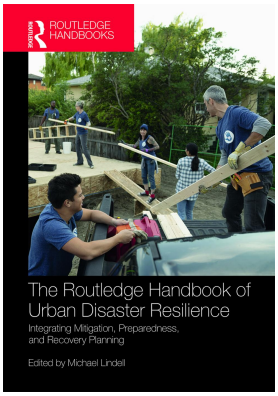

The Routledge Handbook of Urban Disaster Resilience Integrating Mitigation, Preparedness, and Recovery Planning

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Risk Communication

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RISK COMMUNICATION

A Review and Peek Ahead

George Oliver Rogers

Introduction

The risk communication literature is both vast and varied. Although the stated goals of many studies are similar, the approaches vary from focusing on the message, to emphasis on the process and people, to focusing on the organizations doing the communicating. This chapter reviews the risk communication literature and summarizes some of the critical barriers to risk communication in general. It ends by briefly highlighting the daunting challenges posed by climate change.

Risk communication and hazard communication share many aspects of communication, including informing people of potential dangers, predictions of future events, and technical information on how the danger is likely to materialize and what to do about it. Yet they are also distinct in important ways. Hazard communication is communication about well-understood hazards or emergencies, often as they are unfolding. In hazard communication, prior experience is rich with lessons learned from sufficiently frequent occurrences to provide the necessary context for the communication. Prior experience, including outcomes, is often the basis of determining which behaviors are most appropriate under similar circumstances, and may provide touchstones for guiding behavior.

These communications can be, and have been, succinctly adapted to posters to help people respond appropriately in the early phases of emergencies. For example, a poster from the University of California at Irvine campus has entries for evacuations, fire, criminal activity, hazardous materials, earthquakes, medical emergencies, and shooting. The entry for earthquake splits the behaviors into two groups depending on whether the person is in an inside location or an outside location. The poster advises people what actions are possible that can help protect them from harm or injury during the first few moments of the event. It presumes that emergency personnel will be arriving with instructions for later activities that will be of similar quality. These posters, and there seem to be at least a dozen or so examples just for university communities, are posted prior to the event to serve as succinct reminders of potential hazards and appropriate behaviors should one occur. The one described above was posted in a restroom on a "wall of interest" for at least a few moments each day.

Risk communication is communication about risks that are themselves often fraught with uncertainty, complexity, and incompleteness. Not only are the outcomes often difficult to link directly to specific behaviors, actions, and decisions, there is frequently (sometimes considerable) disagreement even among experts about the links between the risks and the outcomes. For example, even in 2014 when more than nine of ten climate scientists agree that human actions are at the root of climate change, there are still many that find climate change a complete hoax foisted upon the public by

proponents of increased government involvement and spending. Similar to so many public health risks, climate change has been subject to bias, including selective reporting by the media, imperfect human information processing, and subjective human decisions required to communicate these complex, multi-faceted problems with uncertain outcomes. For example, nuclear power proponents thought it would be sufficient to communicate the official estimate of the risk of death among the public (2×10^{-6}, or about 2 chances in a million over a lifetime) and compare it to other risks people routinely accept at those levels, like death in a commercial airline crash (in the 1×10^{-5} range) or an automobile accident (in the 1×10^{-4} range, with about 40,000 deaths per year in the US alone). But research soon showed that a variety of other attributes, like dread or common, known or unknown, voluntary or involuntary characteristics of the risks were just as important as risk estimates in producing human response (Slovic et al. 1981). In fact, the research showed that human response was not completely rational in that even risk experts used the bias-inducing cognitive heuristics as laypeople when asked to make risk judgments in areas outside their expertise.

The Goals of Risk Communication

In an effort to help risk communicators learn the art of risk communication without repeating the mistakes of the past, Fischhoff (1995: 138) summarizes the stages of risk communication. His seven stages of risk communication have been widely cited and discussed in the literature, which makes them a "must-read" for any risk communication effort. Abbreviated here for the sake of completeness, the stages suggest that we need to:

- get the numbers right,
- tell the public the numbers,
- explain what the numbers mean,
- show them they accept similar risks,
- show them it's a good deal for them,
- treat them well,
- make them partners.
- all of the above!

These stages range from the public relations of persuasion, to the information transfer of content, to the interpretation of content, to a focus on the process and partnering.

Covello and Sandman (2001: 171–2) summarize the four eras of risk communication. In the first era the strategy was "simply to ignore the public" to the extent possible; protect them certainly, but don't allow them to participate in public policy concerning risk. This was the basic strategy until the mid-1980s when environmental activists began to exert power over environmental policy and, perhaps more importantly, risk communicators found that when these activists were ignored, it exacerbated existing controversies. This gave rise the second era of risk communication, which focused on "how to explain the data better." While risk communicators learned to communicate the risk of small numbers (e.g., parts per billion, deaths per million) in material designed for seventh-to-ninth graders, they also found that the receivers still needed to be motivated to absorb the material. The third era of risk communication was a profound shift in that it addressed public outrage, which in turn required "building a dialogue with the public." To do that the risk communicators found that empathy requires not just awareness of the outrage but recognition that the public was entitled to be outraged—no matter how negligible the risk. But this policy leads to some unsatisfactory situations where, because of the outrage, public funds are used to deal with negligible risks while other more serious concerns are left unaddressed. The fourth era of risk communication came when the

dialogue led to "treating the public as a partner." But this profound change in risk communication has faced significant barriers, including the habit and inertia of old behavior, the propensity of the technical people (who are needed to provide credibility) to fall back on clear boundaries with logical unemotional solutions, and the commitment of some activists to ideological positions that leave little room for compromise.

Chess (2001) points out that the range of choices available to individuals is constrained by organizations. She goes on to place risk communication in the context of the loss of confidence in the chemical industry after the catastrophic Bhopal accident, and a similar release in Institute, West Virginia, in 1985. Even though the Chemical Manufacturers Association implemented the Community Awareness and Emergency Response Program on a voluntary basis, Congress passed the Emergency Planning and Community Right to Know Act in 1986. The goals of the Act include providing for (1) emergency planning for chemical emergencies, (2) emergency notification in case of releases, and (3) community right-to-know about toxic and hazardous materials. The inherent goal of risk communication became clear: to provide people what they need to know to make reasonably informed decisions about the risks they face.

Historical Summary

In 1988 the U. S. Environmental Protection Agency released The Seven Cardinal Rules of Risk Communication—a pamphlet drafted by an academic and a government administrator (Covello and Allen 1988). While this may not have been the first government agency to attempt to communicate risk more effectively, it certainly has been the most widely circulated. The seven cardinal rules put forth seem obvious, even sophomoric, but they are often violated in the practice of risk communication. The seven cardinal rules of risk communication are (see also Covello et al. 1988):

1 Accept and involve the public as a legitimate partner.
2 Plan carefully and evaluate your efforts.
3 Listen to the public's specific concerns.
4 Be honest, frank, and open.
5 Coordinate and collaborate with other credible sources.
6 Meet the needs of the media.
7 Speak clearly and with compassion.

The first rule is driven by the idea that in a democracy people have the right to participate in decisions that affect them by impacting their lives, property, or other things they may value. In a democracy, the goal of risk communication should be to produce a well-informed public capable of reasonably informed decisions, rather than to defuse public concerns. The second rule suggests that risk communication is more likely to be successful if it is carefully planned. The public audience is rarely homogeneous enough to be reached by a single message. The multiple audiences are best reached by various strategies focused on specific interests, needs, concerns, and preferences. Hence, planning the risk communication is essential to effective communication.

Rule three suggests that risk communication is a dialogue, and that by listening to the public risk communication can focus on the aspects of the issue that are most important to the audience, like trust, competence, credibility, fairness, and voluntariness. This avoids the miscommunication that often accompanies preconceived notions about what the people know or think, or which actions to take to deal with risk. The fourth rule suggests that trust and credibility are a risk communicator's most precious assets—they are the hardest to obtain, the easiest to lose, and once lost almost impossible to regain. This rule means maintaining transparency in the process.

The fifth rule suggests that credible voices are powerful motivators. If these voices speak in concert with the message, they provide independent confirmation—few things can undermine the credibility of the message more than disagreement from a credible source. Rule six recognizes the media as the primary transmitter of risk information: they play critical roles in setting policy agendas and determining processes and outcome. Unfortunately, journalists' perspectives are quite different from those of risk communicators. They are more interested in politics and simple messages than the complexities so often required to characterize a risk, and danger makes a better story than safety. Finally, rule seven is a reminder that technical language can be a useful shorthand among professionals with shared background, but it creates significant barriers to a general understanding among people that do not share the professional jargon. Moreover, it reminds the risk communicator that it is okay to share empathy with people over the tragedy of an injury or death.

The mental models approach to risk communication starts from the basic assumption that communicating risk to people needs to be placed in the context of their basic understanding of risk. To achieve the desired outcome of providing people with what they need to know about risk in sufficient detail to allow them to make reasonably informed risk decisions, the mental models approach rests on the idea that existing beliefs about risk affect the interpretation of the risk message. Given this emphasis on the context of what the people know and believe about risk and its circumstances, the mental models approach begins with interviews of key stakeholders (Atman et al. 1994; Morgan et al. 2001). These interviews are followed by confirmatory surveys that provide a broader understanding and consolidation of what is known about the risk. The mental models approach engages technical expertise to develop influence diagrams that can be used to represent the risk during risk communication. Influence diagrams help organize information about the risk, inform people as to what actions are most appropriate, and generally inform decisions about risk. The mental models approach is an integrated set of activities that allows designers of risk communication to select risk communication content, structure messages to best communicate about risk, and organize materials to identify and fill existing gaps in local knowledge about risk. Most importantly, because the mental models approach treats each risk communication situation as a unique case, it precludes the use of *en masse* approaches that treat risk communication as a one-way communication from those that know to those that remain uninformed because the risk communication message failed to address their concerns.

The organization model of risk communication argues that organizations shape the communication of risk in a variety of ways. Beyond the crafting of the message itself, organizations set up the framework in which risk communication takes place. From the outset Chess (2001) points out that organizations constrain risk choices by limiting the range and character of available alternatives. This is similar to Ackoff's (1974) argument that planning problems do not simply appear fully formed out of nowhere. When planning problems are identified, the nature of the circumstances themselves must first be deemed problematic. Then withstanding the scrutiny against a value system, which may or may not be explicit, a decision that this problem needs to be addressed can be made. Risk communication problems are similar. The organization has to determine the appropriate amount of risk information to communicate, which is a function of a variety of risk estimates. This means that not only does the organization have to determine which risk estimate best represents the distribution of possibilities (e.g., best-case, most-likely, worst-case, mean-risk), but whether (and how) to communicate the variation and uncertainty. It also means that the view selected by the organization to be communicated is unlikely to be universally shared by all members of the organization. Chess (2001) argues that because organizations, viewed in an open systems framework, are largely shaped by their environments, understanding organizational behavior, including risk communication, is contingent upon understanding the environmental context of that behavior. Hence, with the loss of legitimacy after the accident at Bhopal in December of 1984, and the subsequent passage of the Emergency Planning and Community Right to Know Act in October of 1986, the Chemical Manufacturers

Association found themselves in an increasingly hostile environment. A major accident had served as a catalyst for intense public hostility and scrutiny, which led to the passage of new legal requirements. The resulting turbulence and uncertainty created a substantial threat to the chemical manufacturers. In this environment Chess (2001: 182) suggests that, "risk communication became a corporate survival mechanism." All social organizations "instinctively" fight for survival. Hence to survive, they had to adapt—namely, to communicate about the risks they impose upon a community.

Barriers to Risk Communication

A clear understanding of the level of risk provides the foundation for effective, ethical risk communication. The barriers to effective risk communication are usually summarized in terms of issues surrounding the exchange of information (cf. Covello et al. 2001), like magnitude and significance, situational contexts such as conflict, lack of coordination, and lack of planning, and issues of human irrationality and trust. Issues of differing perspectives, data presentation and manipulation, and associative language and culture are briefly discussed below.

Even when organizations are trying to communicate the risks involved in a given set of activities, the "language of risk" can be a distinct problem. Such was the case when the US Army attempted to communicate the risks involved in the disposal of the unitary chemical weapons stockpile at Johnston Atoll. When Congress mandated the destruction of the unitary chemical weapons stockpile in December 1985, the US Army engaged in an environmental impact assessment process that ended with the production of an Environmental Impact Statement (US Army 1988). Subsequent decisions called for the on-site disposal of the stockpile stored in the continental United States and the removal of the chemical weapons from Germany by 1992 and subsequent disposal at Johnston Island (Ambrose 1989; GAO 1991). Rogers (1992) examined the risk communication between the Army and native Polynesian cultures in terms of the written record of proceedings, including the Environmental Impact Statement and the transcript from the public hearing in Honolulu. While the Army made great efforts to better understand the risks involved in the disposal process, in part to meet the Congressionally mandated requirement for "maximum protection" of the public, the language used to communicate about risk prevented a meaningful dialogue.

Rogers (1992) identified twelve characteristics where the Army and the native Polynesian cultures failed to share a common perspective on the risks (Table 3.1). To begin with, they failed to agree on the name of the place, its location, or its history. In addition, the native culture viewed the secrecy of national security as simply being used to hide environmental and ecological risks, and viewed the extensive planning as suspect. For example, ships full of munitions to be incinerated arriving at Johnston Atoll during hurricane season was repeatedly mentioned by the public as a serious concern. The approaches of the two cultures were diametrically opposed—the Army used a reductionist approach that examined the detail of individual parts and sub-parts, while the native culture viewed the situation much more holistically, with the whole being more than the sum of the intimately interconnected parts. The Army used deductive logic in a linear, often two-dimensional and bounded space, while the native culture was more inductive, nonlinear, multidimensional, and expansive. But perhaps most important was that these differences in perspective pitted the Army's belief and trust in the system against the native culture's long history of perceived insult and egregious deeds committed by outsiders. In short, the two cultures involved failed to communicate in that "[t]hey failed to establish risk communication dialogue, and never established a common framework for effective risk communication" (Rogers 1992: 437). There was no shared meaning and no dialogue to clarify meaning. Unfortunately, this served to undermine the trust and credibility of both perspectives.

Communicating technical risk information is always a challenge. In the Chemical Weapons Demilitarization program, the US Army spent a great deal of time, energy, and resources determining

Table 3.1 Comparing Perspectives

Characteristic	*U. S. Army*	*Native/Polynesian Cultures*
Place Name	Johnston Atoll, JA or Johnston Island, JI	Kalama Island
Location	800 miles southwest of Hawaii	Part of the Hawaiian Island chain
History	Military presence since 1940s; weapons stored since 1970s	Stolen from the Kingdom of Hawaii in late 1800s
Secrecy	Necessary for national security	Used to hide environmental & ecological risks
Planning	Reduces risk by decreasing chances & consequences of accidents	Arrive during hurricane season
Perceived Risk	Credible accidents w/probabilities greater than 10^{-8} per program	Accidents happen
Acceptable Risk	Minimal risk to dispose of chemical weapons—e.g., plane crash into barge	No risk—the Titanic sank, the Valdez spilled oil
Perspective	Deductive, linear, two dimensional, bounded	Inductive, nonlinear, multi-dimensional, expansive
Approach	Reductionist—examines detail, sum of segmented parts equals whole	Holistic—whole more than sum of parts
Environmental/ Ecological	Non-significant individual impacts	Significant combined impacts disturbances
Belief/Trust	Confidence in system safety	History of perceived insult
Spatial/Temporal Limits	Narrowed around performance period and location of proposed action(s)	Broadened to consider proposed actions as part of long history area wide

Source: Rogers, G. O. (1992) "Aspects of Risk Communication in Two Cultures," *International Journal of Mass Emergencies and Disasters* 10(3): 458, Table 4. Reprinted by permission of the International Research Committee on Disasters.

risks and developing the best ways to portray them to the public (US Army 1988). For example, inasmuch as Congress mandated the "maximum protection" of the public and the prevailing standard developed for commercial nuclear power plants was "reasonable protection" of the public, a new standard had to be developed. Since the "reasonable protection" standard had emerged over several decades to be the development of worst-case scenario emergency plans for risks in the range of 10^{-6} or greater, the "maximum protection" standard was determined to be the 10^{-8} range. These risks were then communicated in graphic form for distributional accidents—not individual accidents but rather accidents that represent a set of similar accidents. For example, a vehicle crash that represents all the potential ways a vehicle can be involved in an accident that could potentially release of chemical agent

More recently the San Jacinto River Authority wanted to communicate the impacts associated with the removal and use of water from Lake Conroe for drinking water. They proposed four scenarios to withdraw 25, 50, 75, and 100 thousand acre-feet of water in four phases of the Groundwater Reduction Plan beginning in 2015, 2025, 2035, and 2045 respectively. Because of the size of Lake Conroe at full pool, these diversions amount to roughly 1 ft/yr, 2 ft/yr, 3 ft/yr, and 4 ft/yr respectively. At the initial public meetings, these were presented as "not much impact" and graphically represented as a plot with the historical lake levels similar to the one presented in Figure 3.1a. But note that if the y-axis of the chart is modified to begin at a lower number, the apparent "impact" depicted appears reduced. So the impact can be manipulated to look greater by

raising the point at which the x-axis crosses the y-axis to as much as 189, or reduced to say 100 or even zero would depict the impacts as nearly imperceptible. They are both small in size by a trick of graphics, and spread throughout the entire time of operation (1974 to 2010). A simple reorganization of the information from historical-order to the frequency-of-occurrence-order yields the graphic representation in Figure 3.1b.

Now it can be seen that lake levels that have not occurred in the 30-plus years of operation occur under the groundwater reduction plan scenarios. Table 3.2 presents the chance of falling below a given lake level under each scenario compared to what has occurred in history. This allows the user to see that lake levels that had a limited chance of occurrence in the past would have an increased chance of occurrence in the future. For example, a lake level of four feet below full pool—which local residents know dry-docks many private docks and severely impacts local marinas—has historically only happened 1.0 percent of the time, but under the proposed scenarios it would be likely to occur 2.6 percent, 6.0 percent, 11.0 percent, and 20.5 percent of the time. Having developed these graphics, the first time we showed them to members of lake-front communities, one resident quickly pointed out that our charts were "all wrong," because they assumed that the reduced lake levels were a risk, when "residents know" reduced lake levels are a certainty—not a risk.

In another case the Federal Emergency Management Agency (FEMA) became concerned—partly because of Congressional inquiries—that communities of color and poverty were responding to hazard warnings less effectively than other communities. FEMA launched the Emergency Preparedness Demonstration program of community-based participatory planning to enhance resiliency in six communities (Berke et al. 2011). In conjunction with that effort, Rogers and Burns (2010) were asked to investigate the subjective meaning of words being used to communicate risk and hazard among typical community residents and the emergency planning and response community serving them. As a consequence, a free-response investigation of subconscious use of words in two communities: Washington, DC, and Port Arthur, Texas was undertaken. In Washington, DC, a group

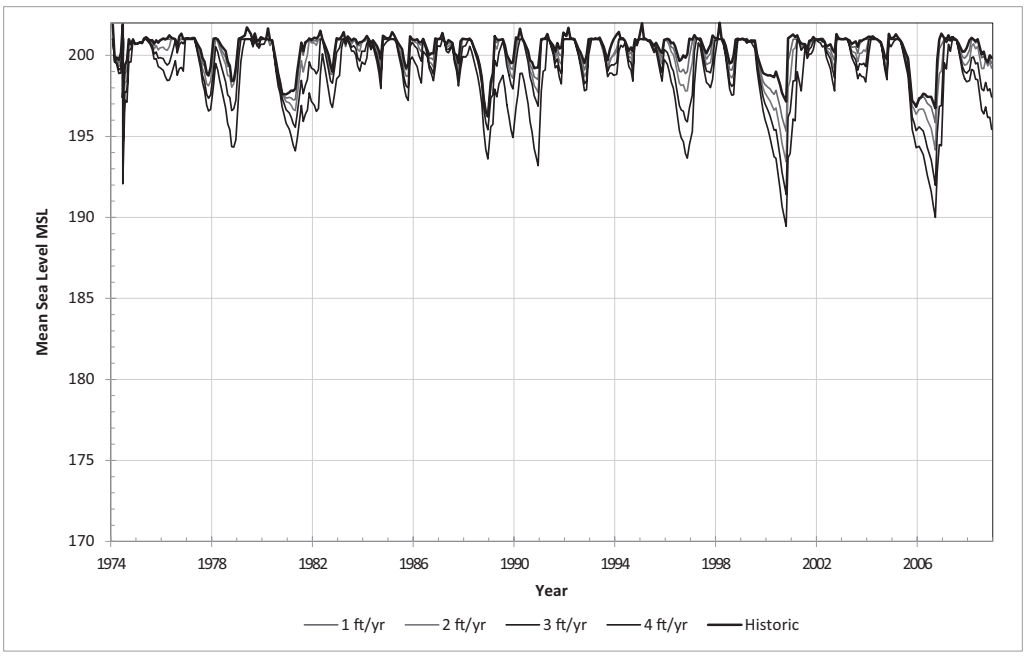

Figure 3.1a Historic and Projected Lake Levels 1974–2009 Emphasizing Depiction of Risk

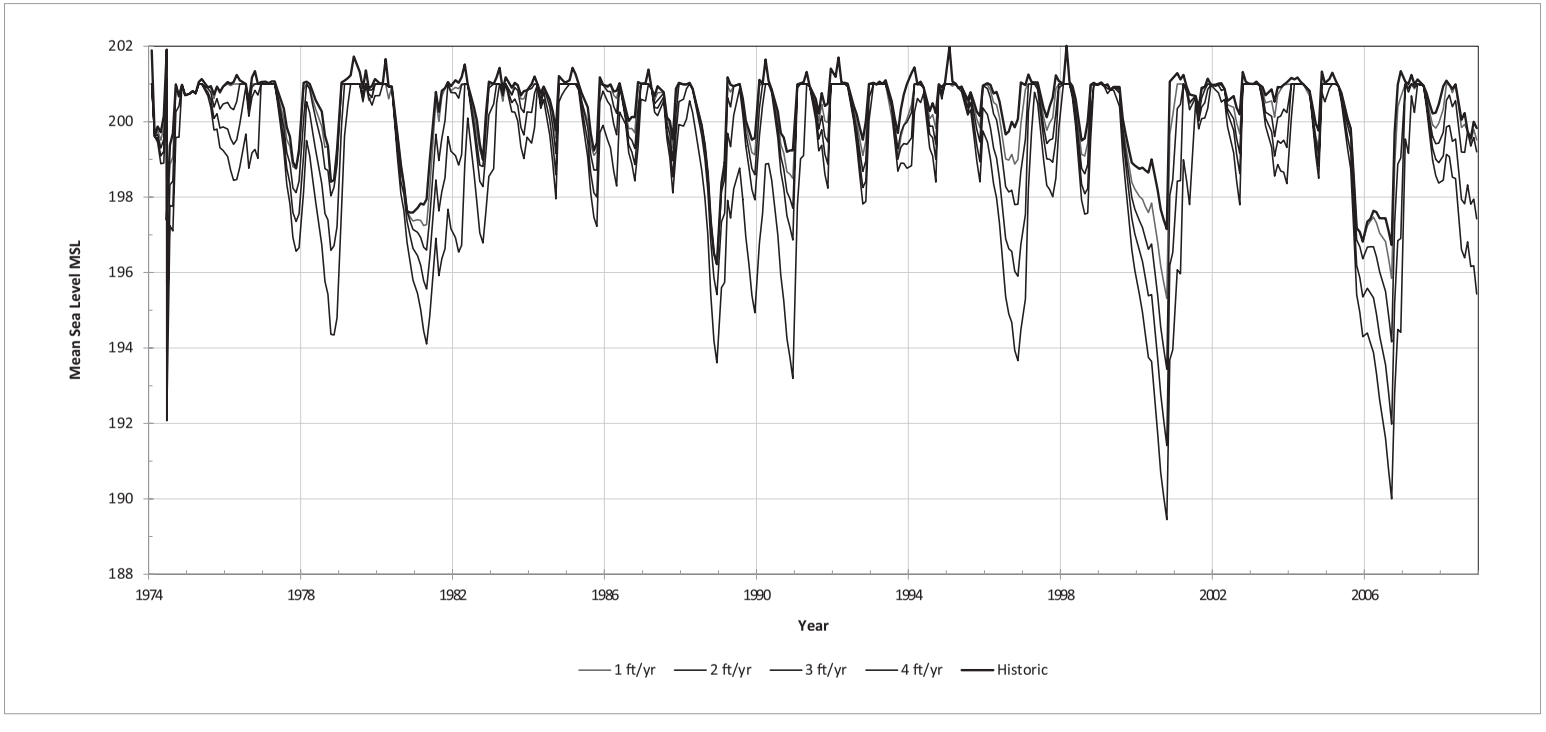

Figure 3.1b Historic and Projected Lake Levels 1974–2009 Minimizing Depiction of Risk

Table 3.2 The Chance of Lake Conroe Falling Below Given MSL Under SJRA GRP Scenarios

Lake level Below (ft)		*History*	*To annually divert*			
MSL	*Full Pool*		*25,000 ac ft*	*50,000 ac ft*	*75,000 ac ft*	*100,000 ac ft*
200	**−1**	21.9%	30.0%	36.7%	46.2%	60.5%
199	**−2**	13.1%	13.3%	19.3%	27.6%	45.5%
198	**−3**	6.0%	7.4%	9.5%	17.1%	29.0%
197	**−4**	1.0%	2.6%	6.0%	11.0%	20.5%
196	**−5**	0.0%	0.7%	1.9%	6.0%	14.3%
195	**−6**	0.0%	0.0%	1.2%	2.6%	10.0%
194	**−7**	0.0%	0.0%	0.5%	1.9%	5.2%
193	**−8**	0.0%	0.0%	0.0%	1.2%	2.6%

of disadvantaged senior citizens was compared with a group of first responders, while in Port Arthur, Texas, the community group (including members of local parent–teacher groups, churches, and community centers) was compared with people working for the local health department, police department, or Community Emergency Response Teams (Rogers and Burns 2010). A list of words was generated from two questions: What ". . .are the most important things that matter in your life?" and ". . .do you feel is most important for the safety and well-being of your community?" Words like family, children, community, friends, health, job, and home topped the list of things most important in your life, while words like police, health, community, education, knowledge, safety, preparedness, and school were most often mentioned as most important for the safety and well-being of the community. A total of 109 unique words were subsequently investigated as stimulus words for the associative group analysis (Szalay and Brent 1967), where participants are asked to respond with as many unique single words as possible to a given stimulus word in 30 seconds.

For example, the simple stimulus word, home, generated nearly 171 and 163 unique words or concepts in Port Arthur, Texas, and Washington, DC, respectively. Some of these response words were only mentioned by one person; others were shared among two or more people. Inasmuch as culture is shared and our emphasis was on shared meaning, we selected 37 response words that were shared by more than one group (Figure 3.2). Fourteen of the words (or concepts) were shared among responders and community members in both communities, including words like safe(ty), family, house, comfort(able), shelter, peace(ful), secure(ity), love, happy(iness), work, life, kids, live, food, and taxes. Eleven response words were shared primarily among responders from both communities, including base, heart, good, castle, nice, dwelling, dog(s), apartment, mortgage, and investment. Another eleven response words come mainly from community members, including owner(ship), warm, mother(mom), children, money, abode, relax(ing), haven, rest, fun, sanctuary, and repair. Some of the response words used in this latter group are shared among responders and community members but not from the same community. Even among the shared response words, there are significant differences between community members and responders. Words like family, comfortable, shelter, and love carry more community members than responders, while words like house are use twice as often among responders compared to community members. Finally, there is also a series of response words that are only used among responders, including base, heart, good, castle, nice, dwelling, dog(s), apartment, mortgage and investment and some other that are mostly used by responders, including haven, rest, and sanctuary. It is interesting to note that responders used response words like mortgage and investment, whereas community members used money and repairs. This may be a reflection of the disadvantaged communities, where money suggests poverty and the lack of resources, and investment suggests the positive asset of a home.

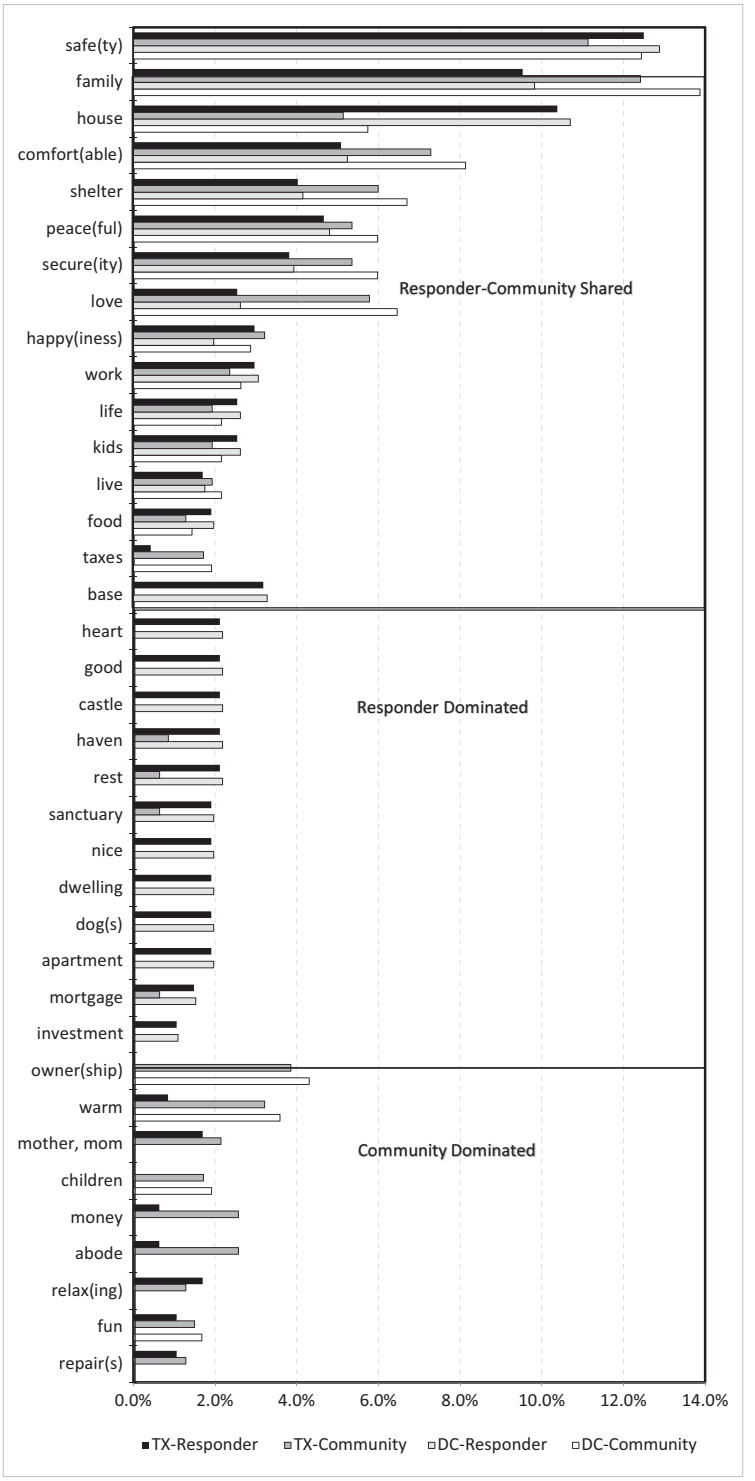

Figure 3.2 Free Response to Stimulus Word Home Among Responders and Community in Washington, DC and Port Arthur, TX

Examples of some of the many potential barriers to risk communication are discussed above, including differing perspectives, data presentation and manipulation, and associative language. These examples underscore some conditions that are more likely to allow risk communication to be successful than when they do not exist. Risk communication efforts are more likely to be successful when

- they rely on *credible information* that remains credible when informed by local scrutiny/knowledge;
- *local participants* are encouraged to actively engage in the process, and *share responsibility* with authorities for potential outcomes;
- risk *outcomes are directly linked to risk events* so that the links between risks and their consequences are well understood and transparent;
- risk *outcomes are relatively uniform and consistent* across a variety of settings;
- the receiver and the sender *share a culture and sub-culture*—a language and its shared usage;
- the *trust between receiver and the sender* is demonstrably genuine, having shared many common experiences, interpretations of the events, and shared responsibility for outcomes;
- the people receiving the risk message perceive themselves to be *treated fairly*;
- the risk communication *message is consistent* with local knowledge and understanding; and
- a *transparent relationship* between risks and desired actions is identified.

Challenges for Climate Change

On March 31, 2014, the Intergovernmental Panel on Climate Change released their Fifth Assessment Report, Phase I Report on Climate Change (IPCC 2014). The Summary for Policy Makers "assesses needs, options, opportunities, constraints, resilience, limits, and other aspects associated with adaptation" to climate change (p. 3). In the first 25 pages of the Summary for Policy Makers the authors use the word risk 181 times—this is before they get to the region-by-region detailed assessment of risks that is the heart of the report. The assessment summarizes the three "key" risks for each region. The regions are Africa, Europe, Asia, Australasia, North American, Central and South America, Polar Regions, Small Islands, and The Ocean. The uncertainty associated with each risk is rated based on the "type, amount, quality and consistency of evidence" (p. 5). The evidence is classified as limited, medium, or robust, while the amount of agreement is classed as low, medium, or high. For example, the first risk discussed in Africa is described as "[c]ompound stress on water resources facing significant strain from overexploitation and degradation at present and increased demand in the future, with drought stress exacerbate in drought-prone regions of Africa (High Confidence)" (p. 27). Each identified risk is assessed as to its climatic drivers and likelihood is assessed for the present, near term (2030–2040), and long term (as either 2°C or 4°C change in the 2080–2100). Each risk is assessed in terms of current conditions, and with high levels of adaptive action to cope with the risk. A momentous undertaking to be sure, but the assessment is done on a five-point scale: Very Low-Low-Medium-High-Very High (Low and High are not listed, but implied by the blank area between Very Low and Medium, and Medium and Very High). The risks listed for North America include "Wildfire induced loss of ecosystem integrity" (p. 28), "Heat-related human mortality" (p. 29), and "Urban floods in riverine and coastal areas" (p. 29); the confidence in each of these is high.

The report goes on to assess the confidence in observations and contribution of climate change on an area-by-area basis for each of four issues: (1) snow & ice, rivers and lakes, floods and drought, (2) terrestrial ecosystems, (3) coastal erosion and marine ecosystems, and (4) food production and livelihoods. For example, the retreat of highland tropical glaciers in Africa, and shrinkage of glaciers in western and northern North America are both high-confidence and reflect a major contribution of climate change. Major contributions of climate change in terrestrial systems include decreases in tree density in Sahel and semi-arid Morocco in Africa, and more frequent wildfires in subarctic

conifer forests and tundra in North America. In marine systems, the decline in coral reefs in tropical African waters, and changes in salmon migration and survival in the Pacific Northwest North America are both experiencing major contributions from climate change. Climate change is also assessed as a major contributor to decline in fruit-bearing trees in Sahel, and impacts on the livelihoods of indigenous people in Canada. The report identifies eight key risks with high confidence that contribute to one or more reason for concern, including the risk of

1 death, injury, ill-health, and disrupted livelihoods in low-lying coastal areas;
2 severe ill-health and disrupted livelihoods in large urban areas due to flooding;
3 extreme weather event impacts on infrastructure and critical services like electricity, water supply, and health and emergency services;
4 mortality and morbidity during periods of extreme heat;
5 food insecurity associated with drought and variability of precipitation;
6 loss of livelihoods and income in rural areas due to insufficient drinking and irrigation water;
7 loss of marine and coastal ecosystems; and
8 loss of terrestrial and inland water ecosystems.

(p. 10)

While it is clear that this undertaking is a massive, exhaustive attempt to identify risks associated with climate change throughout the world, it is also clear that the actions needed to address these risks, both in terms of preventing their occurrence and of adapting as they occur, are mostly locally focused. Clearly, the climate change committee is attempting to communicate about the risks associated with climate change, and they have done an extraordinary job of communicating both the certainty and the uncertainty associated with the risks identified. But to be effective in stimulating appropriate responses, these efforts will have to turn their attention to local risks to local communities. Risk communication will have to consider the unique impacts on local populations, creating local resilience through unique local action. Engendering participation and shared responsibility is unlikely to be effective without direct transparent application of the risks to the local area. The risk communication literature suggests a number of conditions summarized in the previous section that are unlikely to be met on a global scale. The risk communication for climate change faces extreme challenges of communicating a global comprehensive risk in which the outcomes are separated from the initiating events by decades, with unknown uncertainties. And they have to be multicultural, multilingual, and fair in face of the variety of actions that will be required and the extant inequalities among those expected to take the actions. The climate change risk communication requirements are almost antithetic to the principles of risk communication from prior experience. Overcoming the associated barriers will undoubtedly require innovation. Risk communication efforts that build from the local community building blocks are more likely to successfully stimulate appropriate adaptive actions.

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