Weather, Climate, and Narrative: A Relational Model for Democratizing Risk Communication

RAUL P. LEJANO

Department of Environmental Education, Steinhardt School, New York University, New York, New York

EULITO V. CASAS JR. AND ROSABELLA B. MONTES

Division of Natural Sciences and Mathematics, Tacloban College, University of the Philippines Visayas, Tacloban City, Philippines

LYNIE P. LENGWA

Climate Change Adaptation Advocacy Cooperative, Tacloban City, Philippines

ABSTRACT

There is growing evidence that the frequency and magnitude of extreme weather events may be increasing in conjunction with climate change. This means that many communities will encounter phenomena, such as extreme storm surge events, never before experienced by local residents. The tragic effects of Typhoon Haiyan on the city of Tacloban, Philippines, in November 2013 were attributed, in part, to the inability of routine technical bulletins to communicate the unprecedented nature of the predicted storm surge. In response, the authors construct a relational model of risk communication that suggests that narrative messages that simulate direct face-to-face communication may be more effective in spurring action. Conducting a postevent target audience study in the city of Tacloban, the authors tested the relative effectiveness of narrative-based versus technical message designs on residents who chose not to evacuate during the typhoon. Results show increased effectiveness of the narrative design vis-à-vis intent to evacuate, self-relevance and vividness of the message, and perceived authority of the message source. The study also explored factors behind noncompliance with evacuation advisories. The research supports the relational model, which captures insights from recent research on evacuation and emergency preparedness for extreme hazard events. It supports a broader effort to democratize risk communication and, in so doing, increase people's sense of agency in preparing for these events.

1. Introduction

There is gathering evidence that extreme weather events may be increasing in frequency and severity in some areas as a consequence of climate change (Emanuel 2013; Grinsted et al. 2013; Grossmann and Morgan 2011; Schiermeier 2013). A crucial challenge will be that of communicating the risks of these extreme weather events to local communities and agencies, many of which will have never previously encountered such phenomena. It is a tragic fact that, for many of the impacted local communities, the event will have been something outside their personal or institutional memory (Leiserowitz 2006; Soria et al. 2016). In other words,

these communities may not be able to rely on experiential processing (Marx et al. 2007; Siegrist and Gutscher 2008; Vasileiadou and Botzen 2014) or traditional knowledge (Sharma et al. 2013). Resilience to extreme weather events will require a capacity of authorities and the media to make the unfamiliar and unprecedented more tangible and relevant to the public.

One such tragedy occurred during Typhoon Haiyan in November 2013, when the massive storm surge struck Tacloban City, Philippines, resulting in at least 6300 fatalities and nearly 4.1 million residents displaced (NDRRMC 2014; Normile 2014). Post-event field measurements in Leyte revealed storm surge heights of 4 to 8 m with an average inundation height of approximately 6 m (Mas et al. 2015), which was close to that predicted by the national weather agency's storm surge

Corresponding author: Raul Lejano, lejano@nyu.edu

FIG. 1. Track of Typhoon Haiyan.

model (Lagmay et al. 2015). Figure 1 shows the track of the typhoon and the affected areas.

Typhoon Haiyan was unusual in many respects. First, it occurred quite late in the normal typhoon season in the Philippines, which peaks in September and tapers off by November (David et al. 2013). Its forward speed of 41 km h^{-1} was nearly twice the average speed of tropical cyclones making landfall in the Philippines (Takagi and Esteban 2016). But what really distinguished this typhoon from the norm was, first, record wind speed and, second, the shape and bathymetry of the bay off the coast of Tacloban City. Intensity estimates derived from satellite data just before landfall revealed a maximum 1-min sustained wind speed of 315 kph (196 mph), which is a category 5 on the Saffir–Simpson scale (Daniell et al. 2013) and one of the strongest tropical cyclones in recorded history (Normille 2014). Normally, large storm surges do not develop on the coast of eastern Visayas because of the depth of the ocean immediately offshore, but Leyte Bay (which is adjacent to Tacloban City) has a funnel shape that, coupled with the shallow bathymetry in that area, amplified the storm surge (Mori et al. 2014).

Ex post assessments of Typhoon Haiyan placed part of the problem on gaps in risk communication, as many residents were apparently unaware of the danger of the forthcoming storm surge despite the agency's accurate surge model prediction (Neussner 2014; Rasquinho 2014). One report estimated that only about 15 300 out of 220 000 urban residents moved to evacuation centers (Chen et al. 2013). Apparently, part of the problem was that agency communication, regarding the predicted storm surge, was unable to communicate that an event of extraordinary magnitude and potential impact was about to occur—in other words, the warnings were regarded as routine communication and ignored by many members of the public (Lejano et al. 2016; Neussner 2014). Moreover, routine disaster prevention activities were inadequate and, as some literature has suggested (Shaw Scully and Hart 2014), these routines may have even led to a false sense of preparedness. The problem lay in the fact that what was conventional and routine does not suffice in the face of the extraordinary—as one team of reporters on the scene put it, it was a "failure of imagination" (Chen et al. 2013).[1]

---

[1] The event was clearly beyond anything the community had experienced. A similar event that befell Tacloban City dated back to 1897 (Soria et al. 2016).

The question is: How can one better design warning messages so that their recipients might internalize and act upon them, even if the event is a once-in-a-lifetime occurrence that lies outside personal and institutional memory?[2]

In this article, the authors study how improved communication practices can foster greater preparedness, sometimes referred to also as hazard mitigation (Emrich and Cutter 2011), to increasing frequencies and/or severities of extreme weather events. The authors build a *relational model of risk communication* that prescribes more effective strategies for message construction. It ties together insights from different bodies of literature into a simple, exploratory model that the authors proceeded to test in the field.

Communication of risk/hazard information to agencies and the public has been implicated in a number of public emergencies. Eisenman et al. (2007) concluded that the reception of evacuation messages prior to the arrival of Hurricane Katrina contributed to the failure to evacuate of many in lower-income residents in New Orleans, a finding echoed by Cole and Fellows (2008). Marris (2005) found ineffective emergency warnings to have been a key factor in the tragedy of the Indian Ocean tsunami. Manuel (2014) found faulty communication at the heart of controversy over the Elk River Spill [also see Brown (2014)].

There are a number of insights from related research that inform our work. As the literature on hazard and risk communication shows, warning messages can be ineffectual when their recipients find them lacking in self-relevance, vividness, or trustworthiness (Dillard and Hisler 2015; Moyer-Gusé 2008). On the other hand, recent research on hazard warnings around tropical cyclones suggest that messages that are contextualized and personalized can be more effective than messages which are not (Morrow and Nadeau 2012; Morrow et al. 2015). A fundamental assumption behind this approach is that the message recipient has agency and is, ultimately, the decision-maker who cannot simply be assumed to blindly follow the agency's directives. In other words, the recipient should recognize the message to be relevant and comprehensible in order to act upon it. As the risk communication literature emphasizes, the information process must engage and empower the public (Moser and Boykoff 2013; Kasperson 2014).

Previous work on the communication process around Haiyan suggests that recipients of the storm surge warnings were unable to process and interpret the messages correctly, the latter seen as appearing simply technical and routine and, as such, being more likely to be dismissed by local officials and the public (Lejano et al. 2016). The problem lies not so much in the credibility of the agency's forecasts but, rather, the degree to which agency messages are received, understood, and acted upon.[3] The question that most concerns us is: How can hazard warning messages be constructed to be more effective, such that their recipients immediately recognize their relevance to their situations and interpret them correctly? The relational model of communication, which will be discussed next, attempts to answer this question.

2. Constructing a relational model of risk communication

In this article, a relational model of risk communication is developed that encompasses a number of key insights from the hazard and risk communication literature. The model posits an idealized communication situation as one where two or more persons communicate directly, face to face, in a way that increases message self-relevance and promotes affective dimensions of trust and authority. There is evidence, form the field of communication research, that face-to-face communication is a particularly information-rich medium and, logically, should be an important medium for hazard warnings (e.g., see Clark and Brennan 1991). The thesis is that messages that simulate this situation are more prone to capturing the recipient's attention. The logic is straightforward: in face-to-face communication, the message is directly addressed to the recipient and, so,

---

[2] In asking these questions, we do not blame the agencies for a lack of diligence when, in fact, staff and officials exhibited extraordinary dedication, some even losing their lives in the process (Flores 2013).

[3] There is a general perception that the reliability of PAGASA's forecasts has much improved over the last decade, though some of this is anecdotal (Santos 2014). There is some evidence of this. In a recent assessment of forecast skill, PAGASA calculated the mean positional TC (tropical cyclone) forecast error in 2016 to be 48.9, 93.4, and 137.8 nautical miles for 24-, 48-, and 72-h intervals, respectively, which exceeded the agency's target goals for forecast error (M. C. A. Monteverde 2017, unpublished presentation). This is reasonably close to other international agency performance, such as the U.S. National Hurricane Center which reported 24-, 48-, and 72-h TC forecast errors of 39.8, 70.8, and 103.0 nautical miles, respectively (Cangialosi and Franklin 2017). This is also significantly better than the 24-h forecast error calculated by PAGASA during 1994–96 (de Sesto et al. 1998), which was 86.1 nautical miles (note that 48- and 72-h errors were not provided then). With regard to public perception, PAGASA noted an improvement in public confidence after it implemented improvements in communication over a 2-yr period; specifically, reduction of survey responses on perceived inaccuracies in forecasts showed a drop from 25% to 19% (USAID 2017).

immediately self-relevant. Moreover, the recipient can gauge that the messenger is sincere and someone trustworthy. The complicating factor, of course, is that most risk communication is not carried out face to face but through other media (e.g., news bulletin in the newspapers or online). The logical recourse, then, is to construct the message text in such a way as to simulate the communication that occurs face to face.

What this means is that messages should be composed so that they simulate a direct conversation between one person and another. It is appropriate to use the word "simulate" because many communication situations (e.g., agency bulletin) do not allow ideal "bidirectional" communication (Covello et al. 1986; Covello and Sandman 2001). As demonstrated below, messages would take on the form of a narrative, which is a story being told by one person directly to another. Such narrative refers to contextual details directly relevant to the addressee. It is personalized in the sense of being directly addressed to the message recipient (at least in form), most often written in second person. Moreover, the message will come from a specific person, perhaps someone with which the addressee is familiar. Last, the message becomes more narrative-like when it tells a vivid story that uses terms that are richly descriptive of the situation being recounted, as opposed to technical terms that may be unfamiliar to the recipient.

The model builds on and is corroborated by different insights from the literature. Earlier work on risk communication has focused on the effectiveness of narrative-based, as opposed to technical, messages (Betsch et al. 2011; Dahlstrom 2014). More recently, research on persuasion and risk communication during extreme weather events have suggested the following:

- Messages are more effective to the extent that these are more personalized and contextualized, increasing self-relevance of the message (Meredith et al. 2009; Morrow and Nadeau 2012; Morrow et al. 2015; Stein et al. 2010);
- Trust in the message source involves, along with belief in the authority of the sender, affective elements related to familiarity with, and reputability of, the sender (Dunning and Fetchenhauer 2010; Engdahl and Lidskog 2014; Twyman et al. 2008);
- Narrative-like messages can increase the vividness and, so, the credibility of the message (Green and Brock 2000; Han and Fink 2012; Moyer-Gusé 2008). Vividness is also increased by including descriptions of event consequences in the message (Ripberger et al. 2015).

The succeeding model ties these disparate insights together into a coherent conceptual framework.

a. The model

Our *relational model* posits an ideal, or foundational, mode of communication characterized by direct, face-to-face exchange. Direct conversation allows each person to recognize the other, gain or possess trust in someone known to them, and to interact with or query each other. This type of direct exchange is recognized as immediately self-relevant by its participants. Direct communication allows the listener to directly gauge the sincerity and competence of the speaker. This *ideal communication condition* is that of direct, face-to-face conversations between two persons. Although such direct contact between agency officials and each member of the public is not possible, the ideal communication condition can be simulated or approximated in a number of ways, as discussed below.

Such an idealized communication condition naturally is one of maximal personalization and contextualization (since the message is communicated personally and speaks to the recipient's situation directly). It maximizes familiarity with the source of the message and, so long as the messenger has a good relationship with the recipient, can maximize trust. The question, of course, is how can we improve communication in situations where there cannot be direct contact between sender (e.g., the national weather agency) and receiver (e.g., the local resident) such as when a weather agency issues a general weather bulletin. Our research suggests that nondirect communication be crafted to emulate the talk and even the interactivity of direct, face-to-face communication. This entails crafting messages that are more like a narrative than a technical report. Another practice that would follow from this reasoning is to employ media that better approximate the ideal communication condition; for example, hearing the spoken word can be more effective than printed or online text. Another example would be having risk communication be sent directly to the public through short message service (SMS) text to complement printed bulletins.

We can only approximate direct communication in a situation where an agency issues a written hazard warning, such as when predicting a storm surge. In the field research described below, the researchers test the effectiveness of written messages that approximate direct conversation by crafting the message so that it has the following features:

- it is written in second-person voice so that it simulates direct communication to the message recipient;
- it is issued by a specific individual, to simulate direct communication;

- it is written in narrative form (what this entails will be spelled out below), simulating the speaker telling a story to the hearer;
- as narrative, it is written so that it more vividly describes the situation being predicted, using everyday language rather than technical terms.

These characteristics, juxtaposed against the conventional message type, are listed in Table 1. Whereas the traditional language of science is objective, universal, and neutral, the challenge is to design messages (or to empower members of the public to design them) in ways that are personal, cultured, gendered, and contextual.

b. Relationship to other models

1) SOCIAL AMPLIFICATION OF RISK

The relational model emphasizes one specific dimension of the risk communication process (which might be referred to as *relationality*) and so is related to the more comprehensive sociocultural theory of the social amplification of risk (Kasperson et al. 1988), which posits, more generally, that psychological, cultural, and other factors increase or decrease the salience of the message for the recipient. Another related theory is that of the mental models approach (Morgan et al. 2002), which emphasizes how message recipients (e.g., the public) receive and frame the message in different ways than that intended by the messengers. In the case of Typhoon Haiyan, some research suggests that storm surge warnings may have been regarded by the public as routine agency communication that was not distinguishable from the regular weather warnings frequently appearing in the media (Lejano et al. 2016). Our model focuses on one specific aspect of risk communication, relationality, in contrast to the more comprehensive sociocultural theory, which points to factors (other than pure informational content) that frame how the message is received.

2) ELABORATION–LIKELIHOOD MODEL OF COGNITION

Our model also draws from insights from models of cognition, such as the elaboration–likelihood model (ELM). ELM proposes a theory about processes by which a person receives a message from another and how and why such a message is internalized by the person and influences behavior (Petty and Cacioppo 1984, 1986). It is a type of dual-process theory wherein processing of the external message proceeds, cognitively, by way of two alternative routes: central and peripheral.

TABLE 1. Comparing narrative and technical message types.

Relational (narrative) Model	Conventional (technical) Model
Everyday language	Technical language
Second-person	Third-person
Vividness of description	Precision of description
Personalized	Impersonal
Local/contextual	Universal/general
Cultured, gendered	Neutral, universal

Central processing is the classic cognitive route where a person makes an effort to understand the message, reflect on it, and form a decision based on it. This is the type of processing that occurs when a person receives a storm surge warning and decides whether or not the risk is great enough to warrant evacuating one's family—in other words, the message undergoes high elaboration (associated with explicit decision-making). This type of understanding is thought to incur understanding in the person that lasts and effectively guides decisions. Central processing is most likely to occur when the message recipient has the motivation to consider the message and has the ability to process it. When the person is little motivated or unable to take in the message, then cognition proceeds by a second route, peripheral processing, wherein the person is influenced through an affective or heuristic mechanism. In these peripheral processes, it is the indirect emotional or perceptual effect of a message that can, tangentially, influence behavior.

How can we increase the likelihood that a person actively processes a message (i.e., receives it through the central route)? According to ELM theory, motivation is strongly related to self-relevance (i.e., the recipient interprets the message as being directly relevant to self and one's own situation). Closely related to this is the consequentiality of the message (i.e., the recipient understands that the potential consequences of an event or action is great enough to warrant serious consideration). But the person needs the ability or relevant competence to interpret the message or, conversely, the message has to fit the person's interpretive competencies. These three factors—self-relevance, consequentiality, and ability—can be used to increase the degree to which a message is understood and actively processed (Petty and Cacioppo 1986).

Self-relevance may be increased by contextuality, where a message clearly speaks to the person's immediate situation or place; this, in turn, can be increased by framing the message in local terms, addressing it to the recipients directly, or providing relevant information that the recipient can use to recognize that conditions

being described are similar to what one experiences. This is related to the level of specificity of the message (e.g., Zimmerman et al. 2010. Diller and Hisler found message effectiveness to be higher when delivered in first person voice rather than third person—what they refer to as experiential processing (Dillard and Hisler 2015). Consequentiality is increased when the message spells out what the consequences can be in specific terms and links these to actions that can be taken by the recipient. This relates to how explicit and realistic descriptions of consequences are. Ability can be enhanced through ongoing efforts at public education and, at the same time, framing messages so that they can easily be understood by recipients who are not technically trained.

The relational theory constructed herein, while distinct from ELM theory, echoes some of the latter's insights regarding enhanced message reception when the message is personalized and contextualized, thus increasing relevance.

3) NARRATIVE TRANSPORTATION

Transportation theory arose in response to ELM's dual-process model. The dual process model posits that messages take effect either because recipients actively process the information or are indirectly and precognitively influenced by them. Narrative transportation theorists contend that a third route is possible: one in which the recipient imagines herself or himself to be in the situation depicted by the message. This, in turn, makes the situation more real and relevant to the recipient, increasing the message's effect. In this theory, the vividness and plausibility of the narrative or story being communicated is key (Green and Brock 2000).

Transportation theory has implications for risk communication. Specifically, if the message can take on a more storylike structure, be more vivid and realistic, and be compelling as a story, then it stands a better chance of affecting behavior of the recipient. Transportation theory points to vividness and realism of the story as important determinants of effectiveness. Story appraisal theory emphasizes related properties, such as the degree to which the story has a point, is credible, and is generalizable to the rest of society, as more likely to lead the recipient to consider its implications (Berger et al. 2016). Note, however, other theories that discuss how vividness matters for reasons other than transportation effect, such as that of Anand and Sternthal (1987), who propose a resource matching theory (e.g., when the recipient expends little resource, such as time, to interpretation, vivid messages are easier to comprehend).

There are clear overlaps between theories. Self-relevance, as in the ELM theory, is closely intertwined with the vividness and credibility of the scenario or situation being framed by the message. Source credibility and social identity is intertwined with the degree to which the recipient identifies with the messenger, which in turn is related to the qualities of the narrative (Moyer-Gusé 2008).

Clearly, there are limitations to how much risk communication can be cast in the form of narrative. Agency memos may need to be brief and, moreover, may not be able to work explicit stories into their text without sacrificing some of the authoritativeness and technical accuracy expected of official communication. Part of this stems from the differences attributed to stories (which are considered anecdotal) and data (which are considered factual). On the other hand, this raises possibilities of multiple avenues for risk communication, apart from singular official memos and bulletins: examples can be less formal information campaigns or informal blogs or texts that can be spread by word of mouth or texting. The discussion on trust, empathy, and familiarity, below, provides further justification for designing alternative routes of communication.

Our theory echoes a key insight from transportation theory that the message is more narrative-like when it is conveyed in easily understandable language and describes the situation in vivid terms.

4) EMPATHY AND TRUST

Much work has been done, in different domains of research, in how messages can effect cooperation on the part of the recipient. Beyond the formal, ostensible information being conveyed, it is evident that there is important, tacit knowledge that needs to also be transmitted. This tacit knowledge has to do with the recipient understanding that the message is meaningful to her or him and that both messenger and message are to be trusted. Trust, in turn, is sometimes categorized in two different forms: cognitive trust, meaning belief that the source of the message and source are credible, and emotional trust, which is an affective disposition that the messenger is benevolent and sincere (McKnight et al. 1998). This is echoed by research on the "availability" and "affective" heuristics (Tversky and Kahneman 1974; Slovic et al. 2004).

The cognitive basis of trust can be satisfied when the messenger, a government agency for example, is considered technically authoritative and dependable—this is the basic assumption of the theory of reasoned action (Fishbein and Ajzen 1975). However, emotional trust can be missing when the messenger is an impersonal, distant body. To some extent, this type of trust is related

to the characteristic of empathy, or the ability of the recipient of the message to understand and feel what the messenger is conveying. Part of the research on empathy is echoed by the work, discussed above, on transportation; that is, when the message is realistically and vividly conveyed, this can increase empathy on the part of the recipient (Hoffman 2001) or perspective-taking (Batson 2014), either of which can elicit the desired reaction to the message.

The persuasiveness of the message can be affected by the degree to which the recipient identifies with the messenger, which can be related to belonging to the same group, as suggested by social identity theory (McGarty et al. 1994; also Tajfel and Turner 1986), or through similarity (Byrne 1997). Empathy and trust can increase with familiarity with the messenger—whether this involves direct relationship with the latter (Krebs 1970; May 1987) or affiliation of messenger and recipient with the same social group (Barr 1999). The implication for risk communication is that people may be positively influenced when receiving a message directly from a relative, friend, or neighbor from that person's same social group. This is at odds with formal communication from government agencies, which usually display two relevant characteristics: impersonality, which conflicts with the idea that the message be from someone in the recipient's social group of personal social network, and its technical nature, which conflicts with the language used in everyday, interpersonal communication.

Similar to the effect of identification with the source, message effectiveness can increase with identification of the recipient with the story. That is, when the message conjures up memories or thoughts about one's own experience and history, it triggers emotions that can heighten the impact of the message (Dunlop Wakefield and Kashima 2008). In general, emotion-inducing messages tend to be better recalled, as found in the fields of marketing (Escalas et al. 2004; Lang et al. 1995) and health communication (Biener et al. 2006; Dillard and Peck 2000; Pechmann and Reibling 2006).

A particularly interesting possibility is the effect of receiving messages from one's peers. Some research suggests that messages from peers can score higher on quality and likeability than messages from other sources (Sundar and Nass 2001; Walther et al. 2010).

This suggests various avenues for investigation. One is the possibility of having the message be conveyed by a specific authority figure known to the recipient or from an organization directly related to the recipient. Another possibility is to have messages sent through nonofficial channels. The latter can take the form of informal or SMS messages that can then be passed on from person to person within a social network. This can be done through digital media or phone, which preserves the aspect of familiarity. However, some research suggests that it can even be more effective when conveyed directly in face-to-face mode, since direct contact allows facial or bodily cues to facilitate emotional empathy (Iacoboni 2007). The implication is the need for at least some messages to be put in everyday language that can be spread informally from person to person.

Our relational model captures some of the above insights on trust, particularly the idea that communication from a known other, in language simulating direct conversation, increases the level of trust on the part of the recipient. What is unique to our model, which the above models do not feature, is the construction of an idealized communication situation in the form of direct face-to-face conversation.

c. Testing the model

The relational model of risk communication was tested through a survey of Tacloban City residents who chose not to evacuate during Typhoon Haiyan, inquiring into whether a more personalized, contextualized message would be more effective than a technical bulletin. This target audience was chosen as being the subgroup of the local population that was unwilling to evacuate during the typhoon. The survey also explored reasons behind the choice not to evacuate during the typhoon. It is hoped that this and succeeding research can identify improvements to the risk communication process that might be more effective in motivating hitherto resistant population subgroups to act on the hazard warnings.

3. Materials and methods

The research protocol was approved by the university Institutional Review Board, and written informed consent was obtained from the human subjects. Two versions of storm surge warning messages were tested on a sample of 90 Tacloban City residents who chose not to evacuate during Typhoon Haiyan, this population presumably representing those who are most resistant to risk communication. The main hypothesis is that message (e.g., hazard warning) texts that have a narrative form, as opposed to a technical bulletin format, will be more self-relevant, vivid, and authoritative to recipients and thus can have a greater effect on risk avoidance.

Note that the survey design would be effective regardless of the level of stress experienced by interviewees during Haiyan; that is, the hypothesis still holds
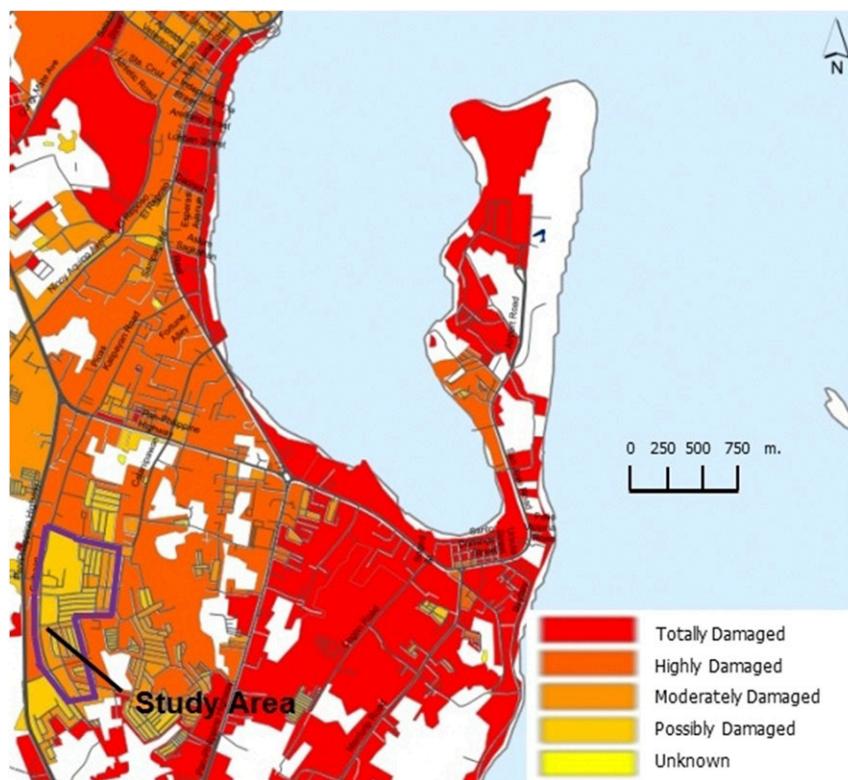
FIG. 2. Typhoon Haiyan impact zone and survey area.

that the narrative message would elicit better responses than the default message, so long as survey respondents were all reasonably similarly affected by the typhoon. The filter questions (described below) introduce this level of similarity. There was a desire to avoid highly traumatized interviewees because their responses might automatically register the maximum willingness to evacuate, regardless of message type (which means there will be less chance of detecting differences between test and control). There is also the possibility that traumatized persons may exhibit the opposite behavior, namely that they may "freeze" and be unable to act (Schmidt et al. 2008). In either case, the best recourse is to try and avoid including highly traumatized individuals in the survey. So then, avoiding traumatized interviewees increases the chance that we see differences in response across message types, and the filter questions also help in this regard.

In recruiting subjects, the researchers used filter questions that screened out Tacloban residents who had lost members of immediate family or close friends during the typhoon, had more than minimal damage to their homes, were victimized by looting, or witnessed the storm surge engulf their immediate

vicinity. As shown in Fig. 2, the interviewees were all selected from two adjacent districts (called barangays), 109 and 109-A, in Tacloban City that were not inundated by the flood water and saw minimal damage during Haiyan.[4]

a. Test design

The hypothesis was tested by having half of the respondents (group A, $n = 45$) read one version of a message (a narrative addressing the recipient directly) and the other half (group B, $n = 45$) an alternative version (a technical bulletin). The narrative message emulates characteristics of direct face-to-face communication, where the sender is a person known to the receiver, and the message directly addresses the receiver's situation. Informational content was kept the same across the two messages. English translations of messages A and B are shown below (the original messages were in the local dialect, Waray, spoken in Tacloban City).

---

[4] Note, too, the eyewitness account of one of the coauthors who lived in this district to the effect that there was little to no flooding and damage in that area.

MESSAGE A (NARRATIVE DESIGN)

To residents of Barangay Pablo,

According to PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration), our barangay may experience a storm surge of 1 ft (up to your knees) tomorrow. You and your family may be in danger. You may be swept by the water, even if low, and carried away. You or your family can be hurt or even drown as the fast-moving water hits. Please evacuate immediately. Call me should you need assistance.

Your tanod (captain) and PAGASA liaison,

Mariano Loreto.

MESSAGE B (TECHNICAL BULLETIN DESIGN)

PAGASA forecast: 1 ft storm surge by tomorrow.

Risk: Possible danger as this level of surge can sweep people away.

Hazard: Possible injuries from trauma or drowning from flood.

Recommendation: Evacuation of residents in affected area.

As seen above, message A better approximates the idealized communication situation since it is written as a direct message from a specific person, addressed in second-person to the recipient, and told in a more story-like manner using everyday language.

b. Recruitment of subjects

The respondents were selected from two adjacent local districts (referred to as barangays), Barangay 109 and Barangay 109-A, in Tacloban City, Leyte, Philippines. The participants were married women who did not evacuate during Typhoon Haiyan, with no immediate family members who were hurt during the typhoon, and with houses undamaged or only slightly damaged during the typhoon. These characteristics of the research locale and the participants were considered necessary to remove possible bias and to exclude sensitized respondents in relation to occurrence of storm surge. The intent was to recruit subjects who were unwilling to follow evacuation advisories (and, presumably, those for whom an improved message design might show the greatest difference). Only females were recruited to reduce confounding effects due to the fact that, as informants shared with the project team, in many cases female heads of households were the ones who attended to seeking shelter in the evacuation centers while the male heads of households monitored conditions around the home.

These barangays were not heavily affected by the onslaught of Typhoon Haiyan in 8 November 2013 and so respondents are thought to be less traumatized by the experience than in other barangays.

The decision to limit the survey to female heads of households was mainly to reduce confounders and variability in the sample. But there is, additionally, ample reason to focus on this subgroup. Traditional, cultural norms in the Philippines have long given the female head of household a primary decision-making role in domestic affairs (Rodell 2002, p. 131). For example, one traditional norm is that of a male breadwinner turning over his income to his wife, who would then make decisions over spending for the family. Results from a recent survey showed that the proportion of households where the female had control over the male's earnings to be about 4 times that where men had control (Castro 2014). And, so, there are reasons to believe that the female head of household would have much say have over how and when to take the family to the evacuation center.

Subjects were randomly assigned to either group A (who were provided the narrative message) or group B (who were provided the default technical bulletin). Written informed consent was obtained from each subject.

c. Data collection

The researchers trained two barangay health workers (BHWs) to assist in the data collection, as these persons have access to and are trusted in the community. The research team was comprised of three of the coauthors plus two BHWs.

The study area was divided into zones, and stratified random sampling was done within each zone, where streets were randomly chosen (along which survey respondents would be recruited). On the chosen streets, each home was approached and survey respondents recruited, and willing participants were alternately assigned to group A (narrative message group) and group B (default message group). As shown in Fig. 2, all the homes in the study community are at least 1.5 km from the coast, and the survey was done in a district that lay outside the areas damaged by floodwater.

The interviewers randomly visited households from the two barangays and interviewed one woman from each household that satisfied the inclusion criteria. Each of the participants were randomly assigned to groups A and B. Participants in group A were asked to read a hypothetical warning message about the occurrence of storm surge using a narrative format while those in group B received the same warning message but phrased using a technical bulletin format. Participants were then asked questions about the likelihood of

evacuating, self-relevance, vividness, trust of the sender, and authority of the sender of the message. The participants rated these five aspects of the message on a Likert scale (1 to 7). They were also asked to answer questions about reasons for not evacuating during Typhoon Haiyan, and to locate their houses in a flood risk hazard map and likewise interpret the said map. Respondents filled out paper questionnaires with the researchers on hand to clarify any questions they had.

d. Questionnaire

The questionnaire can be found online at https://www.environmental-communication.space/download. The most important aspect of the survey was the comparison of willingness to evacuate between a group that received a narrative-like message (group A) and a group that received a standard technical bulletin (group B).

Messages A and B were designed to maintain the same informational content in either case. Message A was designed to resemble actual narrative (which, in the idealized condition, is that of a person talking directly to another); for example, it is written in a second-person point of view. Message B was written to resemble a technical bulletin with language as might be found in an agency weather circular. The questionnaire was written in the vernacular, Waray, and the researchers were all conversant in this language.

The survey instrument provided a menu of possible reasons for not evacuating during Typhoon Haiyan, which respondents rated. The questionnaire allowed for responses outside the menu of options. Last, respondents were provided a storm surge inundation map and asked whether they could locate their homes on the map and interpret the map properly.

e. Data analysis

Groups A and B were compared based on their responses with respect to the likelihood of evacuating, self-relevance, vividness, trust of the sender, and authority of the sender of the message, which were measured on a Likert scale. A one-tailed Mann–Whitney U test was used to assess the significance of differences in responses between groups A and B, on these five aspects of the message. R statistical software was used in the data analysis.

4. Results and discussion

Study results are shown in the following tables. As shown in Table 2, no significant differences were found in the composition of group A versus group B.

As shown in Table 3, responses to varying storm surge messages indicate a statistically higher positive response, in terms of willingness to evacuate, in group A compared to group B (a mean of 5.156 versus 3.711, measured on a Likert scale of 1 to 7). Message A rated significantly higher than message B in self-relevance, vividness, and authority (but not significantly so for trust). In other words, the narrative-based message seemed to be more effective, along several dimensions, than the conventional technical bulletin.

Referring to Table 3, the narrative message rated more highly than the technical bulletin in terms of intent to evacuate, self-relevance and vividness of message, and perceived authority of the messenger. This supports the relational model of risk communication proposed herein. There were no statistically different outcomes between the two messages in terms of perceived trust. One can only speculate as to the latter result, but it is possible that trust rises only when the recipient recognizes the messenger's name.

The questionnaire also inquired into respondents' reasons for not evacuating during Typhoon Haiyan. The responses are shown in Table 4. The first observation is that many of the possible reasons were rated highly (around or above 3.0 on a Likert scale of 1 to 4); that is, multiple factors dissuaded residents from following evacuation advisories. Moreover, it appears that the majority of respondents did hear or read about the storm surge warning but were unclear about what a storm surge was or how severe it would be, suggesting problems with message design. The results shown in Table 4 suggest that multiple reasons hindered member of the public from moving to the evacuation center. This has implications for disaster risk prevention and local governments, as they indicate needed improvements policing communities and the quality of the evacuation centers. To some extent, some of these factors can be addressed in message design (e.g., informing the public about policing and evacuation center conditions).

The most highly rated reasons are (in order of highest to lowest):

(i) a feeling that their home was the safest place to be,
(ii) the fear of burglary in the home while away at the evacuation center,
(iii) significant underestimation of the risk from the storm surge,
(iv) negative perception of the evacuation center, and
(v) uncertainty over what a storm surge is.

5. Conclusions

For many of the communities that will be struck by devastating storm surge, this event will be something local residents and agency staff will have never

TABLE 2. Characteristics of respondents (s.d. = standard deviation).

Characteristic	Group A No.	Group A %	Group B No.	Group B %	Total No.	Total %	Test statistic p value
Age (years)							
(mean ± s.d.)	(56.1 ± 15.5)		(53.1 ± 15.9)		(54.6 ± 15.7)		
21–30	2	4.44	5	11.1	7	7.8	0.906[a]
31–40	9	20.0	6	13.3	15	16.7	0.368
41–50	6	13.3	5	11.1	11	12.2	
51–60	6	13.3	11	24.4	17	18.9	
60 and above	22	48.9	18	40.0	40	44.4	
Number of children							
(mean ± s.d.)	(3.36 ± 2.2)		(3.44 ± 2.1)		(3.40 ± 2.1)		
0	0	0.0	2	4.4	2	2.2	−0.198[a]
1–3	29	64.4	27	60.0	56	62.2	0.844
4–6	11	24.4	12	26.7	23	25.6	
7–9	5	11.1	4	8.9	9	10.0	
Education							
Elementary level/graduate	1	2.2	2	4.4	3	3.3	3.843[b,c,d]
Secondary level/graduate	4	8.9	10	22.2	14	15.6	0.146
College level/graduate	29	64.4	22	48.9	51	56.7	
Graduate level or higher	11	24.4	11	24.4	22	24.4	
Income (in Philippine pesos)							
No answer	4	8.9	3	6.7	7	7.8	5.851[b,d]
Less than 5000	9	20.0	16	35.6	25	27.8	0.211
6000–10,000	6	13.3	7	15.6	13	14.4	
11,000–15,000	8	17.8	4	8.9	12	13.3	
16,000–20,000	5	11.1	8	17.8	13	14.4	
21,000 and above	13	28.9	7	15.6	20	22.2	
Employment							
No answer	2	4.4	2	4.4	4	4.4	0.069[b,d]
Housewife	15	33.3	16	35.5	31	34.4	0.995
Self-employed	5	11.1	5	11.1	10	11.1	
Government/private employee	9	20.0	9	20.0	18	20.0	
Retired employee	14	31.1	13	28.9	27	30.0	

[a] Two-sample t test.
[b] Chi-square test.
[c] Elementary/secondary level/graduate combined because of very low frequencies.
[d] "No answer" category not included in computation.

experienced before. The crucial task is how to prepare the public and emergency responders for an event that lies outside their realm of experience. Adapting to a changing climate will require new strategies for communicating the unfamiliar.

The outcomes of this exploratory research are encouraging in the sense that message design may make a difference in eliciting appropriate responses by the public. An important part of the study design was selecting a target audience that was most resistant to such messages. Test results suggest that a contextualized, personalized, narrative-like message can be more effective than the conventional technical bulletin. We generalize this into what we refer to as the *relational model of risk communication*.

This model depicts a number of observations made by researchers. For example, one study found risk

communication through TV and radio to be more effective than SMS texts (Bean et al. 2014). This would be consistent with the model shown in Fig. 1, where seeing or just hearing the messenger approximates the ideal communication condition more than written text. Suggestions by researchers regarding greater personalization and contextualization of hazard warning messages (e.g., Morrow et al. 2015) are consistent with this model, as well. There is evidence that messages that are more narrative-like are easier to diffuse through a network, whether by word of mouth, social media, or other means (Stein et al. 2010).

The exploratory research described herein provides several promising directions for risk communication practice, including improving message design and increasing interactivity (Moser 2010; USDHS 2016), such as using social media, for risk

TABLE 3. Distribution of responses, storm surge message (group A: $n = 45$, group B: $n = 45$). The p value is for a right-tailed Mann Whitney U test. Asterisks (*) indicate a significance threshold of $p = 0.05$.

Survey item	1	2	3	4	5	6	7	Mean	U	Z	p
III.1 Likelihood of evacuating											
Group A	4	2	3	1	9	16	10	5.156	1443	3.5231	0.0002*
Group B	9	7	2	11	7	4	5	3.711			
III.2 Self-relevance											
Group A	2	0	0	6	7	16	14	5.667	1312	2.7074	0.0032*
Group B	1	7	3	12	4	7	10	4.636			
III.3 Vividness											
Group A	2	0	2	6	7	15	13	5.511	1261	2.0457	0.02*
Group B	5	1	5	11	6	5	12	4.667			
III.4 Trust											
Group A	1	2	0	6	11	13	12	5.467	1038	0.2116	0.4173
Group B	2	2	1	9	7	9	15	5.311			
III.5 Authority											
Group A	1	1	1	6	12	13	11	5.444	1215	1.6764	0.0466*
Group B	1	1	2	16	9	5	11	5.000			

Rating (1-lowest to 7-highest) spans columns 1–7.

communication. Other important issues revolve around new practices that aid in the areas of building public trust, engaging communities, and addressing scientific uncertainty (Covello and Sandman 2001; Fischhoff and Davis 2014). This is part of a broader thrust to increase the contextuality of policies and programs (Lejano 2006).

Other research directions that should be explored include modes of optimizing formal and nonformal modes of risk communication, integrating improved message design with ongoing educational campaigns around "hazard literacy," and reconciling agency staff's need for technical accuracy in reporting (including reporting uncertainty) with the need to speak in the public's everyday language. Of course, we are cognizant of the fact that risk communication is but one element in a whole suite of practices and measures revolving around emergency preparedness (Leelawat et al. 2015; Otto Mehta and Liu. 2018).

This work is part of a broader agenda that involves *democratizing risk communication*—that is, enabling multiple publics, including the most vulnerable, to

TABLE 4. Survey responses: Reasons for non-evacuation ($n = 90$).

Item	1 Does not apply to you	2 Slightly applies to you	3 Moderately applies to you	4 Strongly applies to you	Mean
I did not hear about or know about the coming flood/or storm surge.	40.0	13.3	25.6	21.1	2.278
I heard about the flood/storm surge but did not think the risk was great.	13.3	15.6	27.8	43.3	3.011
I felt my home was the safest place to be.	6.7	6.7	18.9	67.8	3.478
I did not like to stay at the evacuation center.	16.7	16.7	17.8	46.7	2.966
Storm warnings in the past, before Yolanda, are usually exaggerated, nothing usually happens.	13.3	18.9	33.3	34.4	2.889
I heard about the storm surge but the information was unclear about what a storm surge is.	18.9	12.2	26.7	42.2	2.922
I did not think that the information about the storm surge applies to me or my local area.	15.5	23.3	24.4	36.7	2.822
I was afraid to leave my home because someone may break in and rob us.	23.3	4.4	16.7	55.5	3.044
I was waiting for some official or person I know to inform us [about the storm surge] in person.	43.3	15.6	17.8	22.2	2.191

Response distribution (%) spans columns 1–4.

actively participate in seeking, interpreting, and acting upon knowledge about hazards from extreme events.[5] If there is broad participation among the public in risk communication, then nobody is left out, not even the most vulnerable.[6] Rather than be passive recipients of agency messages, an active citizenry can be empowered to craft and implement risk preventive actions that fit their community. Moreover, many receive information not through official channels but informally, hearing it from family and acquaintances, which means the public needs to be able to understand and communicate knowledge concerning risks.[7]

But, in order to democratize risk communication, knowledge must be conveyed in accessible ways—in particular, in the form of a shareable narrative. In addition to ease of transmission, narrative is also a rich medium by which the speaker can express her own experience of risk (Lejano Tavares-Reager and Berkes 2013; Lejano and Stokols 2018).

One thing is certain: conventional, routine messaging may not suffice vis-à-vis nonroutine, extraordinarily extreme weather events, and adaptation to climate change will require new communication strategies for making the singular and unprecedented comprehensible to millions of people.

---

[5] As an example, resources for risk communication can be found on the project website, which can be accessed at https://environmental-communication.space.

[6] This is borne out of extensive research on processes and pathways that render women in some lower-income communities more vulnerable to extreme weather events; see the Gender Report, which can be accessed as Addendum D at https://www.environmental-communication.space/download.

[7] A survey of access to flood warnings, done in the Philippines, found that the most common source of flood warning information among survey respondents was family and friends through word of mouth, phone call, or Facebook, with government agencies being only the second most common source (Mateo and Oki 2011).

REFERENCES

Anand, P., and B. Sternthal, 1987: Resource matching as an explanation for message persuasion. *Perspectives on the Affective and Cognitive Effects of Advertising*, P. Caferrata and A. M. Tybout, Eds., Lexington Books, 135–159.

Barr, A., 1999: Familiarity and trust: An experimental investigation. CSAE Working Paper Series 1999-23, Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford, 23 pp.

Batson, C. D., 2014: *The Altruism Question: Toward a Social-Psychological Answer*. Psychology Press, 268 pp.

Bean, H., B. Liu, S. Madden, D. Mileti, J. Sutton, and M. Woo, 2014: Comprehensive testing of imminent threat public messages for mobile devices. National Consortium for the Study of Terrorism and Responses to Terrorism, 190 pp.

Berger, C. R., Y. Ha, and M. Chen, 2016: Story appraisal theory: From story kernel appraisals to implications and impact. *Commun. Res.*, https://doi.org/10.1177/0093650216641186.

Betsch, C., C. Ulshöfer, F. Renkewitz, and T. Betsch, 2011: The influence of narrative v. statistical information on perceiving vaccination risks. *Med. Decis. Making*, **31**, 742–753, https://doi.org/10.1177/0272989X11400419.

Biener, L., R. L. Reimer, M. Wakefield, G. Szczypka, N. A. Rigotti, and G. Connolly, 2006: Impact of smoking cessation aids and mass media among recent quitters. *Amer. J. Preventive Med.*, **30**, 217–224, https://doi.org/10.1016/j.amepre.2005.10.026.

Brown, V. J., 2014: Risk perception: It's personal. *Environ. Health Perspect.*, **122**, A276, https://doi.org/10.1289/ehp.122-A276.

Byrne, D., 1997: An overview (and underview) of research and theory within the attraction paradigm. *J. Soc. Pers. Relat.*, **14**, 417–431, https://doi.org/10.1177/0265407597143008.

Cangialosi, J., and J. Franklin, 2017: National Hurricane Center forecast verification report: 2016 hurricane season. U.S. National Oceanic and Atmospheric Agency, 72 pp., https://www.nhc.noaa.gov/verification/verify3.shtml.

Castro, L., 2014: Measuring women's empowerment and women's autonomy in the Philippines. *Fifth Global Forum on Gender Statistics*, Aguascalientes, Mexico, United Nations Statistics Division, https://unstats.un.org/unsd/gender/mexico_nov2014/HighLevelPanel%20Philippines.pdf.

Chen, T.-P., J. Arredy, and J. Hookway, 2013: Typhoon Haiyan: How a catastrophe unfolded. *Wall Street Journal*, 26 November 2013, accessed 16 August 2016, http://www.wsj.com/articles/SB10001424052702304465604579217671422015220.

Clark, H. H., and S. E. Brennan, 1991: Grounding in communication. *Perspectives on Socially Shared Cognition*, L. B. Resnick, J. M. Levine, and S. D. Teasley, Eds., American Psychological Association, 127–149.

Cole, T. W., and K. L. Fellows, 2008: Risk communication failure: A case study of New Orleans and Hurricane Katrina. *South. Commun. J.*, **73**, 211–228, https://doi.org/10.1080/10417940802219702.

Covello, V., and P. M. Sandman, 2001: Risk communication: Evolution and revolution. *Solutions to an Environment in Peril*, A. Wolbarst, Ed., John Hopkins University Press, 164–178.

——, P. Slovic, and D. Von Winterfeldt, 1986: *Risk Communication: A Review of the Literature*. National Emergency Training Center, 12 pp.

Dahlstrom, M. F., 2014: Using narratives and storytelling to communicate science with nonexpert audiences. *Proc. Natl. Acad. Sci. USA*, **111**, 13 614–13 620, https://doi.org/10.1073/pnas.1320645111.

Daniell, J., B. Mühr, T. Girard, A. Dittrich, J. Fohringer, C. Lucas, and T. Kunz-Plapp, 2013: Super Typhoon Haiyan/Yolanda–Report No. 2, Center for Disaster Management and Risk Reduction Technology Forensic Disaster Analysis Group (CEDIM FDA), 25 pp., https://www.cedim.de/download/CEDIM_FDA_Haiyan_Rep2.pdf.

David, C. P. C., B. A. B. Racoma, J. Gonzales, and M. V. Clutario, 2013: A manifestation of climate change? A look at Typhoon Yolanda in relation to the historical tropical cyclone archive. *Sci. Diliman*, **25**, 79–86.

de Sesto, A., I. Valeroso, F. Villareal, and W. Tamayo, 1998: A verification of 1994–1998 tropical cyclone movement forecasts of the PAGASA. PAGASA Natural Disaster and Research Branch, NCRB Tech. Rep. 106, 63 pp., https://www1.pagasa.dost.gov.ph/index.php/17-research-and-development/disaster-causing-phenomena#a-verification-of-1994-1998-tropical-cyclone-movement-forecasts-of-pagasa.

Dillard, A. J., and G. Hisler, 2015: Enhancing the effects of a narrative message through experiential information processing: An experimental study. *Psychol. Health*, **30**, 803–820, https://doi.org/10.1080/08870446.2014.996565.

Dillard, J. P., and E. Peck, 2000: Affect and persuasion: Emotional responses to public service announcements. *Commun. Res.*, **27**, 461–495, https://doi.org/10.1177/009365000027004003.

Dunlop, S., M. Wakefield, and Y. Kashima, 2008: Can you feel it? Negative emotion, risk, and narrative in health communication. *Media Psychol.*, **11**, 52–75, https://doi.org/10.1080/15213260701853112.

Dunning, D., and D. Fetchenhauer, 2010: Trust as an expressive rather than an instrumental act. *Adv. Group Process.*, **27**, 97–127, https://doi.org/10.1108/S0882-6145(2010)0000027007.

Eisenman, D. P., K. M. Cordasco, S. Asch, J. F. Golden, and D. Glik, 2007: Disaster planning and risk communication with vulnerable communities: Lessons from Hurricane Katrina. *Amer. J. Public Health*, **97**, S109–S115, https://doi.org/10.2105/AJPH.2005.084335.

Emanuel, K. A., 2013: Downscaling CMIP5 climate models shows increased tropical cyclone activity over the 21st century. *Proc. Natl. Acad. Sci. USA*, **110**, 12 219–12 224, https://doi.org/10.1073/pnas.1301293110.

Emrich, C. T., and S. L. Cutter, 2011: Social vulnerability to climate-sensitive hazards in the southern United States. *Wea. Climate Soc.*, **3**, 193–208, https://doi.org/10.1175/2011WCAS1092.1.

Engdahl, E., and R. Lidskog, 2014: Risk, communication and trust: Towards an emotional understanding of trust. *Public Understanding Sci.*, **23**, 703–717, https://doi.org/10.1177/0963662512460953.

Escalas, J. E., M. C. Moore, and J. E. Britton, 2004: Fishing for feelings? Hooking viewers helps! *J. Consum. Psychol.*, **14**, 105–114, https://doi.org/10.1207/s15327663jcp1401&2_12.

Fischhoff, B., and A. L. Davis, 2014: Communicating scientific uncertainty. *Proc. Natl. Acad. Sci. USA*, **111** (Suppl. 4), 13 664–13 671, https://doi.org/10.1073/pnas.1317504111.

Fishbein, M., and I. Ajzen, 1975: *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research.* Addison-Wesley, xxx pp.

Flores, H., 2013: PAGASA gives up hope for missing member. PhilStar.com, 12 December 2013, accessed 25 October 2014, http://www.philstar.com/headlines/2013/12/12/1267111/pagasa-gives-hope-missing-member.

Green, M. C., and T. C. Brock, 2000: The role of transportation in the persuasiveness of public narratives. *J. Pers. Soc. Psychol.*, **79**, 701–721, https://doi.org/10.1037/0022-3514.79.5.701.

Grinsted, A., J. C. Moore, and S. Jevrejeva, 2013: Projected Atlantic hurricane surge threat from rising temperatures. *Proc. Natl. Acad. Sci. USA*, **110**, 5369–5373, https://doi.org/10.1073/pnas.1209980110.

Grossmann, I., and M. G. Morgan, 2011: Tropical cyclones, climate change, and scientific uncertainty: What do we know, what does it mean, and what should be done? *Climatic Change*, **108**, 543–579, https://doi.org/10.1007/s10584-011-0020-1.

Han, B., and E. L. Fink, 2012: How do statistical and narrative evidence affect persuasion?: The role of evidentiary features. *Argumentation Advocacy*, **49**, 39–59, https://doi.org/10.1080/00028533.2012.11821779.

Hoffman, M. L., 2001: *Empathy and Moral Development: Implications for Caring and Justice.* Cambridge University Press, 342 pp.

Iacoboni, M., 2007: Face to face: The neural basis of social mirroring and empathy. *Psychiatr. Ann.*, **37**, 236–241.

Kasperson, R., 2014: Four questions for risk communication. *J. Risk Res.*, **17**, 1233–1239, https://doi.org/10.1080/13669877.2014.900207.

——, O. Renn, P. Slovic, H. S. Brown, J. Emel, R. Goble, J. X. Kasperson, and S. Ratick, 1988: The social amplification of risk: A conceptual framework. *Risk Anal.*, **8**, 177–187, https://doi.org/10.1111/j.1539-6924.1988.tb01168.x.

Krebs, D. L., 1970: Altruism: An examination of the concept and a review of the literature. *Psychol. Bull.*, **73**, 258–302, https://doi.org/10.1037/h0028987.

Lagmay, A. M. F., and Coauthors, 2015: Devastating storm surges of Typhoon Haiyan. *Int. J. Disaster Risk Reduct.*, **11**, 1–12, https://doi.org/10.1016/j.ijdrr.2014.10.006.

Lang, A., K. Dhillon, and Q. Dong, 1995: The effects of emotional arousal and valence on television viewers' cognitive capacity and memory. *J. Broadcast. Electron. Media*, **39**, 313–327, https://doi.org/10.1080/08838159509364309.

Leelawat, N., A. Suppasri, S. Kure, C. J. Yi, C. M. R. Mateo, and F. Imamura, 2015: Disaster warning system in the Philippines through enterprise engineering perspective: A study on the 2013 Super Typhoon Haiyan. *J. Disaster Res.*, **10**, 1041–1050, https://doi.org/10.20965/jdr.2015.p1041.

Leiserowitz, A., 2006: Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, **77**, 45–72, https://doi.org/10.1007/s10584-006-9059-9.

Lejano, R. P., 2006: *Frameworks for Policy Analysis: Merging Text and Context.* Routledge, 269 pp.

——, and D. Stokols, 2018: Analytics for local knowledge: Exploring a community's experience of risk. *J. Risk Res.*, in press.

——, J. Tavares-Reager, and F. Berkes, 2013: Climate and narrative: Environmental knowledge in everyday life. *Environ. Sci. Policy*, **31**, 61–70, https://doi.org/10.1016/j.envsci.2013.02.009.

——, J. M. Tan, and A. M. W. Wilson, 2016: A textual processing model of risk communication: Lessons from Typhoon Haiyan. *Wea. Climate Soc.*, **8**, 447–463, https://doi.org/10.1175/WCAS-D-16-0023.1.

Manuel, J., 2014: Crisis and emergency risk communication: Lessons from the Elk River spill. *Environ. Health Perspect.*, **122**, A214–A219, https://doi.org/10.1289/ehp.122-A214.

Marris, E., 2005: Inadequate warning system left Asia at the mercy of tsunami. *Nature*, **433**, 3–5, https://doi.org/10.1038/433003a.

Marx, S. M., E. U. Weber, B. S. Orlove, A. Leiserowitz, D. H. Krantz, C. Roncoli, and J. Phillips., 2007: Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Global Environ. Change*, **17**, 47–58, https://doi.org/10.1016/j.gloenvcha.2006.10.004.

Mas, E., J. Bricker, S. Kure, B. Adriano, C. Yi, A. Suppasri, and S. Koshimura, 2015: Field survey report and satellite image interpretation of the 2013 Super Typhoon Haiyan in the Philippines. *Nat. Hazards Earth Syst. Sci.*, **15**, 805–816, https://doi.org/10.5194/nhess-15-805-2015.

Mateo, C. M. R., and T. Oki, 2011: Filipinos' perception about flood warning systems and their behavior. *Proc. Ninth Intl. Symp. on Southeast Asian Water Environment*, Bangkok, Thailand, Southeast Asian Center for Water Environment Technology, 2 pp., https://www.researchgate.net/publication/236960885_Filipinos%27_Perception_About_Flood_Warning_Systems_and_Their_Behavior_Towards_Early_Evacuation.

May, R. M., 1987: More evolution of cooperation. *Nature*, **327**, 15–17, https://doi.org/10.1038/327015a0.

McGarty, C., A. Haslam, K. Hutchinson, and J. Turner, 1994: The effects of salient group membership on persuasion. *Small Group Res.*, **25**, 267–293, https://doi.org/10.1177/1046496494252007.

McKnight, D. H., L. L. Cummings, and N. L. Chervany, 1998: Initial trust formation in new organizational relationships. *Acad. Manage. Rev.*, **23**, 473–490, https://doi.org/10.5465/amr.1998.926622.

Meredith, L. S., and Coauthors, 2009: Analysis of risk communication strategies and approaches with at-risk populations to enhance emergency preparedness, response, and recovery. U.S. Department of Health and Human Services, 48 pp., https://aspe.hhs.gov/report/analysis-risk-communication-strategies-and-approaches-risk-populations-enhance-emergency-preparedness-response-and-recovery-final-report.

Morgan, M. G., B. Fischhoff, A. Bostrom, and C. J. Atman, 2002: *Risk Communication: A Mental Models Approach.* Cambridge University Press, 351 pp.

Mori, N., M. Kato, S. Kim, H. Mase, Y. Shibutani, T. Takemi, K. Tsuboki, and T. Yasuda, 2014: Local amplification of storm surge by Super Typhoon Haiyan in Leyte Gulf. *Geophys. Res. Lett.*, **41**, 5106–5113, https://doi.org/10.1002/2014GL060689.

Morrow, B. H., and L. Nadeau, 2012: National Weather Service warning coordination meteorologists survey; Survey of tropical and extratropical cyclone forecast products. NOAA Eastern Research Group, 33 pp., https://www.academia.edu/4314855/National_Weather_Service_Warning_Coordination_Meteorologists_Survey_of_Tropical_and_Extratropical_Cyclone_Forecast_Products.

——, J. K. Lazo, J. Rhome, and J. Feyen, 2015: Improving storm surge risk communication: Stakeholder perspectives. *Bull. Amer. Meteor. Soc.*, **96**, 35–48, https://doi.org/10.1175/BAMS-D-13-00197.1.

Moser, S. C., 2010: Communicating climate change: History, challenges, process and future directions. *Wiley Interdiscip. Rev.: Climate Change*, **1**, 31–53, https://doi.org/10.1002/wcc.11.

——, and M. T. Boykoff, 2013: *Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World.* Routledge, 336 pp.

Moyer-Gusé, E., 2008: Toward a theory of entertainment persuasion: Explaining the persuasive effects of entertainment-education messages. *Commun. Theory*, **18**, 407–425, https://doi.org/10.1111/j.1468-2885.2008.00328.x.

NDRRMC, 2014: NDRRMC update: Update on effects of Typhoon "YOLANDA" (HAIYAN): 17 April 2014. National Disaster Risk Reduction and Management Council, 2 pp., http://www.ndrrmc.gov.ph/attachments/article/1329/Update_on_Effects_Typhoon_YOLANDA_(Haiyan)_17APR2014.pdf.

Neussner, O., 2014: Assessment of early warning efforts in Leyte for Typhoon Haiyan/Yolanda. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 64 pp., https://www.preventionweb.net/publications/view/36860.

Normile, D., 2014: After the deluge. *Science*, **344**, 355–357, https://doi.org/10.1126/science.344.6182.355.

Otto, P., A. Mehta, and B. Liu, 2018: Mind the gap: Towards and beyond impact to enhance tropical cyclone risk communication. *Trop. Cyclone Res. Rev.*, **7**, 140–151, https://doi.org/10.6057/2018TCRR02.05.

Pechmann, C., and E. T. Reibling, 2006: Antismoking advertisements for youths: An independent evaluation of health, counter-industry, and industry approaches. *Amer. J. Public Health*, **96**, 906–913, https://doi.org/10.2105/AJPH.2004.057273.

Petty, R. E., and J. T. Cacioppo, 1984: Source factors and the elaboration likelihood model of persuasion. *Adv. Consum. Res.*, **11**, 668–672.

——, and ——, 1986: *Communication and Persuasion: Central and Peripheral Routes to Attitude Change.* Springer, 262 pp.

Rasquinho, O., 2014: Lessons learnt from Haiyan/Yolanda. *Training Workshop on Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Early Warning System*, Nanjing, China, WMO, 28 pp., accessed 15 April 2018, https://www.slideserve.com/tate-wheeler/olavo-rasquinho-sec-of-typhoon-committee-on-behalf-of-mr-james-weyman.

Ripberger, J., C. Silva, H. Jenkins-Smith, and M. James, 2015: The influence of consequence-based messages on public responses to tornado warnings. *Bull. Amer. Meteor. Soc.*, **96**, 577–590, https://doi.org/10.1175/BAMS-D-13-00213.1.

Rodell, P. A., 2002: *Culture and Customs of the Philippines.* Greenwood Publishing Group, 247 pp.

Santos, R., 2014: ''PAGASA is more accurate than US, Japan and other agencies''—DOST chief. *Kicker Daily News*, 7 December 2014, accessed 3 November 2017, http://kickerdaily.com/posts/2014/12/pagasa-is-more-accurate-than-us-japan-and-other-agencies-dost-chief/.

Schiermeier, Q., 2013: Did climate change cause Typhoon Haiyan? *Nature*, doi:10.1038/nature.2013.14139.

Schmidt, N. B., J. A. Richey, M. J. Zvolensky, and J. K. Maner, 2008: Exploring human freeze responses to a threat stressor. *J. Behav. Ther. Exp. Psychiatry*, **39**, 292–304, https://doi.org/10.1016/j.jbtep.2007.08.002.

Sharma, U., A. Patwardhan, and A. G. Patt, 2013: Education as a determinant of response to cyclone warnings: Evidence from coastal zones in India. *Ecol. Soc.*, **18**, (18), https://doi.org/10.5751/ES-05439-180218.

Shaw, D., J. Scully, and T. Hart, 2014: The paradox of social resilience: How cognitive strategies and coping mechanisms attenuate and accentuate resilience. *Global Environ. Change*, **25**, 194–203, https://doi.org/10.1016/j.gloenvcha.2014.01.006.

Siegrist, M., and H. Gutscher, 2008: Natural hazards and motivation for mitigation behavior: People cannot predict the affect evoked by a severe flood. *Risk Anal.*, **28**, 771–778, https://doi.org/10.1111/j.1539-6924.2008.01049.x.

Slovic, P., M. L. Finucane, E. Peters, and D. G. MacGregor, 2004: Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Anal.*, **24**, 311–322, https://doi.org/10.1111/j.0272-4332.2004.00433.x.

Soria, J. L. A., and Coauthors, 2016: Repeat storm surge disasters of Typhoon Haiyan and its 1897 predecessor in the Philippines. *Bull. Amer. Meteor. Soc.*, **97**, 31–48, https://doi.org/10.1175/BAMS-D-14-00245.1.

Stein, R. M., L. Dueñas-Osorio, and D. Subramanian, 2010: Who evacuates when hurricanes approach? The role of risk,

information, and location. *Soc. Sci. Quart.*, **91**, 816–834, https://doi.org/10.1111/j.1540-6237.2010.00721.x.

Sundar, S. S., and C. Nass, 2001: Conceptualizing sources in online news. *J. Commun.*, **51**, 52–72, doi:10.1111/j.1460-2466.2001.tb02872.x.

Tajfel, H., and J. C. Turner, 1986: The social identity theory of intergroup behavior. *The Psychology of Intergroup Relations*, S. Worchel and W. G. Austin, Eds., Nelson-Hall, 7–24.

Takagi, H., and M. Esteban, 2016: Statistics of tropical cyclone landfalls in the Philippines: Unusual characteristics of 2013 Typhoon Haiyan. *Nat. Hazards*, **80**, 211–222, https://doi.org/10.1007/s11069-015-1965-6.

Tversky, A., and D. Kahneman, 1974: Judgment under uncertainty: Heuristics and biases. *Science*, **185**, 1124–1131, https://doi.org/10.1126/science.185.4157.1124.

Twyman, M., N. Harvey, and C. Harries, 2008: Trust in motives, trust in competence: Separate factors determining the effectiveness of risk communication. *Judgments Decis. Making*, **3**, 111–120.

USAID, 2017: Project Yolk 3: A customer satisfaction survey on PAGASA weather & climate information in Be Secure's project areas, January 20, 2017. U.S. Agency for International Development, 66 pp., https://pdf.usaid.gov/pdf_docs/PA00MM1Q.pdf.

USDHS, 2016: Final Report: An Integrated Approach to Geo-Target At-Risk Communities and Deploy Effective Crisis Communication Approaches. United States Department of Homeland Security, 91 pp.

Vasileiadou, E., and W. J. W. Botzen, 2014: Communicating adaptation with emotions: The role of intense experiences in raising concern about extreme weather. *Ecol. Soc.*, **19** (36), https://doi.org/10.5751/ES-06474-190236.

Walther, J. B., D. DeAndrea, J. Kim, and J. C. Anthony, 2010: The influence of online comments on perceptions of antimarijuana public service announcements on YouTube. *Human Commun. Res.*, **36**, 469–492, https://doi.org/10.1111/j.1468-2958.2010.01384.x.

Zimmerman, R., C. E. Restrepo, A. Culpen, W. E. Remington, A. Kling, I. Portelli, and G. L. Foltin, 2010: Risk communication for catastrophic events: Results from focus groups. *J. Risk Res.*, **13**, 913–935, https://doi.org/10.1080/13669871003782744.