap analysis methodology therefore goes beyond identifying potential deficiencies in disaster communication. It is also a valuable tool to identify valuable information and information sources.

6.10. Conclusions

Similar to the results of the previous chapter, this chapter has provided evidence of patterns in the information seeking and communication behavior of the different types of respondents. In the Nepal case study, significant relations were found between gender and access to most information and communication channels. Men had greater access to radios, smartphones and computers with internet whereas women had greater access to mobiles with radio. Similar to the Philippines case study, the findings in Nepal do not suggest that women should be sent information through different channels than men. The ICT that women had the greatest access to were the same as the ICT that men had the greatest access to. These were television, radio, smartphones and other mobile technology.

The practical significance is rooted in identifying which groups of people are not reached by certain channels. For instance, 51% of men had either access to smartphones or computers with internet before the earthquake compared to 36% of women. If messages are sent only by social media, there will be more women who do not receive that message than men. Alternative channels could then be aimed at targeting women since they would make up a greater portion of those who need to be informed.

Even greater variances were observed in the relation between site type and access to information and communication channels. In this case, the results suggest that if rural areas are the target audience, the priority for which channels to use should be different than if urban areas were being targeted. Rural areas had much greater access to radio (87%) than television (63%), whereas urban areas had 100% access to television compared to radio (78%). Access to internet and social media was much higher in urban areas than rural areas. In this situation, sending information through online websites may result in almost no rural areas receiving the message. Consequently, when targeting groups of individuals in Nepal, location greatly influences what channels the sender should prioritize.

I also observed that some forms of ICT, such as television, were more vulnerable to impacts than others like smartphones and mobile phones. The channels which proved to be most useful after the earthquake were radio, television, mobile calls and face-to-face communication.

Challenges to obtaining information in the first week after the earthquake were associated with channel issues, content issues and not knowing what information was available or where to find it. In contrast, the biggest challenge to collecting information about impacts and relief efforts for key informants was blocked roads. One does not typically associate roads as being a critical part of the communication network, but with a system that relies on face-to-face communication, blocked roads prevented actors from traveling to meet one another.

Similar to the distribution of warnings in the Philippines, an official flow of disaster response information was also observed in Nepal; this time, for the dissemination of information about aid. Comparable to the Philippines, the official flow of disaster response information in Nepal used two-way channels of communication over one-way channels. Overall, individuals trusted

government officials more than other agencies, and anticipated officials to warn them of future risks.

Finally, I identified local and district officials, police, radio stations and emergent groups to be key actors in the disaster communication system in Nepal. These actors are potential partners for any sender to collaborate with in the future. The various information seeking and communication patterns observed and the roles of the key actors will be incorporated into the discussion and development of the conceptual model in the next chapter.

7. Discussion

The results of the thematic analyses and the case studies reinforce the image of the disaster communication system as a complex network of sources, messages, intermediaries and receivers. While the official communication chain involves a number of intermediaries, it was found that these intermediaries do not reduce the effectiveness of communication. To the contrary, official intermediaries were observed to add context to otherwise general information, thus simplifying the process of fulfilling the information needs of local communities. Official intermediaries were key to delivering internet based information to individuals that lacked internet access. Local officials in particular were trusted and accessible sources of information.

The results of the surveys and interviews provide evidence that patterns exist in how disaster response information reaches the public before and after a disaster. The results confirmed that some groups have less capacity to search for information or communicate than others. Women in general have less access to internet and social media. In Nepal, rural areas were also at a disadvantage compared to urban areas. The majority of individuals and local officials communicated with government or other agencies in the first week after the disasters. In this respect, face-to-face interaction was the most common form of communication with government or other agencies. Interpersonal communication, consisting of face-to-face and machine-assisted, rose after the disasters as mass transmission declined. Mobile phones were also essential for communication, especially after the disasters.

It was observed that semantic problems were more prevalent prior to the disasters and technical problems more prevalent afterwards. Typhoon Haiyan warnings failed to convince the individual respondents to evacuate because the threats were not explained or emphasized. This was confirmed by both individuals and local officials. In each case, individuals cited their lack of knowledge of the disaster communication system to be a challenge to finding information. In addition, the results illustrated that the public's actions can be greatly influenced by their perception of the hazard and protective actions.

7.1. Purpose of Chapter

The purpose of this chapter is to combine the results with the key arguments from the literature in order to answer the research questions. I will first describe the need for any sender to identify their target audience. The target audience is the primary variable in measuring success of communication. I will then draw from the literature, thematic analysis and surveys to discuss the four lines of inquiry that need to be addressed when attempting to inform a target audience. These four lines of inquiry are associated with the four research sub-questions and are centered around the target audience. As such, I will discuss ways to anticipate the information needs of target audiences, pathways for reaching them, barriers along those pathways, as well as the options for obtaining feedback. I will argue that a sender's ability to identify and fix communication problems can be enhanced through improved understanding of the complex disaster communication system. In order to attain this goal, I will propose a model of communication that incorporates the four lines of inquiry. A fundamental feature of the model is that it encourages a disaster communication system to adapt to the dynamic disaster environment. The model relies on evaluation and feedback as methods of quality control. The overall conclusions of this research are provided separately in Chapter 8.

7.2. Selecting a Target Audience

In order for a sender to distribute their disaster response messages in an effective way, it is crucial to identify their target audience. A target audience could be location dependent. It may include all those individuals within a 500 km radius of a predicted typhoon path or all those living in low lying areas. The target audience could also be receiver specific. Those without a vehicle may be targeted to receive information about alternative transportation options. Women may be targeted to receive information concerning reproductive health needs.

Section 5.9.1 discussed how municipal DRRM officers targeted certain barangays in the Philippines. Coastal barangays were targeted first, followed by landslide prone barangays. The selection of a target audience was based on the location of areas with the highest risk to storm surge and landslides. The municipal DRRM officers were in a position to target barangays because their field of experience consisted of local knowledge. Understanding of local context can therefore help senders sharpen their focus.

In contrast to municipal DRRM officers and other local actors, national and international agencies may find it difficult to understand who could benefit from their information. This is evidenced by the overwhelming volume of reports passively posted to online websites during a disaster situation rather than actively sent to those in the local communities who could benefit from the information. Senders need to make a concerted effort to reach those individuals, in particular those who lack internet access. As argued by Case (2012), a sender should not assume that their methods for distributing information will match the methods used by the target audience.

The source must also consider its own intent when identifying a target audience. Every communication carries with it an appeal for the receiver to act in a certain way (von Thun 1981). If the intent is to evacuate an area, the target audience ought to include all those who have not yet evacuated. Similarly, the intent of relief information is often to help individuals obtain aid. The target audience should therefore include all those in need of aid.

7.3. Content of Disaster Response Messages

It is important to view the information needs of the public as being dynamic, because they change throughout a disaster and from one disaster to the next. As a result, it is difficult to set standards for what specific information should be provided to the public leading up to and immediately after disaster events. Information needs can either be anticipated based on past experience and event details or confirmed directly with affected individuals. The classification scheme I developed for disaster response messages is an example of anticipating the information needs of the community, whereas confirming the information needs directly with affected individuals can only be done through two-way communication channels. I argue that an effective disaster communication system incorporates both approaches.

7.3.1. Anticipated information needs: the classification scheme

A disaster environment can be chaotic. It may involve a great deal of uncertainty about what is going to happen, what has happened, what information is needed, and what information is most important. The classification scheme provides structure to the process of sifting through the information available, trying to sort out what information is still needed and establishing

priorities. It enhances any evaluation of the adequacy of messages prior to obtaining feedback from receivers.

The classification scheme provides a baseline of questions which are anticipated to help the public implement response actions. The presence/absence scoring represents a simple first step to interpret disaster response messages by identifying which questions the messages have or have not answered. The framework of the classification scheme then allows for in-depth analysis by comparing the information within and between categories. The result is identification of additional information needs to account for coverage or accuracy issues, and a better understanding of how relevant the information gaps are (see Section 4.3.2). Hence, any source can reference the classification scheme when developing their own disaster response messages. Similarly, any intermediary receiving messages is encouraged to use the classification scheme to help them evaluate messages prior to relaying to the public. In many cases, adjustments may be needed. Therefore, analyzing disaster response messages in near-real-time contributes to identifying deficiencies with the content of the messages. The benefit is that the process can be done while waiting for feedback from the public and when feedback is unavailable.

7.3.2. Confirming information needs with communities

The situational context will determine what type of information will be useful. For example, individuals that are reeling from the impacts of a typhoon, may be more interested in relief information than knowing where the typhoon is moving to next. Alternatively, the location of emergency shelters would be most useful to those who need to evacuate. Furthermore, in all three case studies, individuals' information needs corresponded to their physical needs. If two-way communication is available with the public, then feedback can be sought to confirm their situation and their physical needs, which will provide a good indication of their information needs. Consequently, a disaster response information source does not need to deliver their entire message to everyone; instead, they can customize the information to specific groups of individuals.

Intermediaries can also specifically ask the public if they received certain information, understood it, and if any clarification or further information is needed. Feedback from a few individuals could be used as the base for future communication to a wider audience. The information gaps could also be cross-checked with the public to confirm the relevance of the missing information or to identify if the public received the information from elsewhere. In order to obtain feedback, the sender needs to understand the options for two-way communication and the limits of channel capacity.

7.4. Channels to Receive Information

Disaster response messages can be sent through a variety of communication channels; however, some channels proved to be more effective at reaching particular groups of individuals than others. All three case studies revealed an association between gender and access to some communication channels (see Section 5.3 and 6.3). In addition, Nepal surveys in particular showed a substantial link between site type and access to ICT (see Table 6.3). Age was also a key factor in determining whether or not individuals used social media or the internet.

As a result, a group of individuals characterized by their gender, site type or age can now be targeted in a customized way. The sender can select the channels that the research indicated as

most commonly used among those groups. The sender should also be aware of the characteristics of the channels that ought to influence the design of the message (see Section 2.7.5).

Individuals preferred to receive disaster response information through the same four channels in all three case studies. Though appearing in different orders, these channels were face-to-face interaction, television, radio, and megaphone (see Table 5.5 and Figure 6.5). In Nepal, urban areas preferred television and rural areas preferred face-to-face interaction and radio. Megaphone was selected by approx. 30 – 40% of respondents in all three cases. As discussed by Kress and Leeuwen (2006; see Section 2.7.5), individuals often place more or less trust in certain channels. Hence, providing information through individuals' preferred channels may increase trust in the information.

I will now discuss the main channels of communication used at the local level to deliver disaster response information or to request feedback. In Section 7.6 I will broaden this perspective to include the multiple intermediaries and channels that could be involved in communicating a single message or obtaining feedback. Not all channels are available for all sources. Digital humanitarians for instance, will not have the option of communicating face-to-face. In Section 7.8, I will discuss how barriers to communication can sometimes be circumvented through collaboration among actors.

7.4.1. Face-to-face communication

Face-to-face communication with government agencies and with family and friends played an important role in all three case studies. Face-to-face interaction does not rely on ICT and supports two-way communication. Long or difficult travel can prevent or significantly delay face-to-face communication. In Nepal, blocked roads hindered face-to-face communication to the extent that it was the most cited challenge among key informants. This stresses the fact that face-to-face communication relies on travel which is often restricted in disaster situations. In Nepal, and other regions in the world with remote, hard to reach or mountainous villages, road blockages can disrupt communication.

As discussed by Rogers (1986; see Table 2.3), face-to-face communication has several advantages and relatively few disadvantages. The fact that the source has knowledge of the receiver, or at least the locality of the receiver, increases the likelihood that the source understands the receiver's situational context. Subsequently, the source is able to segment the message and deliver only those parts which are relevant to the receiver. This is beneficial not just for the purpose of efficiency, but also because individuals are more likely to believe messages that are specifically targeted to them (Mileti and Beck 1975; see Section 2.7.5). Furthermore, the sender can engage with the receiver on an emotional level with greater ease than in any other form of communication. The sender and receiver can also share control of the conversation, equally selecting what to discuss. The receiver can therefore ask for more information, clarifications and provide feedback immediately.

The negative aspect of face-to-face interaction is that the message is difficult to preserve. The receiver may write down the message or try to remember it, but this may be difficult in certain circumstances or when the message is long. In addition, face-to-face communication requires physical presence and therefore is limited to local actors.

7.4.2. Interactive (machine assisted) communication

The interactive communication channels observed in the case studies include mobile calls, text messages, and social media (personal messages). None of these were in the top four preferred channels to receive warnings or risk information. In all three case studies, mobiles were the least affected ICT, resulting in interactive communication being a robust option for communicating after a disaster. The combination of the internet, social media and smartphones has made information online more accessible to those who have such ICT. The internet provides the connection, social media the user-friendly interface, and smartphones the mobility to theoretically access information from anywhere, at any time. In Nepal, a greater number of respondents from urban areas had access to smartphones than from rural areas. Men also had greater access to smartphones than women. This 'digital divide' between rural and urban areas, and women and men, is not unique to Nepal but a global issue (IFRC 2015, p.186). Communicating with communities in rural areas and women in all areas, could be improved if alternative communication methods to internet and social media were exploited.

Call, text and social media messaging entail many of the same properties as face-to-face interaction, with some exceptions. In many cases, the source has knowledge of the recipient. Furthermore, the message can be segmented for each receiver or group of receivers. Feedback is immediate with calls but is often delayed with text or social media messaging. Text and social media messages can be preserved whereas calls cannot. Calls can engage the receiver in a socio-emotional way whereas text and social media messages are limited in this regard. Finally, there is the potential for both parties to control the communication.

The Philippines has been referred to as the "social networking capital of the world" (Liao 2008). Based on this claim, one may assume that most Filipinos have access to social media. The results of the surveys revealed otherwise, since the majority of respondents did not use social media before the typhoons. This sparked further investigation. I found that the claim by Liao (2008) is a misinterpretation of a report on the results of an online survey by Universal McCann (2008). The report only surveyed internet users. Thus, it would be a mistake to assume that issuing disaster response messages via social media will reach a large audience in the Philippines. This highlights the issue that senders need to be aware of the channels their target audience uses.

Though the Philippines is a more technologically advanced country than Nepal, social media usage in Nepal was observed to be higher in the case study. Younger individuals in both countries were much more likely to use social media than older generations. Approx. 38% and 71% of those between 18 – 24 years old in the Philippines and Nepal, respectively, used social media before the disasters most days. This stands in contrast to less than 15% and 8% of those 35 years of age or older in the Philippines and Nepal, respectively, using social media most days. Social media as a channel to communicate with individuals would clearly benefit younger generations. The Nepal survey also found that 26% and 3% of urban and rural individuals, respectively, used social media to communicate with family or friends in the first week after the disaster, compared to only 1 – 2% of individuals in the Philippines. It is expected that if the survey had been conducted in a heavy urban area like Manila, there would have been much higher rates of social media usage.

Mobile phones were extremely important; however, they were used in completely different ways in the Philippines compared to Nepal. Text messaging was a common form of communication among the individuals and local government in the Philippines whereas mobile calls was a

common form in Nepal. In Nepal, mobile calls were used by almost three quarters of individuals to communicate with family or friends, which was more than face-to-face interaction. Typhon Hagupit saw more individuals using text message than face-to-face interaction. For Typhoon Haiyan, it appears that the loss of access to mobiles reduced the public's ability to communicate with family and friends. This is evidenced in the fact that 51% of Haiyan individuals did not contact their family or friends after Haiyan, compared to 29% of Hagupit individuals and 3% of Nepal individuals.

7.4.3. Mass transmission

The mass transmission channels observed in the case studies were television, radio, social media (non-personal messages) and internet websites. Only news agencies can disseminate through television and radio, though government agencies often disseminate messages through news agencies. Anyone with internet access can disseminate information through social media, but only those agencies with a large social media following can target a large audience. Government, scientific and relief agencies were observed to use internet websites to post information for the public to find.

Mass transmission channels are characterized by a number of negative attributes to consider. First, the source has little knowledge of the receiver, and therefore little understanding of the situational context. This leads to many or all receivers being sent the same message. In mass transmission, segmentation of the message is therefore low. The fact that feedback is highly limited and delayed adds further to the negative aspects of mass transmission. Another disadvantage lies in the challenge to engage with the receiver on a socio-emotional level. Finally, control of the communication is almost entirely in the hands of the sender. While it is difficult to preserve information delivered via television and radio, information sent via social media and internet websites can be preserved. Nevertheless, a positive characteristic of mass transmission channels is that they are quick and can reach a wide audience; however, confirming who that audience is proves to be difficult.

Television served as a widely used source for information before the typhoons but its utility was greatly hampered by disaster impacts in every case study. Radios appeared more reliable. In Nepal, radio stations were identified as essential and trusted information sources for women and respondents from rural areas. While Drabek (2012, p. 122) argued that television and radio were used as secondary sources to validate warnings, the results point to both as primary sources for warnings in the Philippines. In addition, respondents in Nepal identified television and radio as their preferred channels to receive risk information.

Rarely did individuals select internet websites as a main source for disaster response information. Internet in both the Philippines and Nepal is typically accessed with a smartphone rather than a computer. Some disaster information websites may be challenging for smartphones to navigate due to a combination of data heavy content and poor mobile internet connections. Social media platforms, however, are more user friendly and consume less data than many disaster information websites. In Nepal, those that had access to social media benefitted from it as an information source. In the first week after the earthquake, 30% of respondents from urban areas identified social media as one of their two main sources for information to help them survive (Section 3.3.1). In contrast, Filipinos rarely mentioned social media among their top sources for disaster related information.

In the next section I will introduce the basic unit of the proposed model of disaster communication. I will then discuss key components for an expanded model, drawing on the results of the thematic analyses, surveys, interviews and literature.

7.5. Proposed Model

The typical disaster communication system is complex and operates in a dynamic environment. One of the characteristics of actors in the disaster communication system that differentiates them from actors of other social systems is their common goal of improving public safety and well-being during disaster situations. A second characteristic of these actors is that they achieve their goal through acts of communication with the public. In other words, the actors' strategy encompasses providing the public with information that will influence their actions in disaster situations. For communication to be effective, a number of elements in the information exchange need to be considered. Information travelling from the source to the public may involve a number of actors as suggested in the literature and as proven through the case studies. Figure 7.1 illustrates a single communication interaction between a sender and receiver.

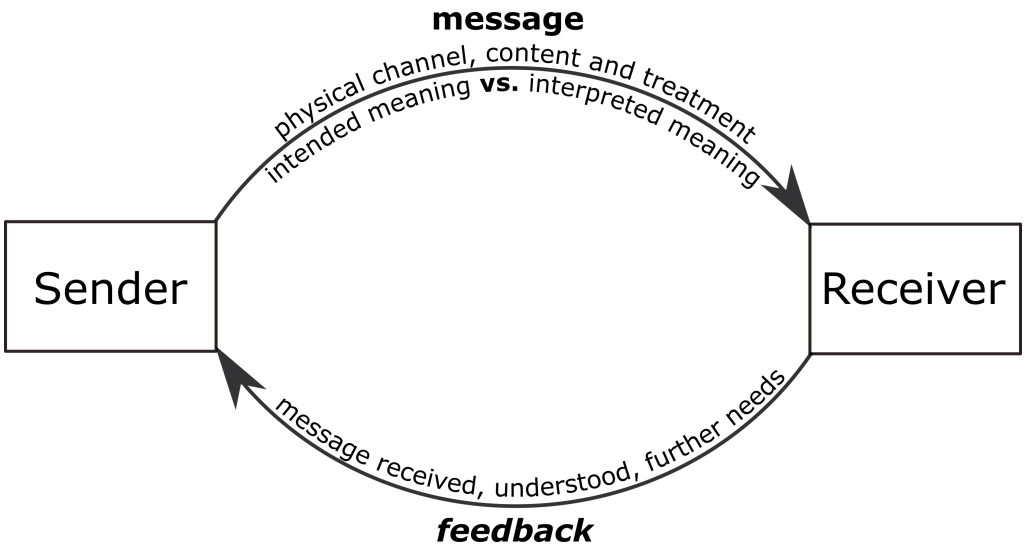

Figure 7.1: Basic unit of proposed model of disaster communication

Communication begins when the sender transmits a disaster response message to the receiver. The literature cautions against assuming that the receiver will interpret the meaning the way that the sender intended. The message will have numerous characteristics that will influence how the meaning is interpreted. The key characteristics are the channel, content, and treatment. The channel may impose limitations on the message, or may be more or less trusted by the receiver. The channel will also either allow for two-way communication or be restricted to one-way transmission. The content will consist of codes and signs, which may or may not be understood by the receiver. The content will also be characterized by information type, quantity and semiotic mode. The treatment refers to how the content is emphasized and prioritized.

Feedback is a major component of the model, but it is dependent on the use of two-way communication channels. The sender can request feedback from the receiver to confirm that the entire message reached the receiver, was understood, and that the reasons for actions not being implemented are explained. In some cases, improvements to disaster response messages are

warranted, whereas in other cases, physical interventions are needed to help receivers implement actions.

The model presented in Figure 7.1 only applies to one transaction of communication between a sender and receiver; however, the literature and case studies indicate that intermediaries are often positioned between the original source and the final receiver. The model therefore serves as a basic unit to illustrate the communication between each pair of actors. By adding basic units together, a disaster communication chain is formed. Multiple chains make up the disaster communication system. I will now discuss advantages and disadvantages of the various chains of intermediaries, or "pathways", observed in the case studies.

7.6. Pathways for Distributing Disaster Response Messages

A number of sources may collect information leading up to or following a disaster, from various levels of government, scientific, news, and relief agencies. In this section I will discuss three options which a national government agency could select to disseminate disaster response messages to the public. While the focus is on the national government, the options are similar for other sources. I refer to each chain of intermediaries as a "pathway" to send information and/or obtain feedback. The channels used in each pathway offer either one-way transmission of messages or two-way communication. The barriers to message transfer and feedback for each pathway will be identified. The attributes of channels discussed in Section 7.4 apply to each act of communication. There are advantages and disadvantages of each pathway. Yet, all pathways contribute to the disaster communication system.

7.6.1. Official intermediaries

Officials were trusted, being among the top two trusted agencies to deliver disaster response information (see Table 5.7 and Figure 6.9). That being said, some officials were more or less trusted by men or women. In both cases in the Philippines, less men than women trusted municipal officials. In Nepal, less women than men trusted political parties. Both of these cases are relevant considering that municipal DRRM officers in the Philippines, and political leaders in Nepal, have major roles in informing individuals in disaster situations (see Sections 5.9.1 and 6.8.2).

As a result of officials being reliable and trusted, they were one of the most selected agencies that individuals anticipated would provide warnings or risk information in the future. In the Philippines, local government officials were the most selected agency that individuals anticipated to receive warnings from in the future, followed by the municipal government. This was repeated in Nepal with three quarters of individuals expecting information about the risk of their area to earthquakes or landslides to come from local officials.

In both the Philippines and Nepal, the official pathway for disaster response information consisted of six levels of actors (see Table 7.1). It was originally postulated that the existence of multiple intermediaries would amplify the technical and semantic problems. However, the official intermediaries were observed to enhance communication of disaster response information in most cases. When needed, official intermediaries converted the disaster response messages into a format and channel that was compatible with the communication technology used by the next receiver in the distribution chain. Without such actions, technical barriers would have prevented information from reaching individuals. For example, in the Philippines municipal

DRRM officers translated messages to the local dialect and sent text messages to barangay captains who in turn converted those text messages to verbal messages delivered to the public by megaphone.

Table 7.1: Official intermediaries for disaster response information

Philippines	Nepal
National DRRMC	Home Ministry
↕	↕
Regional DRRMC	Zone authority
↕	↕
Provincial DRRMC	DDRC
↕	↕
Municipal DRRMC	VDC
↕	↕
Barangay DRRMC	Ward office
↕	↕
Individuals in Barangay	Individuals in ward

The intermediaries also applied their own 'field of experience'. The field of experience of the local officials was essential. Local officials have insight into the everyday routine of individuals and their situation. The official pathway provides local officials with a variety of information that could be important to individuals. This combination of a local field of experience and good access to information, means that local officials can target distinct messages to various groups of individuals based on their shared attributes or situational context. For that reason, local officials act as information brokers between a variety of sources and the community.

In the Philippines, the role of information broker was being filled by a combination of the barangay captain and the municipal DRRM officer. The former had direct access and the knowledge of the individuals in the community, and the latter had access to the typical information that could help those individuals in disaster situations. Beyond the messages sent to them from government or other agencies, municipal DRRM officers also sought information themselves, typically from online websites. They interpreted and prioritized this information prior to sending to the barangay captains.

A similar situation existed in Nepal with the DDRC and the local government fulfilling the role of information broker. A majority of key informants confirmed to have sent information about impacts and relief efforts to the DDRC. More than one third of local officials also received relief information from the DDRC, and a majority anticipated the DDRC to advise them about the risk to hazards in their area. The local government was then critical at collecting the information from the DDRC in person and delivering to the community.

An important ability of local government officials is that they can often distribute information in person or through megaphone to individuals in the community. While the utility of other sources like television dropped after initial disaster impacts, the importance of officials greatly increased in all three cases (see Table 5.6 and Figure 6.7). In the Philippines, officials were selected more often as the best source for information post-typhoon as opposed to pre-typhoon. In general,

the physical presence of local officials ensures that messages reach affected areas, even when there is total collapse of ICT. The proximity of local officials to the affected population also increases the opportunity for feedback through two-way communication. This is supported by the fact that local and municipal officials in the Philippines and ward and VDC officials in Nepal were the top two agencies with whom individuals communicated in the first week after each disaster.

Most of the communication between individuals and officials occurred through face-to-face interaction. Furthermore, in all three cases, a substantial amount of the information sent and received between government units were transmitted through two-way communication channels, such as face-to-face interaction, text messages, and phone calls. Since the entire pathway communicates via two-way communication channels, the official pathway allows for feedback from the public all the way back to the original source (see Figure 7.2).

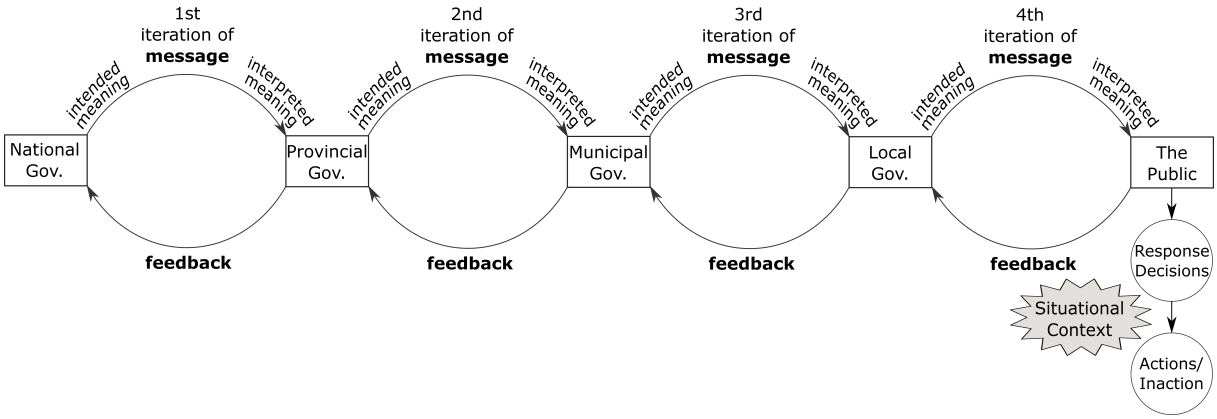

Figure 7.2: Pathway through official intermediaries

Each act of communication adds time to the process and increases the chances of the "broken telephone" effect. However, feedback can correct any misunderstandings that result from aberrant decoding or insufficient information. Through feedback, senders can re-align disaster communication.

The official pathway appeared to be the most successful pathway in the Philippines for dissemination of storm surge advisories before Typhoon Hagupit (see Table 5.13). In this case, the storm surge maps represented very localized information. Furthermore, that information was only available online and was not easy to describe over television or radio. For instance, it is doubtful that television and radio stations would have dedicated the airtime to explain the more than 100 storm surge hazard maps that were available the day before landfall (ABS-CBN 2014). Hence, general warnings through mass media were complemented with community specific warnings delivered through a reliable chain of official intermediaries. I do not argue that the official pathway will always be the most effective to distribute disaster response information. Other pathways relying on superior ICT or fewer intermediaries could potentially prove more effective due to increased information capacity and speed of delivery.

7.6.2. News media

Section 2.7.4 discussed the importance of unofficial sources for general information and disaster warnings. Scanlon (2011) went so far as to argue that news agencies may be the most important information source in the days after a disaster. While news agencies were important before and after the disasters, a clear shift in all three case studies was observed that counters Scanlon's claim. In comparison to official sources and family and friends, news agencies actually decreased in importance after all three disasters.

News media transmit messages through television, radio, newspapers, online websites, and social media. In the Philippines and Nepal, television and radio have the highest potential to reach a large audience, due to widespread access to these channels. The case studies suggest that television and radio are more effective before a disaster, when access to these channels has not yet been affected. Television and radio functioned as the main sources for disaster information before Typhoons Haiyan and Hagupit in the Philippines (see Table 5.6). Access to television and radio was greatly reduced after the typhoons resulting in a decline of the importance of news agencies as an information source. In Nepal, television and radio were the top information sources for general news prior to the earthquake. While access to television was severely impacted, radio was less affected and became the top information source in the first week after the earthquake. The promotion of radio to the top information source is likely caused by the drop in access to television since the number of individuals using radio did not increase.

The news media in general is only capable of one-way communication with a wide audience. Radio stations may take calls from the public, but do not have the capacity to handle large volumes. Reporters often travel to affected areas and communicate directly with affected individuals, but the percentage of the population they reach is quite small. In Nepal, the "volunteer reporters" that exist in many villages appeared to be a critical source of information for the radio stations; however, the intent of the program is for the village to deliver news to the radio station rather than the other way around.

News agencies can and often do communicate with officials and relief agencies. Combining a news reporters' field of experience with the limited amount of feedback obtained from the public, reporters can often question officials about disaster preparations or response activities. Similarly, news agencies can commit time to investigate issues that concern the public. In Nepal, ACORAB established radio programs explaining how people could apply for assistance and countered rumors that were creating panic or confusion for the public. The large network that ACORAB and similar news associations around the world represent, have the potential to transmit information quickly to a wide audience.

National governments often use the news media to distribute disaster response messages. Figure 7.3 illustrates this pathway. While the original source in this case is the national government, the model would be the same if the source was a scientific or relief agency.

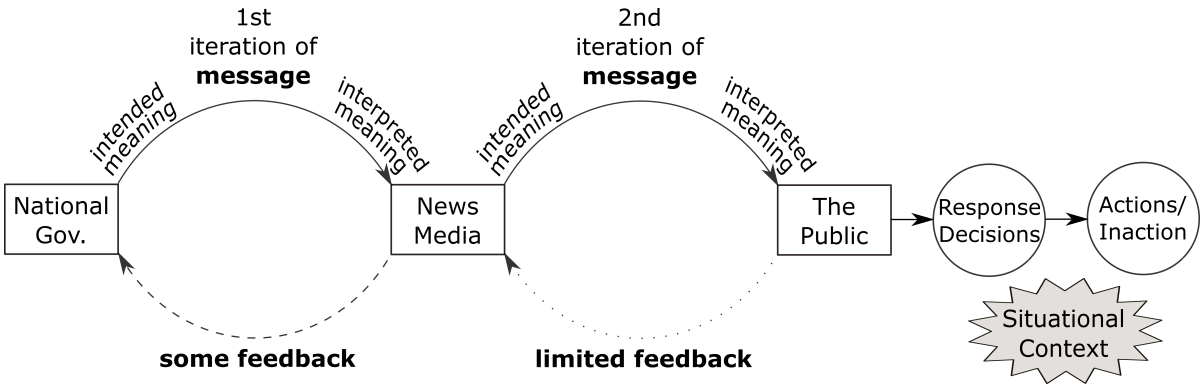

Figure 7.3: Pathway – through news media

The message is encoded with words, symbols, and images which the national government associates with various meanings. For example, the situation report issued by the NDRRMC (2013) one day before Typhoon Haiyan made landfall discussed storm surge as follows:

> "Residents in lower lying and mountainous areas under signal #3, #2, and #1 are alerted against possible flashfloods and landslides. Likewise, those living in coastal areas under signal #3 and #2 are alerted against storm surges which may reach up to 7-meter wave height."

Upon perceiving the above message, a news agency will interpret the meaning based on its understanding of the codes used and its field of experience including its situational awareness. If there is no two-way communication with authorities, the news media will need to rely upon its own staff or work with experts to interpret the message.

A major issue observed in the use of this pathway, was that news agencies often relayed the government's messages to the public without critically analyzing whether or not the content should be adjusted. Morella (2013c) from Agence France-Presse stated that "coastal areas may see waves six meters (20 feet) high", without using the term "storm surge", let alone explaining what a storm surge was. A receiver could misinterpret this message to mean that the waves would not travel much further than the shoreline. Sabillo (2013) of the Philippine Daily Inquirer quoted the president's warning about the danger of the storm surge, but also failed to explain what a storm surge was or why it was dangerous.

For the Typhoon Haiyan thematic analysis, none of the reports collected from news, relief or government agencies explained nor emphasized the danger of the storm surge. Agencies apparently did not understand the severity of the storm surge threat. These examples illustrate how the significance of certain information can be missed by agencies who may lack the appropriate field of experience in the subject matter. The lessons learned from Typhoon Haiyan, appeared to be corrected by the media in the days leading up to landfall of Typhoon Hagupit. The NDRRMC (2014) issued the following warning addressing the storm surge:

> "Expected landfall: Sunday morning over Eastern Samar – Northern Samar area and it will be associated with strong winds, storm surge (up to 4.5 meters) and heavy-intense rainfall."

Surprisingly, this was the only mention of the storm surge in the 40-page situation update. While the NDRRMC did not elaborate on the threat of a storm surge, the information provided by news media greatly filled the information gap. Fortunately, the news media did not simply relay

the storm surge warnings to the public, but provided supplemental information to emphasize the threat of storm surge and explain the dangers. Ranada (2014), Rappler (2014) and the Pacific Disaster Center (2014) all produced articles before landfall that focused entirely on the impending storm surge.

While the change in the media's strategy following Typhoon Haiyan is an improvement, it is unfortunate that it took such a devastating event to initiate the adjustments. I argue that if the media had critically analyzed the Typhoon Haiyan warnings it received from the government, they could have realized, and subsequently reported, the significance of the storm surge threat. In some circumstances it is difficult for the media to know what details of the hazard or disaster situation are most critical. The storm surge threat was just one item on a list of disaster response messages. While in the Typhoon Haiyan and Hagupit experiences, the storm surge threat proved to be the most critical piece of information, in future disasters it could be the risk of landslides, location of safe shelters, or a shift in the path of a typhoon. This underscores the importance of analyzing disaster response messages in near-real-time.

The news media can reach a wide audience, especially before a disaster. In some cases, they can be motivated to compensate for insufficient warnings by providing useful supplementary information. But in general, the news media's regional rather than local field of experience and limited ability to obtain feedback translates to a reduced understanding of local situational context.

7.6.3. Absence of intermediaries

Sources can also disseminate disaster response messages directly to the public (see Figure 7.4). In fact, the above storm surge warnings were available to anyone with internet access. The situation reports were posted to the NDRRMC's website. This represents a passive form of communication. Rather than being sent to the public, the public would need to search for the information themselves, and would need internet to do so. The greatest flaw in this pathway is that deficiencies in the original message cannot be analyzed at any stage by an intermediary. This discrepancy combined with the lack of feedback, results in deficient messages being sent to the public without any means of quality control.

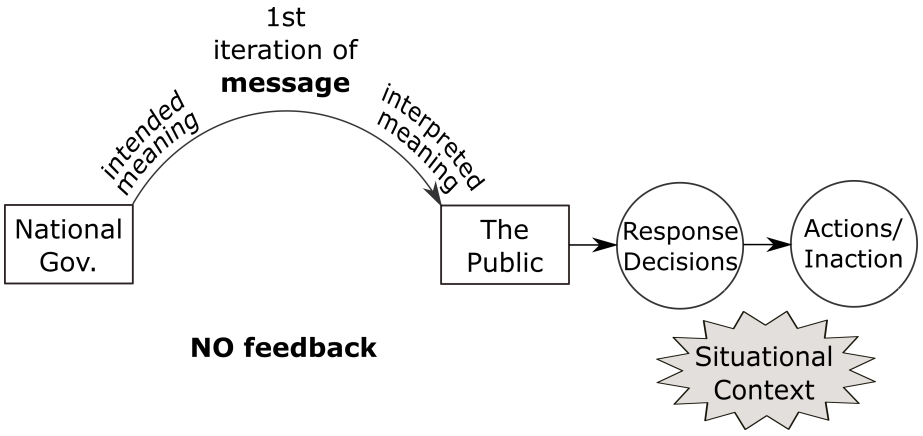

Figure 7.4: Pathway – directly to public

Figure 7.4 does not include a mechanism for feedback for a few reasons. First, if any agency is sending information about a hazard to a very large number of individuals, then responding to feedback from each one would become overwhelming and ineffective. Second, those channels which typically allow national agencies to provide information directly to the public, are internet websites or social media. Websites are typically limited to one-way communication. As the literature and case studies revealed, social media neglects a majority of individuals and especially vulnerable populations.

The national government is not in a position to issue localized information, since it cannot understand the situational context of individuals in every community. Furthermore, the national government is unable to confirm that individuals receive and understand the message. If the information does not result in actions the national government cannot determine why. The fields of experience of agencies with large areas of responsibility are too general to encompass the specific local situational context.

7.6.4. Combined model

The above discussion and diagrams illustrate that a source for disaster response information has options to send messages to the target audience. The options illustrated in Figure 7.5 combine the three pathways discussed above. While they identify the national government as the sender, other sources have similar options for disseminating disaster response information to the public. Each pathway is made up of one or more basic units (see Figure 7.1). Each pathway has its advantages and disadvantages. Using all pathways will increase the chances that the message reaches more individuals; however, each should be used appropriately to ensure that meaning is adequately transferred.

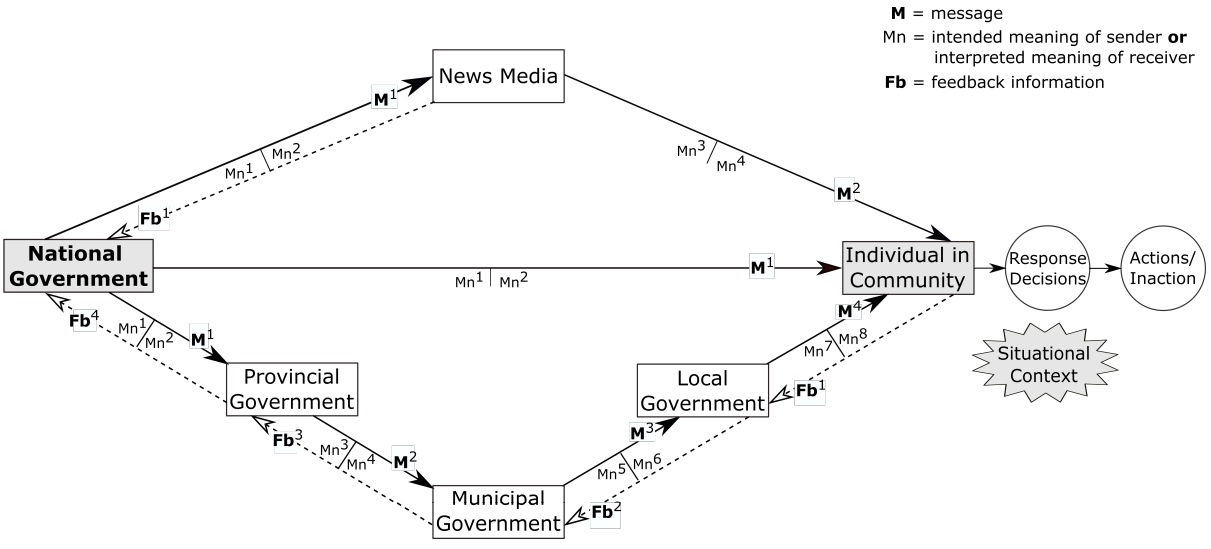

Figure 7.5: Typical pathways for disseminating disaster response information

The purpose of the model is to help the sender to understand the complexity of the system within which it must operate. The more the sender understands the complexity of the system, the more it can adapt its own strategies and influence the strategies of others to improve performance. In this context, some actors can have greater influence over the operation of the

system than others. For instance, the national government typically exerts control over the actions of numerous actors. All actors can impact the context under which all other actors operate. For example, false information issued by a single actor can result in confusion among the public, delay response actions, and create a need to counter that information. This underlines the argument that ineffective communication creates uncertainty (Button 2010; see Section 1.1)

The defining feature of the model is the existence of multiple intermediaries. The model encourages that analysis take place at each instance of communication from both message (process) and meaning (semiotic) perspectives. Several communication channels and codes may be used throughout the information distribution chain. Thus, the model accounts for multiple adjustments to the message as well as interpretations of the meaning. It also uses feedback as the primary mechanism of control over the system.

Feedback is needed to confirm that disaster response information reaches the public, is correctly understood, and that barriers to implementing response actions are identified. Through feedback, the sender may determine that they need to change their message, add to it, or alternatively narrow its focus to be more effective. Due to the fact that there are multiple senders and receivers, a single feedback will not suffice. Instead, feedback is required between each sender and receiver.

Where feedback is unfeasible, the sender will need to rely on the design of the message alone. If a sender deems feedback necessary, but lacks two-way communication with the public, they can explore alternative options. For instance, a sender can collaborate with intermediaries who can obtain feedback. Similarly, when a sender's main information pathways are disrupted because of the disaster impacts, they can explore other pathways to distribute their message. Figure 7.5 depicts only the three most common pathways, but a number of other pathways were also observed, which I will discuss next.

7.7. Other Intermediaries

The model of the communication system, represented by Figure 7.5, could be expanded to include the variety of intermediaries in the disaster communication system. The source could then collaborate with those intermediaries with the capacity to reach their target audience.

7.7.1. Emergent groups and digital humanitarians

Emergent groups, including digital humanitarians have high potential to contribute information to the public during a disaster situation. Since emergent groups form as a response to a disaster, they are more likely to be involved after the disaster impact. Shklovski et al. (2008) suggests that emergent groups form out of a need to compensate for a lack of information through official sources. Kathmandu Living Labs (KLL) is a good example of this. KLL (2015) started QuakeMap out of the need to track humanitarian needs and relief. They collected information from numerous individuals, local officials and agencies, and shared with others. Soon the army and relief agencies were using QuakeMap to coordinate relief efforts.

The strategies of emergent groups can be elaborate. In Nepal, the Inter-Agency Common Feedback Project (CFP, 2015) is an example of feedback being collected for the purpose of informing future communications. CFP first gathered feedback from communities about their perception of the response using face-to-face interaction. The feedback was analyzed and led to

further investigation with officials and aid providers. The findings were then distributed via one-way transmission channels, including radio, email and a website (CFP 2015).

Members of emergent groups could be located within the affected areas, in proximity to them or in a separate country altogether. Communication with the public therefore varies, from face-to-face to interactive communication. Because of their spontaneous nature, it is difficult to plan for emergent groups ahead of a disaster. Consequently, an important step in any adaptive strategy is to recognize emergent groups as soon after a disaster as possible, understand their capabilities and conceive of ways to work together towards a common goal.

7.7.2. Police and Army

In Nepal, one quarter of individuals communicated with the police or army in the first week after the earthquake, with most of this communication being face-to-face. The police or army were also selected as the top agencies to whom individuals could submit complaints regarding discrepancies with aid. Where other intermediaries lacked the capacity to obtain feedback, the police and army excelled at collecting information from communities. Yet, the police and army were rarely selected as an information source by the individuals. This highlights the fact that the mandate of the police and army is to collect information and not provide information to the public. Interviews with police inspectors confirmed this. The different police inspectors confirmed that they regularly collect information about disaster impacts and relief needs directly from individuals in communities through face-to-face interaction. They can relay this information quickly through two-way radio from any police unit to the district headquarters and on to the national headquarters in Kathmandu.

While the police and army in Nepal did not have a mandate to inform populations of relief information, they represent the largest and most resilient communication network in Nepal. The police and army each have their own communication network composed of radio transmitters, repeaters and handheld two-way "walkie-talkies". These networks are quick and reliable forms of two-way communication. Using them as intermediaries would strongly contribute to keeping communities informed of relief information.

7.7.3. Family and friends

Sorenson (2000) argued that informal sources, such as family, friends and neighbors, could account for the delivery of as much as one half of warnings. As shown by the results, family and friends play an important role in the delivery of relief information. Family and friends were one of the two top sources for relief information after all three of the case studies. After Haiyan, when communication was so heavily impacted, family and friends was even selected as the second most selected source for relief information by local officials. Families and friends communicated with each other by face-to-face interaction, text message and mobile calls.

7.8. Strategic action

Once the complexity of the disaster communication system is understood, sources and intermediaries can anticipate how adjustments in the way they operate could improve the effectiveness of communication. Rather than trying to eliminate complexity, senders can attempt to harness it, by incorporating their knowledge of the disaster communication system into

communication planning. Senders can then manage and ideally take advantage of those characteristics of the system that make it complex. One defining characteristic of complex systems is their nonlinearity: small inputs can have large effects (Axelrod and Cohen 1999, p. 14; Holland 1995, p. 23; Kauffman 1995, p. 17). By embracing this feature of complex systems, senders can identify and implement small changes with large positive effects. In addition, senders can detect and repair small deficiencies prior to their effects being detrimental. For example, the sender could distribute satellite phones to high risk localities to ensure communication is maintained during a typhoon or convert a few key words in a warning to the local language. Such "lever points" have great value since little effort can achieve large improvements in effectiveness.

Key to any complex system adapting to changes in the environment is diversity of actors and strategies. Selecting only one strategy for reaching the public runs the risk of premature convergence. Premature convergence refers to when variability is foregone too soon in lieu of a narrow approach that is not guaranteed to work (Axelrod and Cohen 1999, p. 43). An example is to only use television to disseminate disaster response messages, only to find that electricity is cut soon after a tropical cyclone makes landfall. Diversity provides alternative options for completing the goal of the system, resulting in increased resilience against shocks (Axelrod and Cohen 1999, p. 107). For that reason, alternative pathways should be identified to compensate for changes in the environment or system that compromise the effectiveness of the main pathways.

This logic suggests that the variety of established and newly formed actors contributing to disaster communication can add to the resiliency of the system. Recognizing these various actors is the first step to incorporating them into the disaster communication system. When resources are added to the system, such as foreign scientific agencies or emergent groups, the system will need to adapt to incorporate the actors.

During dramatic change, groups of individuals often work together for their mutual benefit, in what is referred to as "Strategic action" (Fligstein and McAdam 2012; see Section 2.7.4). Figure 7.6 describes the relations of some of the actors in the disaster communication system that emerged after the Nepal Earthquake, which I interviewed. These actors are all indirectly connected to one another. The arrows indicate the direction of information flow, with two-sided arrows signifying two-way communication. The DDRC, VDC, district radio and police were well-established actors in the disaster communication system long before the earthquake occurred. KLL and CFP emerged after the earthquake. KLL had mostly an online presence but was physically present in Kathmandu. CFP achieved local physical presence in a number of the "most affected" districts.

Sources and intermediaries who are not accustomed to working together can improve the overall performance of the disaster communication system if they combine efforts. Examples of such collaborations were witnessed in Nepal. The government was quick to incorporate the work of KLL into their response planning. KLL soon found themselves supplying the Nepal Army with maps identifying damaged areas, needs of communities and local contacts to support coordination. Furthermore, relief agencies used KLL's maps to coordinate relief efforts. Collaboration between other actors could have improved the system even further.

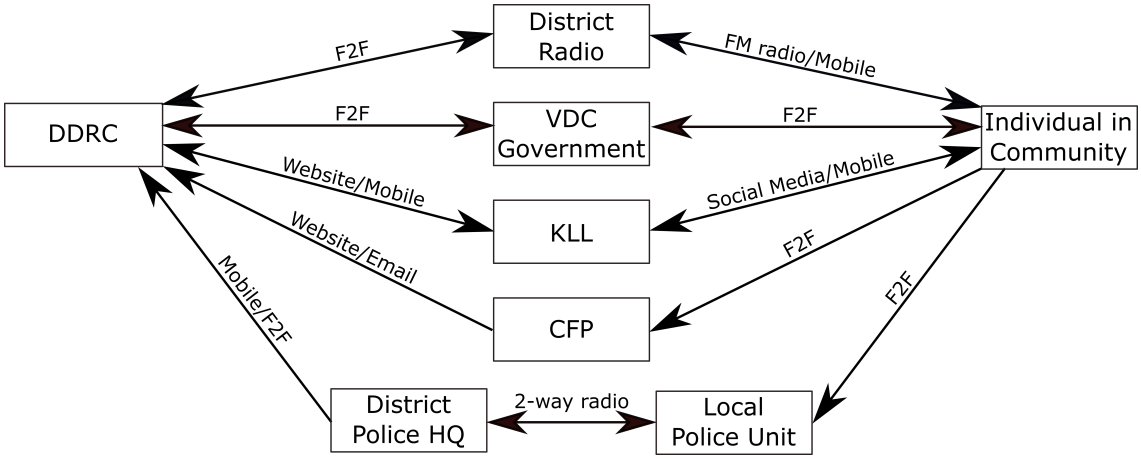

Figure 7.6: District level disaster communication system after the Nepal Earthquake

For instance, KLL collected reports from individuals in disaster affected communities through social media. Individuals were asked to provide a mobile number of the local contact with whom KLL, the army or relief agencies could coordinate relief. KLL claimed that individuals in the community could reach them via social media, call or text. However, KLL's phone number was only displayed on their website and on social media. Hence, even though KLL could be contacted through mobile call or text message, it is highly unlikely that individuals would learn of KLL's phone number without having internet access.

KLL did not have a physical presence to provide their contact information to individuals in affected areas directly. A solution could have been to use other intermediaries to reach individuals. An option would have been for each district radio station to broadcast KLL's number and provide directions to individuals on what information they should include in a text message (i.e., location, need and local contact). While this would have greatly increased the amount of text messages arriving at KLL, they of all groups had the growing resources to sort through a large amount of data. Within the first 48 hours after the earthquake KLL had already amassed a group of 1,500 online digital humanitarians to map damages (Ghimire 2016). Advising individuals through radio of a number to text requests to, could have acted as a lever point. This small act would have connected those without internet access with a large resource pool of digital humanitarians, the army and relief agencies.

7.8.1. Adaptation

The findings of this research reveal that there are three levels of adaptation a sender can pursue to address communication problems. These are task-based, needs-based and system-based adaptation. At the most basic level is task-based adaptation to a specific communication problem. A task-based adaptation occurs when an individual is impeded from completing a task. For example, a local official may typically use the local radio station as an outlet to distribute relief information. If that radio station is no longer functioning, the official can adapt to using a megaphone or post flyers throughout the community. The focus of this adaptation is on completing the task of delivering the message: the act of communication is the problem that needs to be solved.

In a needs-based adaptation, the actor is not provided with a task. Instead, they seek out the needs of the community and adapt their strategy to fulfil that need. The formation of an emergent group is a good example of a needs-based adaptation. As Starbird and Palen (2013) document, emergent groups can form out of the recognition that affected communities require information. The reasoning for the development of the classification scheme and argument for applying it during disaster situations is based on the information needs of disaster affected communities. This approach views the information needs of the individuals as the problem and the act of communication the solution.

Lastly, a system-based adaptation occurs when an actor adjusts their strategy in order to work more effectively within the greater disaster communication system. This approach does not require a communication problem or information need to be present. In fact, system-based adaptation can be carried out to prepare for communication problems and information needs. In this approach, the actor views its own limitations as the problem, and the variations (or complexity) of the greater disaster communication system as the solution. The first two approaches to adaptation are reactive, whereas this third approach is pro-active.

7.8.2. Measuring Success

As Axelrod and Cohen (1999) describe, a complex adaptive system is made up of agents and strategies. Success or failure can be measured at the agent or strategy level. Identifying a successful agent could lead to an attempt to reproduce that agent. An agent may be a source or an intermediary. In Nepal, it was observed that numerous shelter camps had begun to establish camp management committees to serve as the facilitators between the shelter camp and the local government. This agent was being replicated because successful communication between the government and shelter camps was deemed to be the result of the existence of a camp management committee.

On the other hand, if success is deemed to be the result of a particular strategy, then the strategy can be copied by existing agents. Axelrod and Cohen (1999, p. 131) argue that it is often more efficient to copy strategies than attempt to create new agents. In the Philippines, many municipal DRRM officers advised that in order to convince "stubborn" individuals to evacuate prior to Typhoon Hagupit, they threatened them with arrest (and in some cases followed through with arrest to set a precedent). The strategy was replicated by different municipal DRRM officers without the need for new agents.

7.9. Testing the Ability of the Model to Lift the Key Barriers

The overall purpose of having a conceptual model of the disaster communication system, is to use it as a tool to aid discussion in the planning, implementation or evaluation of disaster communication. I will now summarize the key barriers to effective communication of disaster response information and discuss how the model can be used to enhance efforts to lift those barriers. The key barriers are that information needs are dynamic, channels have a limited capacity, channel access varies, transferring meaning is difficult, perceptions can be false, and situational impediments inhibit response actions.

7.9.1. Information needs are dynamic

The classification scheme derived from the thematic analysis (see Section 4.2) is directly linked to the model as a mechanism for quality control. It is particularly useful for one-way communication where feedback is unfeasible. Following the classification scheme as a guideline, each intermediary can undertake a quick presence/absence scoring of the messages they have been asked to relay. Information gaps can be identified and the intermediary can use their own judgement to decide if they should seek additional information from the source or elsewhere.

While the classification scheme can identify the different information that may be needed, it does not highlight which information is most important. In the case of Typhoon Haiyan, the failure to answer the question "how does the threat equal a risk to human lives?" had devastating consequences. While this question is arguably important in any disaster, the details of Typhoon Haiyan that were available the day before landfall could have led intermediaries to anticipate the criticality of this question. The details predicted that a very high storm surge of up to seven meters would occur in communities that had little experience with storm surges in living memory. While the Philippines has had its share of deadly storm surges, Leyte and Samar areas had not had a major storm surge since 1930 (Alojado 2010; NOAH 2014c). Instead of highlighting the danger of storm surges, the reports placed importance on the intensity of the typhoon.

The headings of the NDRRMC situation reports appear to follow a standard. The location, coordinates, strength, movement, and forecast positions appear to always be on the first page and in the same order, suggesting that this information is most important. Threats are not explained nor emphasized, but objectively stated. For instance, wind speeds are identified without an explanation of what damage each wind speed is expected to cause. In the last situation reports issued before landfall of both Typhoon Haiyan (NDRRMC 2013) and Hagupit (NDRRMC 2014), the NDRRMC identified those areas or number of individuals that had been pre-emptively evacuated, and yet did not make any recommendations for more individuals to evacuate. The situation reports failed to appeal to the receiver's sense of emotion or even logic, which Aristotle long ago identified as two of the key modes of persuasion (Kennedy 1991). I argue that by not explaining the meaning and intent of the messages, the NDRRMC's situation reports failed to make an appeal to the public to implement response actions.

Standards aimed at guiding strategy during disasters need to be able to adapt to the needs of the situation. The purpose of receiving feedback in any system is to make changes to the system to improve performance. The fact that the public did not understand the warnings should have triggered changes to the content of warnings. If the government had sought feedback they would have recognized the need to explain why the storm surge was such a major threat. They could have then emphasized the threat with strong rhetoric, symbols or by placing it early in the warning and repeating it. While not included in the thematic analysis, Ranada (2013) from Rappler News did explain what a storm surge was, and went further to state the following:

> "For coastal communities, a storm surge is often the greatest threat to life and property caused by a hurricane. Aside from inundating buildings and infrastructure, it causes battering waves to pummel against structures and eventually destroy them."

This message explained and emphasized the danger of storm surges more than any other government, news or relief agency message collected for the thematic analysis. Ranada (2013) is commended for her strong language which resulted from recognizing that the situation

warranted supplementary information to explain and emphasize the importance of the storm surge. Unfortunately, this message was provided after the worst of the storm surges already affected Palo, Tacloban, and Tanauen areas.

Sources and intermediaries therefore need to recognize changes in information needs. On the one hand, information needs can change from one disaster to the next and on the other hand, information needs change as the disaster progresses. The classification scheme and near-real-time methodology are designed to help a source or intermediary identify the dynamic information needs over the course of the disaster situation.

7.9.2. Channel capacity

The message can be characterized by the channel, content and treatment of that content (see Figure 7.1). The surveys and interviews revealed that the message will change channels as it is disseminated from original source to end-receiver in a community. Even a message which is delivered directly from the scientific or government agency to an individual through online channels will still change channels when the individual relays that information to their family. Each channel has restrictions on the format of the content and the amount of content that can be transmitted. This in turn influences how the content of the message can be treated. As a message changes channels, the content will need to be modified to suit channel constraints. Every adjustment to the message threatens to alter its meaning. For example, a warning that must be reduced to a text message, may not be able to include enough supplementary content to properly explain the risk. By identifying the channels that will be used, a sender can anticipate how technical constraints will magnify semantic problems.

The model helps a sender envisage how the content may need to change to account for different channels. If the format of the message will need to change further down the communication chain, then the original message could be designed to accommodate the final format. For instance, maps conveying locations of aid distribution points will need to be translated to verbal messages if the channel used by the intermediary is radio. Written descriptions of the locations could accompany the maps that are sent to radio broadcasters. The written text can then be read by any intermediary, including those without geographical knowledge of the areas depicted by the maps. Likewise, if a message regarding the process for accessing aid needs to be reduced to a single text message, it may be more effective to replace the entire message with the contact information of the implementing aid agency. The public could then contact the agency themselves for further information and to exploit the benefits of two-way communication.

Each time the content needs to be adjusted, the intermediary will have to make decisions about what information is most important and how it should be explained or emphasized. The decisions will be based on the intermediary's interpretation of the message. The sender can reduce the need for adjustment by distributing in multiple formats. The sender can also attempt to avoid misinterpretation by clearly explaining, emphasizing and prioritizing the most important elements of the message. This is even more important for those pathways which lack feedback. If semantic issues result in a need to provide further explanation or emphasis of a concept (such as risk), which the channel cannot accommodate, a sender may decide that technological improvements are needed.

7.9.3. Access to channels

Before both typhoons, only a small percentage of individuals identified communication challenges related to technical problems. However, access to channels varied and was associated with gender, location, and age. Hence, while there may be no ICT failures before a disaster, some channels will be more or less successful at reaching certain groups of people.

Following each of the three disasters, the most common challenge was lack of access to communication channels. ICT failure appears to have been a major factor in the shift of information sources from mass media before the disasters to government and family/friends afterwards. Government and family/friends could deliver information using face-to-face interaction. That being said, even face-to-face interaction was susceptible to road blockages in Nepal, which prevented government officials from traveling to meet one another.

Prior to any disaster, the model can be used to plan which pathways and associated channels could potentially deliver disaster response information to different areas or groups of individuals. After the disaster has impacted the communities, a reassessment could be completed to evaluate which pathways and channels have been affected. Fixing technical problems that prevent messaging could then be prioritized according to the results of a cost-benefit analysis. For example, a few of the radio stations interviewed in Nepal experienced damages to broadcasting equipment. Each was able to implement repairs achieving temporary operation. The repairs took one to two days and resulted in a reduced broadcasting coverage area. If radio communication in a particular area was prioritized, the government could assist radio stations to recover quicker and to a higher level. Similarly, repairing a blocked road for the purpose of re-establishing face-to-face interaction with a village could also be deemed a priority.

Alternatively, the system could adapt to other potential pathways, such as delivering satellite phones by helicopter, using police two-way radio to disseminate information, or identifying individuals in the area who can relay messages. This last example was observed in Nepal in an interview with a household who had relocated from a remote village to a semi-urban shelter site. All communication to their remote village was cut off. They engaged the help of a friend living in a neighboring village to relay messages back and forth. The household would call the friend and provide a message. In turn, the friend would walk four hours to the remote village, deliver the message, walk back and send a reply. Actors and strategies like these could be replicated and even planned for in future events.

7.9.4. Transferring meaning

As highlighted in the model of Mileti and Sorenson (1990; see Section 2.2.2), understanding provides the foundation for believing and personalizing warning messages. If the message is misunderstood, it could lead to unsafe response actions. Warnings provide the most dramatic examples of the consequences of failing to transfer meaning.

Typhoon Haiyan serves as an example of how the failure to explain a threat (i.e., storm surge) can have devastating results. In the days before Typhoon Haiyan, the major communication challenge was understanding the information provided. Furthermore, a number of individuals stated that the warnings failed to convince them to evacuate because the threats were not explained or emphasized. These responses were repeated by local government officials. PAGASA confirmed that its weather warnings could have done more to explain the dangers of a

storm surge (Bernal 2013). The results and literature suggest that the semantic problem is more prevalent in the warning phase. The uncertainty associated with predicting hazards plays a large role. Disasters affect communities in ways which are difficult to foresee, describe, or believe. However, the semantic problem is exacerbated when the information distributed is difficult for individuals to understand.

Typhoon Haiyan's storm surge surprised many individuals because they were not familiar with the hazard and were not explained what it was. In contrast, the storm surge caused by Typhoon Hagupit required little explanation because of the lessons learned from the Haiyan experience. This illustrates that the details that may pose a semantic issue could be different in every disaster and for every individual. Some individuals may find the details about potential landslide risk difficult to process, whereas others will have a hard time processing the details of flashflood risk. The same is true in the days after the disaster. Some individuals will have difficulties processing the details about how to request emergency assistance, access food or follow sanitary guidelines. Failure to transfer meaning in relief information can therefore also have negative consequences, though their effects may be less noticeable from the outside.

Hence, in both the warning and relief phases, there will be certain information that is challenging for some individuals to mentally process. If the source can anticipate which information will pose semantic difficulties, they can prioritize sending this information through two-way communication channels so that feedback can confirm that individuals processed the information correctly. The model helps the source identify the paths available for two-way communication. The paths available for one-way communication can then be utilized to send basic information, which is easy to comprehend, such as the location of the typhoon, time to landfall, or contact numbers for help. In such a way, the source can optimize their use of different pathways.

7.9.5. Perceptions of the receiver

The PADM model proposed by Lindell and Perry (2004; see Section 2.4.2) argued that an individual's perception of response actions may have a greater influence on their likelihood to implement those actions than their perception of the hazard. Attitudes, heuristics, self-efficacy and response efficacy were thought to play a role in this. Evidence of the role of attitude, heuristics and response efficacy were observed in the Philippines in the answers to those questions about why people did or did not evacuate.

For both Typhoon Haiyan and Hagupit individuals, the top three reasons for evacuating were the individual's perception that their house was not safe, a fear for safety, and their perception of the storm surge risk. In contrast, the top three reasons against evacuating for both typhoons were the individual's perception that their house was safe, their belief that impacts would not be major and their desire to protect their property (see Table 5.10). Of those that did not evacuate before Typhoon Haiyan, 70% thought they should have in hindsight, suggesting that there were faults in their original perceptions about the safety of their home or the level of danger of the hazard. If the public's perception of response efficacy and hazard risk could be sharpened, they may make better response decisions. For example, the greater numbers of evacuees in response to Typhoon Hagupit was accompanied by an increased perception of storm surge risk. This is evidenced by the fact that interest in information regarding storm surges increased from 3% prior to landfall of Typhoon Haiyan to 26% prior to Typhoon Hagupit.

The role of response efficacy was also observed to play a factor in individuals' decision making after disaster impact. In Nepal, negative response efficacy was a factor which prevented some individuals from attempting to contact government or aid agencies. Because of their belief that the government would not help them after the disaster, a number of individuals did not seek any assistance. Some individuals even had a perception that trying to seek assistance would have negative consequences. The respondents explained that by asking a local official for aid, they would be forced to support that official's political party in the future.

Warning and relief messages should therefore counter negative perception issues as discussed in Section 2.4.4. Two-way communication channels can be used to identify perception issues. Perception issues can also be anticipated. When the sender must rely on one-way communication channels, they should place even more importance on anticipating perception issues. For example, messages can highlight the conditions of the hazard that make it particularly unique or similar to past disasters. Instructions could go beyond advising people what to do and explain how the recommended actions will keep them safe, or conversely, how not implementing such actions will be dangerous.

7.9.6. Situational impediments

Individuals can only respond within their own capacity. Those without a vehicle will have difficulties evacuating before landfall of a typhoon. Someone who is injured will have difficulties leaving their home to seek aid. Such situational impediments were a key component to Lindell and Perry's revised PADM model (2011). Feedback is one of the critical components of the PADM model. Without feedback, there is no way to confirm if individuals are not implementing response actions because of a lack of information or because of physical barriers. Obtaining feedback can therefore help to identify if a physical intervention is needed. Examples may include supplying buses to transport those without a vehicle, or delivering aid to households with mobility issues.

7.10. Limitations

The presence/absence scoring as well as the comparative analyses of actual events in near-real-time was done by myself, an external observer to the entire disaster communication system. These evaluations could potentially be more accurate if carried out by intermediaries within the disaster communication system. Each unique model could also benefit from the insight of those within the disaster communication system.

The thematic analyses were limited to tropical cyclones, earthquakes and floods. The case studies were limited to typhoons and an earthquake. Some results may not be applicable to other types of disasters. That being said, the theoretical framework can be generalized to other disaster situations. For instance, the pathways for communicating with the public will be similar in any country. The difference may be in the impact each disaster type has on the communication system. The information needs should also be re-assessed for each different disaster type.

7.11. Further research

One of the assumptions that was verified by comparing the thematic analyses with the survey results was that there is a wealth of valuable information available online that fails to help disaster affected communities because it never reaches them. Furthermore, information that does reach the public may not be fully understood. Although many organizations produce valuable information during a disaster situation, most non-government agencies do not have a mandate to ensure their information is delivered to the communities who could benefit from it. Scientific agencies for example do not have any academic incentive to actually help communities during a disaster. Yet, there is often a desire or even moral obligation to help. An important question that could be asked of any agency involved in reporting on disasters is: which information that they collect or produce could benefit the individuals in the disaster affected areas?

Once the above question is answered, the potential source could begin investigating how they could target those individuals who could benefit from the information. By differentiating the intermediaries and channels through which the information would need to flow, the potential source could optimize the form and content of their message. The key to advancing this research is to not restrict one's focus to improving the effectiveness of those sources already contributing to the disaster communication system. The goal for further research is to discover more sources and ways to inform the public. By expanding the variety of the disaster communication system, it will become more resilient to the external shocks associated with disasters.

8. Conclusions

This research suggests that disaster communication systems are far from achieving an optimum level of performance. Predictable communication problems are too often overlooked. For instance, the literature provides considerable evidence that individuals in disaster situations do not blindly follow instructions. Yet, the default approach for sources and intermediaries is a stimulus-response model of communication. The main research question was: how can a sender identify and fix communication problems? I argue that the first step is for the sender to reject the stimulus-response model of communication.

The stimulus-response model leads senders to making a series of mistakes that jeopardize the effectiveness of communication. First, senders often fail to learn the characteristics of the target audience. If the sender is unaware of the attributes of the target audience, they cannot tailor the content of the message to suit the needs of the target audience. Second, senders fail to understand the meaning and intent of the message that they distribute to the public. The sender cannot confirm that individuals understood the message if they do not fully comprehend the message themselves. Third, senders fail to design the message so that the meaning is clearly understood by the receiver. Even when the sender understands the intent of the message, they can fail to adequately explain that intent through an effective use of codes and signs. Finally, senders often misinterpret inaction by the public to signify that they are ignoring instructions. Inaction indicates a communication problem, but it does not explain the problem. By automatically assuming the public is to blame for its inaction, the sender fails to perceive faults in its own strategy.

The research has provided evidence that the above mistakes are more likely to occur by a sender whose field of experience does not include knowledge at the local level. For instance, the case studies have highlighted the fact that the channels used by the public will limit the amount and type of content that can be included in a disaster response message. Furthermore, the literature argues that the content needs to address receiver attributes. Senders who are not familiar with the channels and attributes that characterize individuals are unable to optimize the message for the target audience.

As a source for disaster response information, it is therefore important to select intermediaries who are knowledgeable of the target audience. In all three case studies, the combination of the local and municipal/district government were crucial to effective communication. Local officials understood the characteristics of their constituents. Furthermore, they could obtain direct feedback from the public through two-way communication. In general, local actors can advise sources of the channels of communication and the message content that is most applicable to the public. As a disaster unfolds, local actors can relay feedback from the public to the source, in order to improve future disaster response messages in near-real-time. Identifying the variety of actors in the disaster communication system, especially local actors, is therefore a key step for a source to improve the effectiveness of communication.

Communication can also be improved by a better understanding of the channels that are utilized by the public. The surveys provide evidence to argue that the majority of individuals in the Philippines and Nepal did not have access to internet at the time of the disasters. Considering the high volume of information available online at the time of the disasters, this finding stresses the importance of senders confirming that the channels they use to distribute information are accessible to the public. The findings of the case studies underscored this theory. In the

Philippines, though interactive websites were created to map hazards, the public did not access these sites. Instead, the warnings reached the public by text message and megaphone. In Nepal, the greatest barrier to communication among officials was blocked roads, due to a reliance on face-to-face interaction over any form of technology. These examples support the argument of Sorenson (2000), that the source cannot expect practice to keep up with the state of the art.

While senders should not rely too heavily on advanced technology, they should also not discard those technologies altogether. Despite the fact that the majority of respondents lacked internet access, for those in Nepal who used social media, it proved to be an important communication channel. Hence, every additional channel should be welcomed for increasing the options available to communicate with the public. The option of connecting with the public through social media will become more viable as internet penetration rises in the Philippines, Nepal and in other countries where internet penetration is currently low.

The case studies have revealed that the system for disseminating disaster response messages consists of a complex network of sources, intermediaries, channels and receivers. Sources and intermediaries could improve performance by learning of the various pathways available to reach the public. The major challenge however, is recognizing the various pathways and the advantages and disadvantages of each. The disaster complicates this challenge by disrupting pathways of communication and creating a demand for information.

Drabek (2013) argues that "complex systems will fail in complex ways" (p. 51). I support this theory and argue that the opposite is also true: complex systems are *repaired* in complex ways. For example, ICT failures after a disaster may require impromptu collaboration among actors, adjustments to strategies or implementation of alternative technologies to maintain communication with the public. The greater a sender's understanding of the complexity of the disaster communication system, the more likely they are able to implement complex solutions. In addition, knowledge of the system can help senders anticipate communication problems and confirm them by exploiting feedback channels. In other words, a source or intermediary's capacity to identify and fix communication problems and potential solutions is directly related to their understanding of the complex disaster communication system.

In order to support senders in visualizing the potential pathways for communicating with the public, I have proposed a conceptual model of the disaster communication system. The model combines micro and macro perspectives of the communication system. At the micro level, I have investigated the single act of communication between a sender and receiver. The elements of communication at this level are the message content, treatment, channel, intended meaning and interpreted meaning. The primary control mechanism is feedback, though it is only available with two-way communication. At the macro level, I have thoroughly explored the complex disaster communication systems in the Philippines and Nepal. The elements of the communication system at the macro level are the actors and strategies. In this regard, the model is designed to enhance discussion among senders in order to lift the typical barriers to communicating a disaster response message to the public.

The key barriers can be summarized as follows: information needs are dynamic; channels impose limitations on content; access to channels varies among individuals; meaning is difficult to transfer; perceptions can be inaccurate; and situational impediments can inhibit response actions. These barriers are magnified by the complexity of the disaster communication system. However, the characteristics of the disaster communication system that make it complex also offer solutions to communication problems.

The model will change depending on the actual layout of the disaster communication system. I have provided a few examples of how the model could appear. It is important however, that senders consider their own unique knowledge of the system. To this end, I have introduced a basic unit of the model, which can be used as a building block to construct a model of any disaster communication system. The model makes each act of communication visible, from sources to intermediaries and target audience.

Although the literature provides guidelines for the content of disaster response messages, such content often fails to appear in disaster warnings in practice. Thus, the model encourages every intermediary to critically analyze the information they receive prior to relaying it down the communication chain. For this purpose, a methodology has been developed that begins with a simple presence/absence scoring of disaster response messages. The classification scheme then supports further comparative analysis. While this provides the first form of quality control, the system is mainly controlled by feedback.

The model can then be used to enhance discussion when communication problems occur, such as loss of communication channels or misunderstandings along the communication chain. By visualizing the available options for sending messages and obtaining feedback, the sender can adapt its strategy to improve performance. In addition, the model can help a sender anticipate communication problems. For instance, by observing which channels will be used throughout the chain, the sender can anticipate where channels will limit the amount or type of information sent. As a result, the sender can decide how they will adapt their strategy, such as changing the message, the channel or the intermediary. By identifying potential problems before a disaster occurs, the sender can adjust their strategy prior to the disaster environment complicating the situation even further. As pathways become disrupted during the disaster situation, the sender can turn to the model to quickly visualize alternative solutions. Finally, after the response phase is over, the model can serve as a reference to guide investigations into what went wrong, and thus contribute to lessons learned investigations.

The literature on systems theory asserts that the complexity of a non-linear system, such as the disaster communication system, can never be fully comprehended. This should not discourage actors but rather inspire them to continuously expand their understanding of the disaster communication system.

References

All internet websites accessed 22 November 2016 unless otherwise noted.

ABS-CBN. (2014). Storm surge warnings as of 11pm Friday, Dec. 5. *ABS-CBN News*. Retrieved from http://news.abs-cbn.com/focus/12/05/14/storm-surge-warnings-11pm-friday-dec-5

Association of Community Radio Broadcasters. (2016). Website. Retrieved from www.acorab.org.np/index.php?pagename=aboutus

Agence France-Presse. (2013a). Pakistan quake survivors face long wait for aid. *Agence France-Presse*. Retrieved from http://reliefweb.int/report/pakistan/pakistan-quake-survivors-face-long-wait-aid

———. (2013b). Disaster systems failed, says Philippine president. *Agence France-Presse*. Published 18 November 2013. Retrieved from http://reliefweb.int/report/philippines/disaster-systems-failed-says-philippine-president

Aguirre, M. (2013). International Medical Corps Teams Responding to Typhoon Haiyan in the Philippines. Published 09 November 2013. International Medical Corps. Retrieved from http://reliefweb.int/report/philippines/international-medical-corps-teams-responding-typhoon-haiyan-philippines

Alojado, D. (2010). The Twelve Typhoons of the Philippines (1947 – 2009). Retrieved from http://www.typhoon2000.ph/stormstats/12WorstPhilippineTyphoons.htm

Aloudat, A., Michael, K., and Yan, J. (2007). Location-based services in emergency management-from government to citizens: Global case studies, in in Mendis, P, Lai, J, Dawson, E and Abbass, H, Recent Advances in Security Technology, Australian Homeland Security Research Centre, Melbourne, 2007, pp. 190-201.

Aoyama, E., Evangelides, A., Greeff, D., Mier-Lavin, I., Nishiyama, K., and Pappagallo, L. (2013). Communicating in Disasters: Examining the Relationship between Humanitarian Organizations and Local Media. Capstone Project commissioned by Internews.

Appleby, L. (2013). Connecting the last mile: The role of communications in the Great East Japan Earthquake. Internews Europe. Retrieved from http://internews.org/research-publications/connecting-last-mile-role-communications-great-east-japan-earthquake

Arai, K. (2013). How to transmit disaster information effectively: A linguistic perspective on Japan's tsunami warning evacuation instructions. *International Journal of Disaster Risk Science* 4(3): 150 – 158.

Asian Human Rights Committee. (2011). "Philippines: Mindanao Disaster - Improving Warning Systems". Press release. 21 December 2011. Retrieved from http://reliefweb.int/report/philippines/philippines-mindanao-disaster-improving-warning-systems-profiling-corpses-are

Auf der Heide, E. (2004). Common Misperceptions about Disasters: Panic, the 'Disaster Syndrome', and Looting, in *The First 72 Hours: A Community Approach to Disaster Preparedness* pp. 340 - 380, O'leary, M., Ed. Lincoln (Nebraska), iUniverse Publishing.

Axelrod, R., and Cohen, M. D. (1999). *Harnessing Complexity: Organizational Implications of a Scientific Frontier*. Free Press, New York. Kindle Edition.

Bandura, A. (2001). Social Cognitive Theory of Mass Communication. *Media Psychology* Vol. 3, pp. 265–299.

Bankoff, G. (2007). Storms of History: Water, hazard and society in the Philippines 1565 – 1930, in *A World of Water: Rain, Rivers and Seas in Southeast Asian Histories*, pp. 154 – 183. Boomgaard, P. (Ed.). KITLV Press, Leiden, The Netherlands.

Barnlund, D. C. (1970). "A transaction model of communication" in *Language Behavior: A Book of Readings in Communication,* pp. 43 – 61. Mouton, The Hague.

British Broadcasting Corporation (BBC). (2014). Philippines Typhoon Hagupit makes landfall as thousands flee. *BBC*. Published 06 December 2014. Retrieved from http://www.bbc.com/news/world-asia-30356298

Beneito-Montagut, R., Shaw, D., and Brewster, C. (2013). Web 2.0 and Social Media in Disaster Management: Using Web 2.0 applications and Semantic Technologies to strengthen public resilience to disasters. Aston University, Birmingham, UK

Bernal, B. (2013). 'Storm surge' not explained enough – PAGASA official. *Rappler News*. Retrieved from http://www.rappler.com/move-ph/issues/disasters/typhoon-yolanda/43735-yolandaph-haiyan-preparedness-philippines

Bernardo-Lokin, K (2015). Ericsson Philippines: Thank-you, 2015. *The Manila Times*. Retrieved from www.manilatimes.net/ericsson-philippines-thank-you-2015/235469/

Boyatzis, R. E. (1998). *Transforming Qualitative Information: Thematic Analysis and Code Development*. Sage, Thousands Oaks.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.

Budd, R. W., Thorp, R. K., Donohew, L. (1967). *Content Analysis of Communications*. The Macmillan Company, New York.

Button, G. (2010). *Disaster Culture: Knowledge and Uncertainty in the Wake of Human and Environmental Catastrophe*. Routledge, London. Kindle Edition.

Case, D. O. (2012). *Looking for information: A survey of research on information seeking, needs and behavior, 3rd Ed.* Emerald Group Publishing.

Castells, M. (2005). The Network Society: From Knowledge to Policy, in *The Network Society: From Knowledge to Policy,* Castells, M. and Cardoso, G., (Eds.), pp. 3 – 21. Johns Hopkins Center for Transatlantic Relations, Washington, DC.

Center for Excellence in Disaster Management and Humanitarian Assistance. (2015). Disaster Information Report: Nepal Earthquake. Published 09 May 2015. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/150509_U_CDIR_NepalEarthquake.pdf

Central Bureau of Statistics. (2012). National Population and Housing Census 2011 – Volume 1. Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics. Kathmandu. Retrieved from http://unstats.un.org/unsd/demographic/sources/census/wphc/Nepal/Nepal-Census-2011-Vol1.pdf

Central Bureau of Statistics. (2013). Nepal in Figures 2014. Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics. Retrieved from http://cbs.gov.np/image/data/Publication/Nepal%20in%20Figures%20English%202014.pdf

Central Weather Bureau. (2016). "Typhoon Warning". Retrieved from http://cwb.gov.tw/V7e/prevent/warning/l10big.htm? Accessed 06 July 2016

Chaiken, S., and Maheswaran, D. (1994). Heuristic processing can bias systematic processing: effects of source credibility, argument ambiguity, and task importance on attitude judgment. *Journal of personality and social psychology*, *66*(3), 460.

Chandler, D. (2002). *Semiotics: the basics*. Routledge, London.

Chandler, D. (2007). *Semiotics: the basics 2nd Edition*. Routledge, London.

Chaney, P. L., Weaver, G. S., Youngblood, S. A., and Pitts, K. (2013). Household preparedness for tornado hazards: The 2011 disaster in DeKalb County, Alabama. *Weather, Climate, and Society*, *5*(4), 345-358.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences 2nd Ed*. Lawrence Erlbaum Associates, New York.

———. (1992). A Power Primer. *Psychological Bulletin*. Vol. 112 (1), pp 155 – 159.

Comfort, L. K. (1999). *Shared Risk: Complex Systems in Seismic Response*. Elsevier Science, Amsterdam.

———. (2007a). Crisis Management in Hindsight: Cognition, Communication, Coordination, and Control. *Public Administration Review*, 67(s1), 189 – 197.

Comfort, L. K., & Kapucu, N. (2006). Inter-organizational coordination in extreme events: The World Trade Center attacks, September 11, 2001. *Natural hazards*, *39*(2), 309-327.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications, Thousand Oaks, California.

Crowe, A. (2012). *Disasters 2.0: The application of social media systems for modern emergency management*. CRC press, Boca Raton.

Daniell, J., Schmidt, H.M., Schaefer, A., Hoechner, A., Girard, T., Brink, S., Kunz-Plapp, T., Mühr, B., Dittrich, A., Vervaeck, A., Wenzel, F., Khazai, B., Anhorn, J., Floerchinger, V., Strader, A., Schorlemmer, D., Beutin, T., Fanselow, F. (2015). Nepal Earthquakes – Report # 3. Retrieved from www.cedim.de/download/CEDIM_ImpactSummary_EarthquakeNepal2015_Report3.pdf

Dey, I. (1993). *Qualitative Data Analysis: A user Friendly Guide for Social Scientists*. Routledge, London.

Dominguez, C., (1994). Can SA be defined? In *Situational awareness: Papers and annotated bibliography,* Vidulich, M., Dominguez, C., Vogel, E., and Mcmillan, G. (Eds.) Wright-Patterson Air Force Base, OH: Air Force Systems Command, pp. 5 – 15.

Drabek, T. E. (2012). *Human system responses to disaster: An inventory of sociological findings*. Springer-Verlag, New York.

Drabek, T. E. (2013) *The Human Side of Disaster, Second Edition*. Taylor and Francis CRC.

Dudley, E., and Haaland, A. (1993). *Communicating Building Safety: Guidelines for methods of communicating technical information to local builders and households*. Intermediate Technology Publications, London.

Eco, U. (1979). *The Role of the Reader: explorations in the semiotics of texts*. Indiana University Press, Bloomington.

Eco, U. (1972). "Towards a Semiotic Inquiry into the Television Message" in *Internationalizing Cultural Studies: An Anthology* (2004) Wiley-Blackwell Publishing.

The Economist. (2014). Typhoon Hagupit: The readiness is all. *The Economist*. Retrieved from www.economist.com/node/21635806

Federal Emergency Management Agency. (2013). Hurricane Sandy FEMA after-action report. United States Federal Emergency Management Agency. Retrieved from www.fema.gov/media-library/assets/documents/33772

Fiske, J. (1990). *Introduction to Communication Studies 2nd Ed.* Routledge, London. ISBN 0-415-04672-6

Fligstein, N., and McAdam, D. (2012) *A Theory of Fields.* Oxford University Press, Oxford.

Flyvbjerg, B. (2004). Five misunderstandings about case-study research. *Sosiologisk tidsskrift*, *2*, 117-143.

Garnett, J. L., and Kouzmin, A. (2007). Communicating throughout Katrina: Competing and complementary conceptual lenses on crisis communication. *Public Administration Review*, *67*(s1), 171-188.

Garschagen, M., Hagenlocher, M., Kloos, J., Pardoe, J., Lanzendörfer, M., Mucke, P., Radtke, K., Rhyner, J., Walter, B., Welle, T. and Birkmann, J. (2015). World Risk Report 2015. Bündnis Entwicklung Hilft and UNU-EHS.

Ghimire, S. (2016). Data Revolution. Published 27 May 2016. *Republica*, Vol. 8(30). Retrieved from http://admin.myrepublica.com/the-week/story/43132/banking-on-data.html

Girard, T., Wenzel, F., Khazai, B., Kunz-Plapp, T., Daniell, J. E., & Brink, S. A. (2014). Near-Real-Time Analysis of Publicly Communicated Disaster Response Information. *International Journal of Disaster Risk Science*, 5(3), 165 – 175.

GMA News. (2014). LIST: Areas under threat of storm surge, according to Project NOAH. *GMA News.* Published 06 December 2014. Retrieved from http://www.gmanetwork.com/news/story/391342/scitech/weather/list-areas-under-threat-of-storm-surge-according-to-project-noah#sthash.Ez1WPRMw.dpuf

GoogleDocs. (2015). Nepal Quake Resource Document and Relief Coordination Form. Retrieved from https://docs.google.com/document/d/1_wLkYkBj1gFUQzpZOvNQQo10AS0vDDOLJ9k1M1eqQ3M/edit

Government of Nepal. (2015a). Nepal Earthquake Casualties List. Retrieved from: http://eq.nitc.gov.np/

———. (2015b). Relief Distributed by District Administration Office. Nepal Disaster Risk Reduction Portal website. Retrieved from http://drrportal.gov.np/distribution

Government of Odisha. (2013). Memorandum on the Very Severe Cyclone Phailin and the Subsequent Flood 12-15 October 2013. The Revenue and Disaster Management Department Government of Odisha. Retrieved from http://www.unep.org/pdf/UNEP_GEAS_NOV_2013.pdf

Gravetter, F. J., and Wallnau, L. B. (2016). *Statistics for the Behavioral Sciences, 10th Ed.* Cengage Learning, Boston.

The Guardian. (2014). Typhoon Hagupit: More than half a million Philippines residents flee storm surge. *The Guardian.* Published 05 December 2014.

Hall, S. (1980). "Encoding/decoding." In *Culture, Media, Language, pp. 128–38* Stuart Hall, Dorothy Hobson, Andrew Love, and Paul Willis (eds.), London: Hutchinson, 1980.

Haddow, G.D., and Haddow, K.S. (2014). *Disaster Communications in a Changing Media World.* Elselvier, Oxford.

Hartley, J. (2002). *Communication, Culture and Media Studies: The Key Concepts, 3rd Ed.* Routledge, London.

Harvard Humanitarian Initiative. (2011). *Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies.* UN Foundation & Vodafone Foundation Technology Partnership. Washington, D.C.

Helsloot, I., and A. Ruitenberg. (2004). Citizen response to disasters: A survey of literature and some practical implications. *Journal of Contingencies and Crisis Management 12(3): 98–111.*

Holland, J. H. (1995) *Hidden Order: How Adaption Builds Complexity*. Perseus Books, Reading, Massachusetts.

———. (2014). Signals and Boundaries: Building Blocks for Complex Adaptive Systems. The MIT Press, Cambridge, Massachusetts.

Humanity Road. (2013). Typhoon Haiyan - Online situation reports. Retrieved from http://reliefweb.int/disaster/tc-2013-000139-phl?f[0]=field_source%3A13123

———. (2015). Humanity Road – Nepal Situation Report #2: Social Media Situation Report. Published 26 April 2015. http://humanityroad.org/wp-content/uploads/2015/04/HumanityRoadNepalSitrep2Apr26Summary.pdf

Imran, M., Elbassuoni, S. M., Castillo, C., Diaz, F., & Meier, P. (2013). Extracting information nuggets from disaster-related messages in social media. *Proc. of ISCRAM*, Baden-Baden, Germany.

Inter-Agency Common Feedback Project. (2015). Inter-Agency Common Feedback Project Nepal Earthquake 2015. Retrieved from http://reliefweb.int/report/nepal/inter-agency-common-feedback-project-nepal-earthquake-2015

International Federation of Red Cross and Red Crescent Societies (IFRC). (2014). Information Bulletin Philippines: Typhoon Hagupit. IFRC. Published on 11 Dec. 2014. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/PHtc111214.pdf

———. (2015). *World Disasters Report.* IFRC, Geneva, Switzerland.

International Organization for Migration. (2013). UNFPA estimates 200,000 pregnant women need help in aftermath of super typhoon. Published 10 November 2013. Retrieved from http://reliefweb.int/report/philippines/typhoon-haiyan-situation-report-no-2

Internet Live Stats. (2016). Philippines Internet Users. Retrieved from www.internetlivestats.com/internet-users/philippines/

Internet World Stats. (2015). Internet Users in Asia November 2015. Internet World Stats. Retrieved from www.internetworldstats.com/stats3.htm

Internews. (2014). Nepal Media Survey 2014 Provides Valuable Data on Nepali's Communication Preferences http://www.cdacnetwork.org/i/20150501170807-kbmt7/

Jamal, A., and J. Crisp. (2002). Real-time humanitarian evaluations: Some frequently asked questions. Geneva: United Nations High Commissioner for Refugees Evaluation and Policy Analysis Unit. Retrieved from www.unhcr.org/3ce372204.html

Joffe, H., and Yardley, L. (2004). Content and Thematic Analysis, in *Research Methods for Clinical and Health Psychology*, Marks, D. F., and Yardley, L. (Eds.), pp. 56 – 68. Sage, London.

Kathmandu Living Labs. (2015) QuakeMap.org website. Available at: kathmanduliving labs.org/project/details/quakemap-org

Kauffman, S. (1995) *Alone in the Universe: the Search for Laws of Self-Organization and Complexity*. Oxford University Press, New York. Kindle Edition.

Kennedy, G. A. (1991). *On Rhetoric: A Theory of Civic Discourse*. Oxford University Press, Oxford.

Khazai, B., Anhorn, J., Brink, S., Girard, T., Jimee, G.K., Parajuli, B., Wagle, S., Khanal, O., Shresta, S., and Manandhar, R. (2015). Emergent Issues and Vulnerability Factors in Temporary and

Intermediate Shelters Following the 2015 Nepal Earthquake. Center for Disaster Management and Risk Reduction Technology, Karlsruhe.

Killian, L. M. (2002). An Introduction to Methodological Problems of Field Studies in Disasters, in *Methods of Disaster Research*. Stallings, R. A. (Ed.). Xlibris Corporation.

Kress, G. (2009). Multimodality: A Social Semiotic Approach to Contemporary Communication. Routledge, London.

Kress, G. and Leeuwen, T.v. (2006). *Reading Images: the Grammar of Visual Design, 2nd Edition*. First published 1996. Routledge, New York.

Krippendorf K. (2004). *Content Analysis: An Introduction to its Methodology*. Sage Publications, London.

Kuhlthau, C. C. (1993). *Seeking Meaning*. Norwood, NJ: Ablex.

Lagmay, A. M. F. et al. (2015). Devastating storm surges of Typhoon Haiyan. *Int. J. of Disaster Risk Reduction*, *11*, 1-12.

Lopatovska, I., and Smiley, B. (2013). Proposed model of information behaviour in crisis: the case of Hurricane Sandy. *Information Research: An International Electronic Journal*, *19*(1), n1.

Larano, C. (2014). Typhoon Tears Through Philippines. *Wall Street Journal*. Published 06 Dec 2014. Retrieved from http://www.wsj.com/articles/typhoon-tears-through-philippines-1417835790?tesla=y

Lasswell, H. (1948). The structure and function of communication in society. In *The communication of ideas*, L. Bryson Ed. New York: Institute for Religious and Social Studies.

Liao, J. (2008). The Philippines – Social Networking Capital of the World. *Manila Bulletin online*. Published 20 May 2008. Retrieved from https://web.archive.org/web/20081011094639/http://www.mb.com.ph/issues/2008/05/20/TECH20080520124703.html

Liu, S. B., Palen, L., Sutton, J., Hughes, A. L., & Vieweg, S. (2008). In search of the bigger picture: The emergent role of on-line photo sharing in times of disaster. In *Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM)*.

Lindell, M.K., and Perry, R.W. (1987). Warning Mechanisms in Emergency Response Systems Article. *Int. J. of Mass Emergencies and Disasters*.

———. (2004). *Communicating Environmental Risk in Multiethnic Communities*. Sage Publications, London.

———. (2011). The Protective Action Decision Model: Theoretical Modifications and Additional Evidence. *Risk Analysis* Vol. 32 No.4.

Luhmann, N. (1989). *Ecological Communication*. The University of Chicago Press, Chicago. (Originally published 1986 in German)

———. (1995). *Social Systems*. Stanford University Press, Stanford, California. (Originally published in German, 1984 as Soziale Systeme: Grundriβ einer allgemeinen Theorie, Suhrkamp Verlag, Frankfurt am Main)

———. (2013). *Introduction to systems theory*. Polity Press, Cambridge. Originally published in German in 2002.

Maxwell, T.A. (2003). The public need to know: Emergencies, government organizations, and public information. *Government Information Quarterly 20(3): 233–258*.

May, A. L. (2006). *First Informers in the Disaster Zone: The Lessons of Katrina*. The Aspen Institute, Washington.

McLean, I., D. Oughton, S. Ellis, B. Wakelin, and C.B. Rubin. (2012). Review of the civil defence emergency management response to the 22 February Christchurch Earthquake. Ministry of Civil Defence and Emergency Management. Retrieved from http://www.civildefence.govt.nz/assets/Uploads/publications/Review-CDEM-Response-22-February-Christchurch-Earthquake.pdf

McQuail, D., and Windahl, S. (1993). *Communication Models for the Study of Mass Communication, 2nd Ed.*, Longman Publishing, New York.

McQuail, D. (2010). *McQuail's Mass Communication Theory 6th Ed.*. Sage publications, London.

Médecins Sans Frontières. (2013). Typhoon Haiyan: Priority is reaching isolated areas. Published 13 November 2013. Retrieved from http://reliefweb.int/report/philippines/typhoon-haiyan-priority-reaching-isolated-areas

Meier, P. (2015). *Digital Humanitarians: how Big Data is Changing the Face of Humanitarian Response*. Crc Press, Boca Raton.

Mileti, D. S. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States*. National Academies Press Short. Kindle Edition.

Mileti, D. S. and Beck, E. M. (1975). Communication in crisis: explaining evacuation symbolically. *Communication Research,* 2(1), 24-49.

Mileti, D.S., Bandy, R., Bourque, L.B., Johnson, A., Kano, M., Peek, L., Sutton, J., and Wood, M. (2006) "Annotated Bibliography for Public Risk Communication on Warnings for Public Protective Actions Response and Public Education (Revision 4)".

Mileti, D.S., Sorenson, J.H. (1990). "Communication of Emergency Public Warnings: a social science perspective and state of the art assessment". Oakridge National Laboratory, Oakridge, Tennessee.

Ministry of Home Affairs. (2015). Nepal Earthquake 2072 : Situation Update as of 11th May. Retrieved from http://drrportal.gov.np/uploads/document/14.pdf

Morella, C. (2013a). Aid pushes through to Philippine typhoon survivors. *Agence France-Presse*. Published on 16 November 2013. Retrieved from http://reliefweb.int/report/philippines/aid-pushes-through-philippine-typhoon-survivors

———. (2013b). Mass burial cancelled as Philippines anger turns deadly. *Agence France-Presse*. Published 13 November 2013. Retrieved from http://reliefweb.int/report/philippines/deadly-crush-filipinos-try-flee-typhoon-nightmare

———. (2013c). World's strongest typhoon swirls towards Philippines. *Agence France-Presse*. Published 7 Nov 2013. Retrieved from http://reliefweb.int/report/philippines/mass-evacuations-philippines-ahead-super-typhoon

Mori, N., Kato, M., Kim, S., Mase, H., Shibutani, Y., Takemi, T., ... & Yasuda, T. (2014). Local amplification of storm surge by Super Typhoon Haiyan in Leyte Gulf. *Geophysical research letters*, *41*(14), 5106-5113.

Nationwide Operational Assessment Hazards (NOAH). (2014a). Official list of localities: Typhoon Ruby (Hagupit) Storm Surge Advisory. Retrieved from blog.noah.dost.gov.ph/2014/12/04/official-list-of-localities-typhoon-ruby-hagupit-storm-surge-advisory/

———. (2014b) Storm surge inundation validation in Daram, Samar during Typhoon Hagupit (2014). Retrieved from http://blog.noah.dost.gov.ph/2016 /06/17/storm-surge-inundation-validation-in-daram-samar-during-typhoon-hagupit-2014/

———. (2014c). Compilation of Storm Surge Occurrences in the Philippines. Retrieved from http://blog.noah.dost.gov.ph/2014/02/04/compilation-of-storm-surge-occurrences-in-the-philippines/

National Disaster Risk Reduction and Management Council. (2011). NDRRMC update: Sitrep No.1 re: Preparedness and response to the effects of tropical storm "SENDONG", 16 December 2011. Retrieved from http://reliefweb.int/report/philippines/ndrrmc-update-sitrep-no1-re-preparedness-and-response-effects-tropical-storm

———. (2013). Situational Report re Effects of Typhoon YOLANDA (HAIYAN). Situation report website. Retrieved from http://ndrrmc.gov.ph/21-disaster-events/1329-situational-report-re-effects-of-typhoon-yolanda-haiyan

———. (2014). Effects of Typhoon "Ruby" (HAGUPIT). Situation report website. Retrieved from http://ndrrmc.gov.ph/21-disaster-events/1356-preparedness-measures-for-typhoon-ruby-hagupit

Nepal Relief. (2015). Nepal relief information portal website. Retrieved from http://nepalrelief.net/

Nepal Telecommunications Authority. (2016). Management Information System Report (17, November – 15, December, 2015). NTA. Year: XII, Issue: 85 (133). Published February 2016. Retrieved from: http://www.nta.gov.np/en/mis-reports-en

Neussner, O. (2014). Assessment of Early Warning Efforts in Leyte for Typhoon Haiyan/Yolanda. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Retrieved from http://www.preventionweb.net/publications/view/36860

Nöth, W. (1990). *Handbook of Semiotics*. Indiana University Press, Bloomington.

———. (2013). Human Communication from the Semiotic Perspective, in *Theories of Information, Communication and Knowledge: A Multidisciplinary Approach*. Ibekwe-SanJuan, F., and Dousa, T. M. ed. Springer, London.

Ogden, C.K., and Richards, I.A. ed. (1923). *The Meaning of Meaning: a study of the influence of language upon thought and of the science of symbolism*. Harcourt, Brace and World, London.

Open Mic Nepal. (2015). Rumor tracking website: www.quakehelpdesk.org/openmic.php

O'Sullivan, T., Hartley, J., Saunders, D., Montgomery, M., and Fiske, J. (1994). *Key Concepts in Communication and Cultural Studies,* London 2nd ed., 1994.

Organisation for Economic Co-operation and Development. (2010). Glossary of key terms in evaluation and results based management. OECD. Retrieved from https://www.oecd.org/dac/evaluation/2754804.pdf

Oxfam. (2013). Cyclone leaves destruction and homelessness in India – But many lives saved by quick action. Retrieved from http://www.oxfam.org.uk/media-centre/press-releases/2013/10/cyclone-leaves-destruction-and-homelessness-in-india--but-many-lives-saved-by-quick-action

Pacchioli, D. (2013) Communication in the Fukushima Crisis: How did officials, scientists, and the media perform? *Oceanus Magazine*. 9 May 2013. Retrieved from http://www.whoi.edu/oceanus/feature/communicating-science

Padhy, G., Padhy, R. N., Das, S., & Mishra, A. (2015). A review on management of cyclone phailin: early warning and timely action saved lives. *Indian Journal of Forensic and Community Medicine*, *2*(1), 56-63.

Palen, L., Hiltz, S. R., and Liu, S. B. (2007). Online forums supporting grassroots participation in emergency preparedness and response. *Communications of the ACM*, *50*(3), 54-58.

Palen, L., & Liu, S. B. (2007). Citizen communications in crisis: anticipating a future of ICT-supported public participation. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 727-736). ACM.

Pallant, J. (2007). *SPSS Survival Manual: A Step by Step Guide to Data Analysis using SPSS for Windows 3rd ed.,* Open University Press, Berkshire, England.

Pechta, L. E., Brandenburg, D. C., Seeger, M. W. (2010). Understanding the Dynamics of Emergency Communication: Propositions for a Four-Channel Model. *Journal of Homeland Security and Emergency Management: Vol. 7: Iss. 1, Article 55.*

Peirce, C. S. (1960). *Collected Papers of Charles Sanders Peirce*. Charles Hartshorne and Paul Weiss (eds.), Vol. I-II, The Belknap Press of Harvard University Press, Cambridge Massachusetts.

Perloff, R. M. (2010). *The Dynamics of Persuasion: Communication and Attitudes in the Twenty-first Century, 4th Ed.* Routledge, New York.

Perry, R. W. (1979). Evacuation decision-making in natural disasters. *Mass emergencies*, *4*(1), 25-38.

———. (1987). Warning Mechanisms in Emergency Response Systems. *Int. J. of Mass Emergencies and Disasters.* Vol. 5 (2) pp. 137 – 153.

Petley, D.N., Hearn, G.J., Hart, A., Rosser, N.J., Dunning, S.A., Oven, K., and Mitchell, W.A. (2007). Trends in landslide occurrence in Nepal. *Natural Hazards* Vol. 43, pp. 23 – 44.

Philippine Statistics Authority. (2012). Household Population of the Philippines Reaches 92.1 Million. Retrieved from https://www.psa.gov.ph/content/household-population-philippines-reaches-921-million

Potts, L. (2014). *Social Media in Disaster Response: How Experience Architects can Build for Participation*. Routledge, New York.

Price, G., (2013). India Survives Cyclone Phailin. Chatham House. 15 October 2013. Retrieved from https://www.chathamhouse.org/node/13230

Quarantelli, E. L., and Dynes, R. R. (1977). Response to social crisis and disaster. *Annual review of sociology*, 23-49.

Quarantelli, E. L. (1978). *Disasters: Theory and Research*. Sage, Beverly Hills.

———. (1983). People's Reactions to Emergency Warnings. Disaster Research Center, University of Delaware.

———. (1980). Evacuation Behavior and Problems: Findings and Implications from the Research Literature. Disaster Research Center, The Ohio State University, Columbus, OH.

Ranada, P. (2013). Leyte Warned of Storm Surges. *Rappler News*. Published on 8 Nov. 2013. Retrieved from www.rappler.com/nation/43179-yolanda-storm-surges

———. (2014). How to know if storm surge threatens your area. *Rappler News*. Published on 4 Dec. 2014. Retrieved from www.rappler.com/move-ph/issues/disasters/76974-project-noah-storm-surge-hazard-maps

Rappler. (2016). About Rappler. *Rappler News*. Published 14 Dec. 2011. Retrieved at www.rappler.com/about-rappler/about-us/385-about-rappler

———. (2014). NOAH: More areas warned vs Ruby storm surges. *Rappler News*. Published on 6 Dec. 2014. Retrieved from www.rappler.com/move-ph/issues/disasters/typhoon-ruby/77149-20141206-5am-ruby-storm-surge-warnings

ReliefWeb. (2014). What is ReliefWeb? Retrieved from http://reliefweb.int/about

———. (2015). Nepal Earthquakes: April 2015. Retrieved from http://reliefweb.int/disaster/eq-2015-000048-npl

Renn, O., Schweizer, P.J., Dreyer, M., and Klinke, A. (2007). *Risiko*. Gesellschaft fur okologische Kommunikation mbH, Munich.

Resource Nepal. (2015). Nepal Earthquake Relief Resource website. Retrieved from http://www.resourcenepal.org/

Reuters. (2013). Survivors "walk like zombies" after Philippine typhoon kills estimated 10,000. *Reuters*. Retrieved from www.trust.org/item/20131110063916-3y9e4/

Reynolds, B., and Seeger, M. W. (2005). Crisis and emergency risk communication as an integrative model. *Journal of health communication*, *10*(1), 43-55.

Rogers, E. M. (1983). *Diffusion of innovations, 3rd edition*. The Free Press, New York.

———. (1986). *Communication technology*. The Free Press, New York.

Rogers, G.O., Sorenson, J. (1993). "Diffusion of Emergency Warning: Comparing Empirical and Simulation Results". *Risk Analysis*, January 1993. DOI: 10.1007/978-1-4899-0730-1_14

Rubin, D. M. (1987). How the news media reported on Three Mile Island and Chernobyl. *Journal of communication*, *37*(3), 42-57.

Sabillo, K. A. (2013). Aquino: PH Ready to Face Supertyphoon 'Yolanda'. *Philippine Daily Inquirer*. November 7, 2013.

Saifi, S. (2013). Pakistan quake death toll rises to 356. *CNN*. Retrieved from www.edition.cnn.com/2013/09/26/world/asia/pakistan-earthquake/

Sapkota, Krishna (2014) Exploring the emerging impacts of open aid data and budget data in Nepal. Freedom Forum, Kathmandu. Retrieved from http://www.opendataresearch.org/sites/default/files/publications/Open%20Aid%20and%20Budget%20Data%20in%20Nepal%20-%2015th%20Sept-print.pdf

Sarter, N. B., and Woods, D. D. (1991). Situation awareness: A critical but ill-defined phenomenon. *The International Journal of Aviation Psychology*, *1*(1), 45-57.

Saussure, F. de., (1959). *Nature of the Linguistic Sign: Course in General Linguistics*. Forgotten Books, London. (Originally published in 1916).

Scanlon, J. (2011). Research about the mass media and disaster: Never (well hardly ever) the twain shall meet, in *Journalism Theory and Practice, Detrani, J. (Ed.)*, 233-269. Apple Academic Press, Oakville, ON.

Schramm, W. (1954). How communication works, in *The Process and Effects of Mass Communication*. Urbana, IL: University of Illinois Press.

Schreier, M. (2012). *Qualitative Content Analysis in Practice*. Sage, London.

Schulz von Thun, F. (1981). *Miteinander reden: Störungen und Klärungen. Psychologie der* zwischenmenschlichen Kommunikation. Rowohlt, Reinbek. ISBN 3-499-17489-8

Seeger, M. W. (2006). Best practices in crisis communication: An expert panel process. *Journal of Applied Communication Research*, *34*(3), 232-244.

Sellnow, T. L., and Seeger, M. W. (2013). *Theorizing Crisis Communication*. John Wiley & Sons, West Sussex, UK.

Senapati, A., (2013). Mass evacuation on in coastal districts. Down to Earth. 11 October 2013. Retrieved from http://www.downtoearth.org.in/content/mass-evacuation-coastal-districts

Shannon, C. E., and Weaver, W. (1949). *The Mathematical Theory of Communication*. University of Illinois press, Chicago.

Sheales, R. (2010). Victoria unveils response to Black Saturday report. *ABC News*. Published 27 August 2010. Retrieved from www.abc.net.au/news/2010-08-27/victoria-unveils-response-to-black-saturday-report/960660

Shklovski, I., Palen, L., & Sutton, J. (2008). Finding community through information and communication technology in disaster response. In *Proceedings of the 2008 ACM conference on Computer supported cooperative work* (pp. 127-136). ACM.

Sorenson, J.H. (2000). "Hazard Warning Systems: Review of 20 years of Progress", Natural Hazards Review 1:119–125.

Sorenson, J. H. and Mileti, D. S. (1991). Risk communication in emergencies, in *Communicating Risks to the Public: International Perspectives*. Kasperson, R. E., and Stallen, P. J. M. (eds.). Kluwer Acedemic Publishers, Dordrecht.

Sorenson, J.H., and Mileti, D.S. (1988). Warning and evacuation: answering some basic questions. *Industrial Crisis Quarterly*, 2: 195–209.

Sphere India. (2013). Sitrep-2: Severe Cyclonic Storm "Phailin". Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/Sitrep-2%2B%2BSevere%2BCyclonic%2BStrom-PHAILIN%2B11.10.2013.pdf

St. Denis, L. A., Palen, L., and Anderson, K. M. (2014). Mastering social media: An analysis of Jefferson county's communications during the 2013 Colorado floods. In *11th International ISCRAM Conference* (pp. 737-746).

Stallings, R. A. (2002). Disaster Research: Unique or Not?, in *Methods of Disaster Research*. Stallings, R. A. (Ed.). Xlibris Corporation.

Standby Task Force. (2015). The Standby Task Force's Situational Review of Aid Responders in Nepal: Final 2W Report of 513 Organizations Responding, as of May 6, 2015. Retrieved from http://www.standbytaskforce.org/category/nepal-eq-3w/

Starbird, K. and Palen, L. (2013). Working and Sustaining the Virtual "Disaster Desk", in *Proceedings of the 2013 Conference on Computer Supported Cooperative Work* (pp. 491-502)

Starks, T. (2012). Katrina's lessons seen in response to Sandy. *CQ Weekly*. Retrieved from http://public.cq.com/docs/weeklyreport/weeklyreport-000004197197.html

Streeter, C.L. (1991). Redundancy in Social Systems: Implications for Warning and Evacuation Planning. *Int. J. of Mass Emergencies and Disasters,* 9 (2) pp. 167-182.

Sutton, J., Palen, L., & Shklovski, I. (2008). Backchannels on the front lines: Emergent uses of social media in the 2007 southern California wildfires. In *Proceedings of the 5th International ISCRAM Conference* (pp. 624-632). Washington, DC.

Transparency International. (2015). Corruption by Country. http://www.transparency.org/country#NPL

Tripathy, D., Joshi, M., Gupta, M., Hazarika, R., and Jain, S. (2014). Addressing Underlying Causes. Asian Disaster Reduction and Response Network Ground Truth, June 2014. Retrieved from www.adrrn.net/publications/ADRRN-Paper-series-Addressing-Underlying-Causes.pdf

Tropical Storm Risk. (2008). Myanmar: Track and windspeed of severe cyclonic Nargis (as of 01 May 2008). Retrieved from http://reliefweb.int/map/myanmar/myanmar-track-and-windspeed-severe-cyclonic-nargis-01-may-2008

Twitter. (2015a). Published 26 April 2015. Retrieved from https://twitter.com/search?q=parbat%20%23nepalearthquake&src=typd [3] Accessed 26 April 2015

Twitter. (2015b). Published 26 April 2015. Retrieved from https://twitter.com/search?src=typd&q=palpa%20%23nepalearthquake Accessed 26 April 2015

Tyler, T. R. (2001). The psychology of public dissatisfaction with government, in *What is it about government that Americans dislike*, 227-242. Hibbing, J.R., and Theiss-Morse, E. (Eds.), Cambridge University Press, New York.

Uhr, G., Conyers, S., Keegan, B., Drysdale, C., and Vlasic, K. (2014). "She lost her blow but dumped a load: Far North Queensland swamped with floods as Cyclone Ita heads south of Cairns". *The Cairns Post*. 13 April 2013. Retrieved from http://www.cairnspost.com.au/news/special-features/she-lost-her-blow-but-dumped-a-load-far-north-queensland-swamped-with-floods-as-cyclone-ita-heads-south-of-cairns/story-fnjz9tr1-1226879482288

United Nations Development Programme (UNDP). (2014). Human Development Report 2014 – Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience. United Nations Development Programme. Retrieved from http://www.undp.org/content/undp/en/home/presscenter/events/2014/july/HDR2014.html

United Nations Office for the Coordination of Humanitarian Affairs. (2013a). "The After Action Review/ Lessons Learned Workshops for Typhoon Bopha Response", UNOCHA.

———. (2013b). Pakistan flash update #3 on Balochistan Earthquake. United Nations Office for the Coordination of Humanitarian Affairs. http://reliefweb.int/report/pakistan/ocha-pakistan-flash-update-3-balochistan-earthquake

———. (2013c). Philippines: Typhoon Haiyan Situation Report No. 1 (as of 7 November 2013). Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/OCHAPhilippinesTyphoonHaiyanSitrepNo.1.7November2013.pdf

———. (2015a). Nepal Earthquake 2015 Situation Report no. 13. United Nations Office for the Coordination of Humanitarian Affairs.

———. (2015b). Monthly Situation Report 01.07.2015. UNOCHA Nepal Earthquake Assessment Unit. Retrieved from https://www.humanitarianresponse.info/en/system/files/documents/files/assessment_unit_-_monthly_situation_analysis_june_2015_1.pdf

United Nations Population Fund. (2013). UNFPA estimates 200,000 pregnant women need help in aftermath of super typhoon. Published on 11 November 2013. Retrieved from http://reliefweb.int/report/philippines/unfpa-estimates-200000-pregnant-women-need-help-aftermath-super-typhoon

United States Agency for International Development. (2015). Nepal – Earthquake Fact Sheet #4. Published 29 April 2015. Retrieved from http://reliefweb.int/report/nepal/nepal-earthquake-fact-sheet-4-fiscal-year-fy-2015-april-29-2015

Universal McCann. (2008). Power to the People – Social Media Tracker Wave 3. Retrieved from https://web.archive.org/web/20080921002044/http://www.universalmccann.com/Assets/wave_3_20080403093750.pdf

Verma, S., Vieweg, S., Corvey, W. J., Palen, L., Martin, J. H., Palmer, M., Schram, A., Anderson, K. M. (2011). Natural Language Processing to the Rescue? Extracting" Situational Awareness" Tweets During Mass Emergency. *Proceedings of the Fifth International AAAI Conference on Weblogs and Social Media.*

Voltaire, T., (2015). How a small Samar town survived deadly storm surges. *Rappler News*. Retrieved from www.rappler.com/move-ph/issues/disasters/83273-zero-casualty-daram-samar-storm-surges-typhoon-ruby

Watzlawick, P., Beavin, J. H., & Jackson, D. D. (1967). *Pragmatics of human communication: A study of interactional patterns, pathologies, and paradoxes*. Norton and Company, New York.

Welch, Matt (2005). They Shoot Helicopters Don't They? How journalists spread rumors during Katrina. *Reason,* 37 (7) pp. 16 – 18.

Wenger, D. E. (1978). Community Response to Disaster, in *Disasters: Theory and Research, Quarantelli E. L. Ed.* Sage, Beverly Hills.

Wersig, G. and U. Nevelling. (1975). The Phenomena of Interest to Information Science. *Information Scientist*, 9, pp. 127 – 140.

The White House. (2006). The Federal Response to Hurricane Katrina: Lessons learned. Retrieved from https://georgewbush-whitehouse.archives.gov/reports/katrina-lessons-learned/

Wiener, N. (1961). *Cybernetics or Control and Communication in the Animal and the Machine, 2nd Ed.*. MIT Press, Cambridge, Massachusetts. (Original work published in 1948)

World Health Organization. (2013). WHO responding to health needs caused by Typhoon Haiyan ("Yolanda"). Published 11 November 2013. Retrieved from http://reliefweb.int/report/philippines/who-responding-health-needs-caused-typhoon-haiyan-yolanda

Zoleta-Nantes, D. (2013). Typhoon Haiyan: a perfect storm of neglect. *The Conversation*. Retrieved from http://theconversation.com/typhoon-haiyan-a-perfect-storm-of-corruption-and-neglect-20149