Developing Messages for Protective Actions to Take During Earthquake Shaking

GeoHazards International
June 2015

GeoHazards International
A Nonprofit Working Toward Global Earthquake Safety

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Table of Contents

Acknowledgments vi

Executive Summary 1
Purpose and Scope 2
Navigation 3
Audience 3
Common Types of Protective Actions 3
Highlights of this Guidance 4

Background and Findings 7
Project Background 8
Purpose and Use of this Guidance Document 9
Findings and Highlights of Technical Background Information 10
The Dangers 10
Protective Actions 14
What Causes People to Believe the Message 20
Time Available to Take Protective Action 22

The Process and Team to Create Messages 24
Designing the Process to Involve the Right People from the Beginning 25
The Message Development Committee 25
Subcommittees to Address Specific Populations and Settings 27
Political Context 28

PART I. Considerations for Developing Messaging Content 29
Geographic Area or Jurisdiction 30
Existing Beliefs, Traditions, Customs 31
Local Earthquake Hazard 32
Time Available to Take Protective Action, Based on Geologic Environment 33
Local Site Conditions and Effects 35
Secondary Hazards 36
Local Buildings 36
The Concept of Characteristic Building Stock 37
Population Exposure 41
Social and Gender Considerations 41
Populations with Unique Functional or Access Needs 42
Mobility Impediments 42
Neurologic or Sensory Impairments that Affect Physical Reactions 42
Cognitive Impairments 43
High Occupancy and Institutional Settings 43
Schools 43
Large Buildings Where Many People Assemble 43
Hospitals 44
Laboratories and Kitchens 44
Developing Message Content: Bringing Together All Considerations 44
Suggested Protective Actions for Common Contexts 48
Choosing Protective Actions to Recommend for People Remaining Inside Buildings 49
Examples: How to Determine Message Content Based on Local Considerations 50
Example 1 – Area of high seismic hazard dominated by rural, vernacular masonry buildings 50
Example 2 – Dense urban area along fault with many open ground story buildings 51

Example 3 – Island with offshore subduction zone and traditional timber buildings 51

PART II. Forming Effective Messages 53

Forms of Messages 54

The Slogan 54

The 60-Second Message 54

The 60-Minute Message 54

What All Forms of Messages Should Contain 54

Developing a Slogan for Protective Action 55

Effective Messaging 56

Community Values 57

Social Context and Considerations 57

PART III. Developing a Communication Strategy 59

Communication Program Design 60

Channels for Communicating the Message 60

Information Sources 60

Types of Audiences and Trustworthy Spokespersons and Leaders 60

Recommendations for Future Work and References 61

Recommendations for Future Research to Support Protective Actions Guidance 62

References 63

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Executive Summary

Photo credit: Bipin Shrestha, provided by Earthquake Engineering Research Institute

"In addition to providing information that is reliable, valid and current, messages must be formulated in ways that help audiences appreciate the uncertainties involved yet at the same time not be so confused by them that they decide against taking any action."

Kathleen Tierney
Guidance for Seismic Safety Advocates:
Communicating Risk to the Public and Other Stakeholders

Purpose and Scope

This document provides guidance on developing messages about what people should do *during* earthquake shaking to protect themselves from injury or death. The document refers to this behavior as protective action. The guidance does not advocate one protective action over another. Rather, it describes a process to use and key considerations for creating effective messages that serve different contexts.

This document focuses on actions to take *during* an earthquake, because information on what to do *before* and *after* is available elsewhere. Messages for what to do during earthquake shaking form one part of a broader earthquake safety messaging campaign, as Figure 1 shows. Protective actions messages must complement mitigation and preparedness efforts that will make people much safer from earthquakes in the long term. This document is the result of the project "Guidance on Developing Messages for Protective Actions to Take during Earthquake Shaking" funded by USAID/OFDA. For a description of the project goals and activities, please see the Introduction.

There is no single perfect protective action message, for any nation, or for any jurisdiction. Jurisdictions have different customs, beliefs, buildings, geology, and capacities, and therefore different messaging needs. It is absolutely essential that people understand their specific circumstances and situations and make decisions based on that understanding.

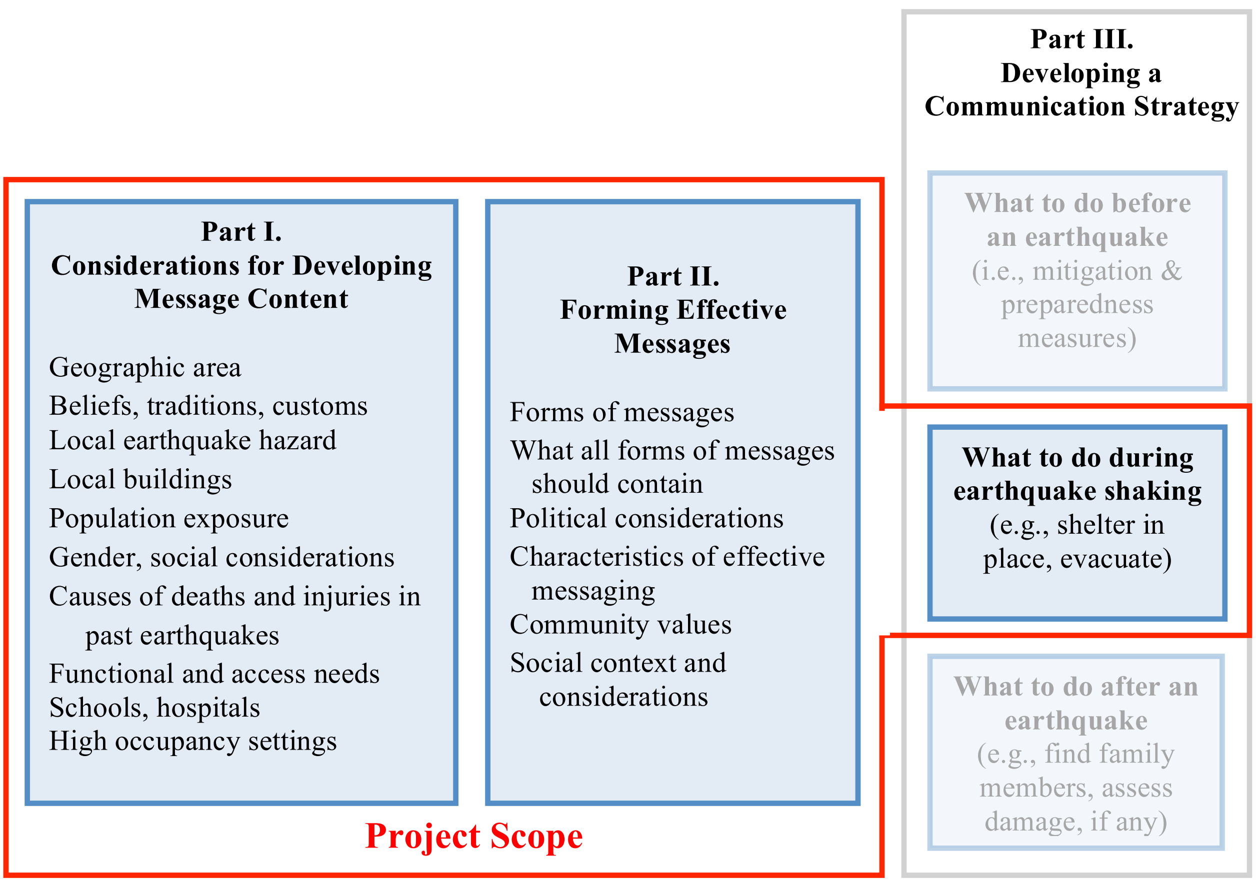

Figure 1. Diagram illustrating how the project scope is part of a larger messaging campaign about earthquake safety.

Navigation

The content of the document is divided into the following sections:

- **Background and Findings.** Explains the project history, describes the dangers people face during earthquakes, and summarizes the primary findings on which the guidance is based.
- **The Process and Team to Create Messages.** Describes whom to involve in discussions about forming protective actions messages that work for the local context, how to structure the consultation process, and how to proceed with Parts I, II and III.
- **Part I: Considerations for Developing Message Content.** Explains the need for protective actions messages to address local customs, existing knowledge and beliefs, social restrictions, local hazards and building types, and describes ways to combine these considerations to select locally appropriate protective actions.
- **Part II: Forming Effective Messages.** Discusses creating messages to communicate protective actions to the public. Considers three kinds of messages: the "slogan"; the 60-second message; and the 60-minute message.
- **Part III: Developing a Communication Strategy.** Covers getting to know the audience, identifying good spokespersons, and identifying channels of communication to reach the intended audience.

Audience

The intended audience of this document is people who are responsible for developing and delivering protective action messages to large audiences. This might be disaster management agencies, nonprofit organizations, or scientific organizations.

Common Types of Protective Actions

Two types of protective actions are commonly advocated or practiced when inside a building. One action is to stay in the building and take shelter, which can include going to a pre-identified "safe zone" inside the building (as done in Peru) or taking cover under sturdy furniture such as a table (best known as Drop, Cover, and Hold On). Both are illustrated in Figure 2. Instructions for sheltering in the building typically include making yourself small and protecting your head and neck. The second type of protective action is to evacuate buildings quickly. Evacuation is a common protective action, but official messages rarely mention it.

Protective action messages may advocate only one, or a combination, of these two types of actions. Some messages[1] advocate evacuation only if a person is in a single story earthen building with a heavy roof. Even though these different protective actions and variants are advocated, evidence showing that one particular action is more effective than another, and under what circumstances, is fragmentary and limited.

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[1] Examples include: International Federation of Red Cross and Red Crescent Societies (IFRC) (2013) and GHI and partners (2005).

Figure 2. Two different messages regarding what action to take inside a building: going to a pre-identified "safe zone" (left) and Drop, Cover, and Hold On (right). Images courtesy: Instituto Nacional de Defensa Civil (INDECI), Peru and ShakeOut.org, USA.

Those attempting to formulate protective action messages for use in emerging countries face a particularly difficult task. Existing literature from low- and middle-income countries[2] provides limited quantitative data about the effectiveness of various types of protective actions for past earthquakes, and most epidemiological studies in these countries focus on the medical causes of deaths and types of injuries rather than on the types and effectiveness of protective actions taken. In general, there is a lack of information comparing the efficacy of various protective actions taken in diverse contexts (e.g., different parts of the world, different predominant building types, different earthquake events).

Guidance can be developed, however, to explain when certain protective actions are likely to be effective versus when they are not. Physical principles, knowledge of building damage and collapse patterns, understanding of human behavior and the social context, and existing data on protective actions can all contribute to effective guidance.

Highlights of this Guidance

The guidance provided in this document is intended to help people or organizations develop protective action messages that will help as many people as possible within their jurisdiction be safer during earthquakes.

We recommend that message creators assemble representatives from technical disciplines and stakeholder groups into a Message Development Committee. The committee's task is to ensure that messages are appropriate for the context and population. The committee can use this guidance document to recognize necessary considerations, potential pitfalls and complexities,

[2] Summaries of available studies, including several helpful tables, can be found in Doocy, et al. (2013); as well as Armenian, et al. (1992) Spence and So (2009), and Petal (2011).

what expertise to gather, and steps in the process. The guidance is based on two fundamental findings:

1. No single action is appropriate in all locations; and
2. With information from trusted local experts, individuals should, in advance of an earthquake occurring, evaluate and understand the hazards posed by their location and surroundings.

The guidance encourages local message creators to understand the community's risk, and it helps them to identify the most appropriate action(s) to recommend in their local setting. Local authorities and leaders have the responsibility to determine the best message for their jurisdiction as a whole, and to create modified messages for people who are unable to follow the standard guidance due to physical or cognitive limitations.

When buildings collapse rapidly, even the most advisable protective actions have limited ability to protect occupants. It is impossible to predict exactly how buildings will perform during an earthquake whose location and shaking intensity will not be known until after the event; therefore, no single protective action can provide safety for every person in every circumstance. In some cases, actions that will make some individuals safer would make the majority less safe, and vice versa. Message givers can empower people to make informed choices about safety, and to act, by describing actions to take, by emphasizing situational awareness, and by encouraging them to take steps prior to an earthquake to make themselves and their families safer.

People's existing beliefs and customs, as well as the social context, must be considered during development of messages and the strategy for communicating them. Several variables (e.g., culture, gender, literacy, social context, previous earthquake experience) affect how people perceive the risks earthquakes pose to them, and what actions they believe will be protective. People follow a process of evaluating and processing information before deciding whether they will believe and act on a message. Understanding this process is crucial to motivating action. Messages that present new information should come from trusted sources—maybe from organizations not typically involved in message dissemination.

During earthquakes strong enough to cause major damage, the length of time available to take protective action may only be five seconds. This "window of opportunity" is the time between the first perceptible shaking and the stronger shaking that makes walking difficult. The five seconds to act is an estimate based on reasonable scientific assumptions of the likely locations of moderate to large earthquakes with respect to population centers in active tectonic regions worldwide.[3] The time to act will vary by location and will differ from one earthquake to another. It will be less than five seconds in some locations and greater than five seconds in other locations. (It will be much less if an earthquake is centered directly beneath a city, but such "direct hits" are very rare.) In some regions, faults are located far enough away that more than five seconds may be available to act, but message creators should **not** assume more available time than five seconds without very strong scientific evidence. The short time available for

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[3] Based on an analysis described in Hough (2014) in the companion volume.

action means that people must be able to reach safer areas (or cover) quickly and constrains the options that are feasible. A portion of the available time to act will likely be lost to "milling," which occurs when people process information, look for behavioral cues from others, and decide what to do. Some people may freeze.

Buildings often "shed" pieces of masonry, cladding, glass, and heavy items placed on balconies and rooftops, at levels of shaking lower than that necessary to cause collapse. These falling objects create a "danger zone" near the building perimeter, but the general public may not realize that such objects can fall and strike them. In dense urban areas, safe open space between buildings may not exist. Practically, this means that rapid evacuation is advisable primarily in situations where people are on the ground story of small-footprint buildings that are very likely to collapse, and safe open space is reachable within a few seconds.

In most other cases, sheltering inside the building is likely to be the better option. The safest locations inside a building depend on the type of building, interior elements, and its contents and furnishings. If sturdy furniture is available, taking cover underneath it can help prevent injuries from falling objects. In locations without protective cover, making oneself small and protecting the head and neck can reduce the chances of being struck by falling objects. Determining sheltering locations requires that people be aware of their surroundings and is best done ahead of time, along with implementing measures to improve the safety of the places where people spend the majority of their time. Because there is little time to act once shaking begins, people should regularly practice protective actions in the places where they spend the most time.

Though the specific actions that are likely to save the most lives will differ with context, an underlying message emerges: *wherever you go, look for the safest place you could reach within five seconds after the shaking starts*.

Earthquake protective actions may require judgment. For this reason, messages can help people develop *situational awareness*, which refers to understanding what can hurt them and the best way to stay safe in a particular context. Message givers must provide people with information beyond a short, memorable slogan-type message. It can be helpful to prepare "60 second" messages providing basic instructions, such as in the example on the left side of Figure 2, and an in-depth "60 minute" message providing detailed guidance. Involving local communications professionals and those who truly understand community values can lead to effective, memorable messages in the local language and social context.

Although protective actions messages are important and the main focus of this document, the most effective way to improve the safety of communities is to engrain a culture of mitigation and preparedness. This includes a large number of efforts, such as developing and enforcing an adequate building code, strengthening existing vulnerable structures, and relocating people to safer areas (for instance, not building on slopes that could have deadly landslides). Safe buildings protect people far better than any protective action. Empowering people to know what actions can make them safer, and why, has the potential to help people understand that acting before the shaking starts is the only truly effective way to protect themselves.

Background and Findings

What earthquake risks do these children face in their unreinforced brick school building, and what might be the appropriate message?

Project Background

In those unnerving first seconds of earthquake shaking, many people will have a limited ability to identify that the shaking is indeed an earthquake and to select the action that will best protect them or their loved ones in the immediate vicinity from harm. Shaking intensity varies greatly over a wide geographic area—from a level that is perceptible to humans, but not damaging in any way, to a level causing light and non-lethal damage, to an intense level that can knock people to the floor and cause buildings to collapse. When the shaking begins, no one can predict exactly how intense it will eventually become or how long it will last. It can be difficult to determine ahead of time whether specific buildings are likely to collapse due to an expected level of shaking, even for experienced structural engineers. Despite the challenges, educating communities about what to do during earthquake shaking may help people avoid injuries or death, especially in the short term before buildings can be made safer. Those responsible for developing and disseminating safety messages have an obligation to promote the most appropriate messages on protective actions to take during earthquake shaking and to not disseminate inappropriate and potentially deadly advice.

Determining the most appropriate message for a whole jurisdiction is a difficult task. Prior to this project, no clear guidance existed on how to consider the numerous factors involved in creating an appropriate message for areas with many vulnerable buildings or on how to interpret the limited data and numerous—often conflicting—anecdotes endorsing one protective action over another. The guidance offered in this document intends to help organizations and communities as they develop the best advice on protective actions to take during earthquake shaking for the greatest number of people.

This document is a result of a USAID/OFDA-funded project "Developing Guidance on Protective Actions to Take during Earthquake Shaking". The ultimate goal of this project is to contribute to saving lives and reducing injuries among vulnerable populations, particularly those living in earthquake-prone low- and middle-income countries, by supporting professionals' efforts to develop and promote appropriate messages that instruct people how best to protect themselves during earthquake shaking.

To prepare this guidance, a project team, formed and led by GeoHazards International (GHI), conducted the following project activities:

1) performed a literature review on relevant topics within the fields of earthquake epidemiology, building evacuation, human behavior during earthquakes, protective actions, risk communication, seismology, structural engineering, and urban search and rescue;
2) formed an international group of messaging professionals—those involved in creating and/or disseminating safety messages to the public—and held regular conference calls to discuss various themes related to the project;
3) developed, administered, and analyzed a survey on the perceptions, common practices, and obstacles that messaging professionals face when creating protective action messages;
4) developed, administered, and analyzed surveys on the knowledge and reception of earthquake protective actions among the general public in India, Peru, and Turkey, to understand which messages they receive and believe, and how they learned these messages;
5) commissioned technical papers in the fields of epidemiology of earthquake deaths and injuries, human behavior during earthquakes, risk communication, seismology, and

structural engineering;

6) developed a background paper covering the findings from the surveys that were administered and the literature survey, as well as a summary of the professional messaging group Skype discussions; and
7) convened a two-day workshop in Istanbul, Turkey with 19 international participants, including five technical experts, ten messaging professionals, and four GHI staff.

The guidance in this document is based on the available evidence, sound scientific and engineering principles, logic, and the professional judgment of subject matter experts and messaging professionals, gathered during the process described above.

Purpose and Use of this Guidance Document

The purpose of this document is to help guide decisions on what message to communicate and how to communicate it. Local authorities have the responsibility to determine the best message for their jurisdiction as a whole, recognizing that the safest action for the majority may be less safe or even unsafe for some individuals. Anecdotes touting the effectiveness—and ineffectiveness—of any particular protective action are likely to exist but should not be used without applying professional judgment that places the anecdote in the context of available evidence.

This document provides guidance on developing protective actions messages that consider local context (e.g., the knowledge, beliefs, customs, and hazard awareness of the people affected; the local hazard and building types; and the proximity of buildings to each other). It is intended to guide people and organizations that are developing and/or delivering protective actions messages. The guidance is limited to the scope shown in Figure 1—that is, to messages of what to do *during* earthquake shaking, not what to do before or after. This is just one part of a much broader messaging program. Although this guidance document will touch upon considerations for tying protective actions messages into the broader earthquake safety messaging program, details of developing such a program are outside the scope of this project and document.

This document contains the following sections:

- **Background and Findings.** Explains the project history, describes the process of developing the guidance, explains the dangers people face during earthquakes, and summarizes the primary findings on which the guidance is based (this section).
- **The Process and Team to Create Messages.** Describes whom to involve in discussions about forming protective actions messages that work for the local context, how to structure the consultation process, and how to proceed with Parts I, II and III (see next bullet points).
- **Part I: Considerations for Developing Message Content.** Explains different factors that should be taken into account when deciding what message to give to people. This includes identifying and considering the geographic area's characteristics (e.g., local hazards, local customs, predominant building types, population exposure), and who will act on the message. Describes ways to combine these considerations to select locally appropriate protective actions. Examples show how to apply different considerations in some typical built environments and contexts.

- **Part II: Forming Effective Messages.** Discusses how to effectively create messages that communicate the content (i.e., the recommended protective actions and when to take them) developed in Part I. Considers three kinds of messages: 1) the "slogan" message, which is only a few words and is catchy; 2) the 60-second message, which provides more information and a concise explanation of why a certain action is good to take; and 3) the 60-minute message, which provides more detailed information on specific circumstances and situations (e.g., homes with children, hospitals)
- **Part III: Developing a Communication Strategy.** Covers getting to know the audience, identifying good spokespersons, and identifying channels of communication to reach the intended audience.

Findings and Highlights of Technical Background Information

To determine the considerations and process for developing effective protective action messages, the project team collected background information from technical literature, surveys of the public, and consultations with and surveys of messaging professionals. This section summarizes significant findings related to protective actions messaging and highlights important technical background information. A companion volume contains background papers that summarize technical information on human behavior during earthquakes (Wachtendorf and Penta, 2014), risk communication for earthquakes and tsunamis (Lindell, 2014), earthquake hazard (Hough, 2014), building vulnerability (Gulkan, 2014), and causes of deaths and injuries during earthquakes (Wood, 2014), as well as a GHI staff background paper describing the project's consultations, surveys, and literature review (Cedillos et al., 2014).

The Dangers

Protective actions intend to prevent injury or death caused by earthquakes. Understanding how earthquakes kill and injure is the first step to understanding what actions will protect people. Earthquakes generate the following threats to people:

- building damage and collapse due to shaking, including damage to the architectural shell and utility systems, and movement of contents;
- bridges and other non-building structures that suffer damage or collapse, also due to shaking;
- human behavior in response to shaking (e.g., stampede, falls when running out, jumping out of windows of multi-story buildings); and
- secondary hazard events triggered by the earthquake such as tsunamis, fires, hazardous materials releases, landslides, and other types of ground failure.

This document focuses on the threats posed by building damage (to the structure, architectural shell, utilities and contents), which cause the majority of deaths and injuries in most earthquakes.[4] Buildings differ in the ways that they threaten peoples' safety:

- collapse or damage to the building structure itself, including dust generated by a collapse that can suffocate people inside the building;

[4] Numerous studies; see Doocy et al. (2013), background paper by Wood (2014), and Spence and So (2009). Large tsunami-generating earthquakes, such as the M9.1 2004 Sumatra earthquake and the M9.0 2011 East Japan earthquake, are exceptions. In these events, the tsunami often kills the most people.

- objects falling, sliding, or toppling inside the building (examples include furniture, glass, office equipment, laboratory chemicals, and light fixtures); and
- objects falling from the building exterior (examples include parts of masonry walls, parapets or gables, cladding, glass, overhead water tanks, signs, and ornamentation).

Multiple studies show that most fatalities are directly caused by building collapse, typically by crushing, compressive asphyxiation, or being struck by falling debris. Asphyxiation due to inhaling dust from a building collapse has been cited as a significant cause of death in some earthquakes.[5] Certain building types, such as earthen buildings, appear to generate the most dust, but film footage of the collapse of reinforced concrete and masonry buildings also shows thick clouds of dust rising above the wreckage. Despite the documented role of dust inhalation, none of the protective actions described in the subsequent section includes protection against asphyxiation due to dust inhalation. Participants in the messaging professionals group and workshop identified this as a significant need. Message creators should consider providing guidance to minimize dust inhalation, such as covering the nose and mouth with clothing or a dust mask[6] in situations where collapse is likely and people may be trapped.

Although building collapses cause the majority of deaths, many people do survive collapses. Studies following past earthquakes indicate that only one or two in 10 people inside a collapsed building are likely to die, on average,[7] even in heavy construction such as concrete or masonry. Of the people who die, some are killed immediately, some are trapped or too badly injured to free themselves and perish before they can be rescued, and some later succumb to their injuries. Survival rates for those trapped in a collapsed building depend on many factors, including effectiveness of search and rescue efforts.[8] Furthermore, in most earthquakes, not every building in a severely shaken area will collapse,[9] and the area of very strong, collapse-inducing shaking is typically small compared to the area over which damage occurs, exposing fewer people to potential collapse.[10] This means that in a typical earthquake, the threats posed by falling objects

[5] See discussion of causes of death in background paper by Wood (2014); multiple studies show that many individuals experiencing building collapse die from asphyxiation as their breathing passages become lined and clogged with dust, and dust fills their lungs. Postmortem examinations of earthquake deaths in Armenia and Kobe, Japan identified large volumes of dust in nasal cavities, throats, and respiratory passages indicating asphyxiation as the cause of death (Hogan & Burstein, 2007).

[6] Preparedness programs by the Aga Khan Development Network provide a dust mask as part of a compact kit of personal protective equipment to be mounted underneath desks. People can access the masks quickly when they take cover under the desks.

[7] See Spence and So (2009) and Spence et al. (2011) for an in-depth discussion of fatalities due to earthquakes. Observed fatality rates have been substantially higher in certain highly lethal types of collapses, such as “pancake” collapses, in which very little vertical space is left between floor slabs because of faulty design or poor construction in reinforced concrete buildings.

[8] Spence and So (2009); see Krimgold (1989a and b) for a discussion of search and rescue following earthquakes. Locals working in the immediate aftermath, rather than international teams that arrive later, make most rescues.

[9] See background paper by Gulkan (2014) for a discussion of why buildings collapse in earthquakes, and how frequently.

[10] See discussion of population affected by various shaking intensities in background paper by Hough (2014), based on 2008-2014 data from the USGS PAGER (Prompt Assessment of Global Earthquakes for Response) system; this dataset includes several high-fatality earthquakes, such as the 2008 Wenchuan, China and 2010 Haiti earthquakes.

inside and outside buildings are likely to affect a larger number of people than the threat of collapsing buildings and therefore should not be ignored.

However, in certain types of highly lethal building collapses, observed fatality rates[11] have been substantially higher than the average one to two in 10. If a large, multi-story building collapses rapidly soon after shaking begins, protective actions may have limited effectiveness, no matter the action. Most occupants will not have time to evacuate, and shelter-inside options are unlikely to protect occupants from large, heavy structural members.[12] "Pancake" collapses, in which the concrete floor slabs come to rest on top of each other with very little space in between, are especially deadly. People should not assume that they will always be able to evacuate smaller unreinforced masonry and earthen buildings; high death tolls in these buildings in some earthquakes indicate otherwise.[13] Because earthquakes can occur at any time of day or night, and because collapses are often lethal despite attempts at protective action[14], protective actions **cannot** be considered a substitute for safe construction. Broader messaging campaigns should clearly address this point.

Even if the building suffers little to no structural damage, contents and furnishings moving about inside the building can create significant dangers. For example, tall, heavy furniture can topple, laboratory chemicals can spill, and broken glass on the floor can cut unprotected feet (especially in homes when earthquakes occur at night).[15] Taller, more vulnerable buildings can collapse onto, or shower falling debris onto, adjacent shorter buildings.

Once outside the building, there are still threats to safety. In areas where buildings are aggregated closely together and streets are narrow, people exiting a building are in danger from objects falling from that building as well as from neighboring buildings. In many cases, objects on the exterior of buildings are poorly attached, or are among the first parts of the building to fail, and can fall even in light to moderate shaking that will not collapse the building. Portions of exterior masonry walls, parapets, and gables can fail and fall into the street or onto neighboring buildings. Numerous post-earthquake photographs, such as Figure 3, show substantial fallen debris near buildings, and structural engineers have noted such failures for decades. However,

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[11] Spence and So (2009) found much higher fatality rates in collapsed buildings in Muzaffarabad (56% of occupants killed), Manshera (63%), Bagh (44% killed), Pakistan in the 2005 Kashmir earthquake. Fatality rates surpassed 90% in some collapsed precast concrete buildings (Noji et al., 1990) in the 1988 Armenia earthquake.

[12] Noji et al. (1990) and Armenian et al. (1997) discuss particularly lethal failures of precast concrete buildings in the 1988 Armenia earthquake.

[13] Survivor surveys by So et al. (2008) following the 2005 Kashmir earthquake indicate that many people were inside at the time of the earthquake, and unable to get out of single story stone masonry buildings before they collapsed; many people were similarly unable to escape collapsing single story stone masonry and earthen buildings in the 1988 Armenia (Noji et al., 1990), 1993 Latur, India (Parasuraman, 1995), and 2003 Bam, Iran (Maheri et al., 2005) earthquakes, among others.

[14] Alexander (2012) found that during the 2009 L'Aquila, Italy earthquake, protective actions were of unpredictable effectiveness at the maximum damage grade on the European Macroseismic Scale, defined as occurring when more than 50% of the building collapses. This earthquake caused numerous collapses of unreinforced stone masonry buildings.

[15] See discussions of injuries in Petal (2011) and Wood (2014).

there are few quantitative data on the harm to people who are outside of buildings in dense urban areas from structural damage and exterior falling hazards.

Falling objects create a "danger zone" near building facades that people must cross while trying to evacuate during shaking. (Some people refer to this area as a "kill zone" because of reports from multiple earthquakes of people being killed by falling debris outside buildings.[16]) The size of the "danger zone" depends on the height of the building, the type and origin of falling objects, and whether the building or neighboring buildings are at risk of collapse.[17] The physics of masonry wall collapse and post-earthquake observations indicate that the few meters adjacent to the building are the most hazardous for falling objects.[18]

Figure 3. Fallen bricks near building from front wall collapse (left) and partial wall collapses (right), 2015 Gorkha Nepal earthquake (Credits: Anne Sanquini, (left), Bipin Shrestha (right), provided by Earthquake Engineering Research Institute)

Buildings constructed to modern earthquake-resistant codes are designed to protect the lives of occupants but may incur damage in a major earthquake. Even in buildings considered safe from collapse, there is still a risk of falling hazards inside and outside. Designing buildings to have little structural damage is generally expensive and typically done only for buildings such as hospitals and emergency operations centers.

In addition to threats from falling objects in the "danger zone," human behavior poses threats during evacuations and running out. Crowding, in places with limited exits, creates conditions in

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[16] For example, 1970 Peru; 1976 Friuli, Italy (both in Armenian et al. 1992); 2011 Christchurch earthquakes (see New Zealand Police and The New Zealand Herald reports that list location of death for all fatalities); and multiple California earthquakes.

[17] Danger zones created by objects falling from buildings, including structural collapse debris, have been defined in efforts to keep firefighters safe and to prevent casualties in aftershocks. Standard guidance for structural collapse is 1.5 times the building height, which includes a collapse zone equal to the building height plus an allowance for scattering debris (CALBO, 2013; NIOSH 2010). Smaller danger zones have been defined for potential falling objects such as upper story masonry walls (1.5 times upper story height) and parapets (3m) (Christchurch City Council, 2010).

[18] See discussion of wall collapses in FEMA (2008).

which mass behavior[19] is possible as people surge toward limited exits, though stampedes have rarely occurred during earthquakes. Exiting during shaking, especially attempts to move down stairs, can lead to falls and resulting injuries.[20]

Secondary hazards cause extensive loss of life in some earthquakes. People protect themselves from most secondary hazards by evacuating away from the threatened area after the shaking stops. For example, where a tsunami may strike after an earthquake, people should evacuate to high ground or to vertical evacuation structures such as upper floors in strong buildings. For post-earthquake fires, messages on what to do after shaking typically contain advice on preventing fires.

Protective Actions

The information gathered during this project—from technical literature, surveys of the public, and consultations with and surveys of messaging professionals—shows that there is no single protective action that has been universally accepted as the best course of action to take in all contexts. The project's survey of professionals responsible for safety messages in 17 countries, and review of the technical literature, reveal two main categories of protective actions that message givers currently advocate for people who are inside buildings when an earthquake strikes:

- Shelter within the building (includes Drop, Cover, and Hold On, go to a safer place within the building, stand in doorway, and other actions inside the building); and
- Evacuate the building (go outdoors).

Table 1 lists specific actions for each of these two categories.

For individuals outdoors when shaking occurs, the guidance to remain outdoors is almost universally accepted and is supported by both available evidence and logic. Yet, people need to act with awareness if they are outside in densely built-up areas without safe open spaces and where building pieces such as glass and cladding are likely to fall. In these places, being outside may be more dangerous than being inside a building. The applicability of the universally accepted guidance should be re-examined for such areas, after further study. (Such situations are likely to be rare in low- and middle-income countries, but may occur in areas dominated by new construction.)

For those in areas with major secondary hazards such as tsunamis, there was general agreement that the presence of a secondary hazard should not affect the recommended action to take *during shaking itself*. Rather, the message should have three parts: the recommended action during shaking, ways to help determine whether the secondary hazard is likely (for tsunamis, usually by

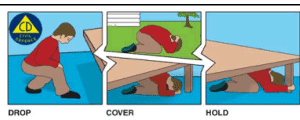
[19] Santos and Aguirre (2004) describe mass behavior, which is a response of crowds to a diminishing opportunity to escape and differs from panic, which is hysterical antisocial behavior. For stampedes during earthquakes, see discussion in background paper by Wood (2014); stampedes occurred in the 1990 Luzon, Philippines and 1992 Egypt earthquakes.

[20] The majority of hospitalizations in the 1994 Northridge, California, USA earthquake were due to falls suffered while trying to move during shaking (Peek-Asa et al., 1998), though this earthquake primarily affected wood-frame houses that rarely collapsed.

observing strength or duration of shaking), and the action to protect oneself from the secondary hazard once the shaking stops, such as "evacuate immediately to higher ground" for tsunamis. Messaging professionals recommended during consultations that all messages to shelter within the building should be followed by a second message to evacuate the building after shaking stops. An exception would be situations in which the evacuation itself would be more hazardous than remaining in a potentially damaged building,[21] such as in hospitals or locations without a safe open space to assemble outside.

Table 1 provides examples of common types of protective actions and provides examples of when these actions are effective and ineffective. Each of these protective actions has the potential to increase the chances of survival in particular circumstances. The challenge, identified in the literature review and the survey research, is to determine under what circumstances the protective action is effective.

Table 1. Common types of protective actions and accompanying messages, and examples of when they are likely to be effective and ineffective.

Protective Action	Description	Rationale	Examples of when this protective action is likely to be effective	Examples of when this protective action is likely to be ineffective
		Shelter Actions Within the Building		
Drop, Cover, and Hold on (DCH)	 Drop to knees, make yourself small, and take cover under sturdy furniture (usually), such as a table or desk, and hold on; includes similar actions to protect the head and neck from falling objects in locations without sufficient cover and for people unable to take cover.	Dropping to knees prevents injuries from falls; making oneself small creates a smaller target for falling objects. Protecting head and neck reduces injuries to these most vulnerable parts of the body. Taking cover under sturdy furniture protects people from falling objects. Sturdy furniture protects the head and neck of the person underneath it. Holding on keeps the furniture positioned for protection.	Inside a well designed and constructed building that contains sturdy furniture. Inside a building unlikely to collapse that contains falling hazards (e.g., bookshelves, light fixtures).	Inside a building very likely to collapse. Available furniture would provide little to no protection. Inside a school chemistry lab with bottles that can fall onto the ground, break, and release chemicals. In a kitchen near a stove with hot liquids that might spill.

[21] Major structural damage that puts the building at risk of collapse during a strong aftershock might not be readily apparent from all, or even most, interior locations. For example, people in the upper stories of a building with a badly damaged open ground story would not be able to see the damage without going outside.

Protective Action	**Description**	**Rationale**	**Examples of when this protective action is likely to be effective**	**Examples of when this protective action is likely to be ineffective**
Assume fetal position	Curl up in a position similar to a baby in the mother's womb.	Makes a person small to create a smaller target for falling objects.	Inside a building unlikely to collapse and having few dangerous falling objects. Sturdy furniture is not available for taking cover. Person can get down low, next to a piece of furniture that may deflect falling objects.	Inside a building that is very likely to collapse. Inside a building with dangerous interior objects that can fall. Inside a school chemistry lab with bottles that can fall onto the ground, break, and release chemicals. In a kitchen near a stove with hot liquids that might topple.
Go to a designated safe zone	 (Translated: "Safe Zone in Case of Earthquake") In large buildings, "safe zones" are pre-determined and clearly marked, inside and sometimes outside the building. "Safe zones" are explained, so people can identify them in smaller buildings without markings.	Pre-determining helps people to identify and reach safe zones during earthquake shaking. People can mitigate the threat of falling objects in areas where they spend the most time. Marked "safe zones" are often stronger areas such as near major vertical structural members or interior corners in masonry buildings.	In well-built buildings unlikely to collapse, and with "safe zones" properly identified and marked by a qualified engineer AND the zones remain clear of falling hazards. Assumes people understand the zones and follow the signs. May provide some protection in some collapses, as major vertical structural members may not be completely crushed.	Inside buildings very likely to collapse. Marked safe zones are not properly identified by a qualified person (safe zones may differ depending on the type of building). Objects that can fall (e.g., heavy bookshelf, heavy light fixtures) are near the identified and marked safe zone. Locations where falling masonry is likely.
Stand in a doorway	Take shelter under a door frame.	In past collapses of masonry buildings, some timber door frames have remained standing.	Inside a dangerous masonry or earthen building likely to be severely damaged AND the door frame is supported by structural members (i.e., structural posts and lintel). Doorway(s) has enough space for all occupants.	In modern buildings where door frames are not structural members. Doors can be heavy and might swing and hurt people standing in the doorway. In a high occupancy building where there are more people than doorways, even if the doorways are considered a safe place. If other people try to run out, they may collide with the person in the doorway.
Move to a	Stand or crouch at the corner	In concrete	Inside a well-designed	Exterior corners may be

Protective Action	**Description**	**Rationale**	**Examples of when this protective action is likely to be effective**	**Examples of when this protective action is likely to be ineffective**
corner of the room	of the room.	buildings with unreinforced masonry walls, the corner column may stay intact, whereas the walls are more likely to collapse. In masonry buildings, interior corners are less likely to have major damage than exterior walls.	or code-compliant concrete building* and there are few occupants in the room. Provides some protection in well-built (not necessarily reinforced) masonry buildings.	the initial point of failure and could be dangerous. If there are several occupants.
Go near an inside wall or column	Crouch next to an interior wall or column.	Interior walls (in masonry buildings) and major structural members are unlikely to be completely crushed and are thus likely to create voids.	If there are no dangerous interior objects including masonry from damaged infill wall, which can fall.	If there are significant interior objects, including masonry from interior walls, that can fall.
Move to an upper floor	Go up at least one story higher in the building.	The ground floor is the most hazardous place in an open-ground-story building, and upper stories of concrete buildings may be less likely to collapse than lower stories.	On the ground story of an open-ground-story building in an area without safe open space outside. On lower stories of a reinforced concrete building with weak lower stories, and only if time to move safely on stairs prior to collapse.	Inside a building that is likely to suffer pancake-type collapse. Inside a building with upper stories as weak or weaker than lower stories. Stairs are inadequate or there is insufficient time to move higher up.
Triangle of Life	Take shelter next to a sturdy object, rather than under it.	The object may create a triangular void** next to it (where the person would be taking shelter) if the building were to collapse.	Inside a building, with heavy floors, that is very likely to collapse AND there is no sturdy furniture to take shelter under AND there are sturdy, dense objects that are not easily toppled or crushed (e.g., short filing cabinet).	If the sturdy object itself could slide (e.g., refrigerator, washing machine) and pin or crush. If exposed to other objects that are likely to slide or topple. If objects falling from above (e.g., cabinet and shelf contents) might injure someone. Near masonry walls where damage causes falling masonry.
Evacuation Actions				

Protective Action	Description	Rationale	Examples of when this protective action is likely to be effective	Examples of when this protective action is likely to be ineffective
Evacuate	Exit the building quickly***.	Getting out of a building protects people from possibly being killed or trapped in a collapse.	Inside a badly-built structure that is vulnerable to collapse (especially if it has a heavy roof and walls) AND one is located near an exit that leads to safe open space.	Inside a building that is unlikely to collapse. Inside a building that has dangerous falling hazards directly outside (e.g., parapets, chimneys, gable walls, masonry infill walls, water tanks, glass and cladding, decorative elements, planters, large business signs over exits). If it is impossible or unsafe for the majority of occupants to exit the building before the earthquake is over (for example, in high occupancy buildings with limited exits).
Go to a designated safe zone outside building	Evacuate from the building to marked safe areas outside, similar to a fire or other evacuation. Evacuation is typically slower than the rapid evacuation above, and can be based on a warning from an early warning system.	There is enough warning time for an orderly evacuation of single-story and even multi-story buildings.	In a few areas, such as Mexico City, with early warning systems and long times between the remote fault rupture and commencement of strong shaking.	In areas with nearby faults likely to have a short time before strong shaking begins.

* Most buildings constructed to modern earthquake-resistant design codes are designed to protect the lives of occupants but incur significant structural damage in a major earthquake as a way of dissipating seismic energy. Designing buildings to have little structural damage is generally expensive and is typically done only for important buildings, such as hospitals and emergency operations centers.
** See discussion in subsequent section on the Triangle of Life.
*** Evacuation does NOT include jumping out of windows above the ground story, which is very risky and likely to result in injury or death.
Graphics sources: Drop, Cover, and Hold On: New Zealand Ministry of Civil Defence and Emergency Management; Safe Zone: INDECI, Peru.

Effectiveness of Protective Actions

Studies that directly address the effectiveness of specific protective actions are rare,[22] especially in places where many heavy buildings collapsed. However, some evidence does exist. Epidemiological studies of deaths and injuries in past earthquakes provide information on where and how people have been killed or injured, and surveys of survivors document actions people

[22] See background paper by Wood (2014) for a discussion of data available in published literature. Petal (2011) and Doocy et al. (2013) contain several helpful tables summarizing available studies. Some studies (e.g., Spence and So, 2009) use terms such as "evasive action" that make it difficult to determine specific actions, or only discuss whether people remained inside buildings or evacuated (e.g., Armenian et al. 1992) and do not mention the specific actions taken inside buildings.

took.[23] These studies, coupled with structural engineering judgment, based on decades of post-earthquake observations and research of building damage and collapse in earthquakes, form the basis for Table 1. Surprisingly, no quantitative data on locations of casualties and survivors are available from search and rescue operations. Survival anecdotes, while emotionally compelling, are not used as a basis to determine effectiveness without applying professional judgment.

Available studies[24] indicate that protecting oneself from falling objects and restricting movement during strong shaking helps prevent injuries from falls. The limited data—typically either for evacuation or for Drop, Cover, and Hold On—indicate that effectiveness in preventing death and injury depends strongly on the building type, typical damage or collapse type, and risk of being struck by objects falling from building exteriors.[25] When buildings collapse, those who are able to move without falling, and who exit without being struck by falling or sliding objects on the way out or outside, may avoid death or injury due to building collapse.[26] Small, single story buildings are the easiest to exit quickly and in many cases are the only buildings that can realistically be evacuated by most people in the time available, as discussed later in this document. Drop, Cover, and Hold On is effective when buildings do not collapse, and may be more effective in situations where it is more dangerous outside the building than inside. In some types of collapses, Drop, Cover, and Hold On may protect occupants,[27] if the sheltering furniture is sturdy enough.

Concerns about the Triangle of Life

Perhaps the most controversial protective actions message to emerge in recent years is the Triangle of Life, which circulates primarily via "viral" email messages following earthquakes and is rarely disseminated by official sources. There are no data that support the message creator's contention that ordinary building contents create survivable, triangular shaped voids next to them during building collapses, except possibly in buildings with lightweight floors and roofs and which contain large and sturdy contents.[28] Contents move during shaking, and it is difficult to identify, prior to the earthquake, where sturdy furnishings or other contents might create void spaces. The Triangle of Life will *not* protect people inside buildings from the threat of falling objects nearly as well as being underneath sturdy furniture will protect them. However, in the absence of cover, making oneself small alongside sturdy furniture (that one can't get underneath, such as a couch), and that is unlikely to topple or slide, may reduce the chances of being struck by falling objects.

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[23] See background paper by Wood (2014); a number of references discuss available studies, including Doocy et al. (2013), Petal (2011) and Spence and So (2009).

[24] Studies on causes of injuries during earthquakes include Johnston et al. (2014), Peek-Asa et al. (1998), Petal, (2009), Shoaf et al., (1998).

[25] Discussions in multiple references, including Wood (2014) and Armenian et al. (1997) and Petal (2011).

[26] See Wood (2014) for a discussion of studies on the effectiveness of evacuating.

[27] NSET-Nepal reported that in some stone masonry schools collapsed by the 2011 Sikkim – Nepal border earthquake, desks would have protected students taking cover under them, had the earthquake occurred during school hours (Gurgain, personal communication, 2014).

[28] See discussion of collapse types and potential locations of survivable voids in FEMA (2008).

Prevalence of Protective Actions

According to the project survey, Drop, Cover, and Hold On was the action most commonly recommended by messaging professionals' own agencies (49%), though a substantial fraction of professionals reported that their agencies gave messages recommending other actions, as Table 2 shows. While most agencies disseminate a message advocating a single protective action, some prescribe different protective actions in different contexts. For example, the International Federation of Red Cross and Red Crescent Society's (IFRC) recent key messages document recommends evacuation of those inside single story adobe buildings with heavy roofs, and Drop, Cover, and Hold On in all other buildings.[29] In many countries, government agencies have prepared materials with illustrations and simple messages for posting in schools and other public places in an effort to raise public awareness that rapid actions can be taken by anyone to protect themselves during earthquakes.

Table 2. Protective actions recommended in messages disseminated by messaging professionals' agencies (respondents could select multiple answers)

	Agency Distributes
Drop, Cover, and Hold On	49%
Go to suitable place	33%
Run out of building	21%
If in earthen building, run out	21%
Triangle of Life	12%
None	16%
Other	16%
Unknown	---

Situational Awareness

The evidence discussed above indicates that the best protective action to take might vary significantly from building to building, situation to situation, and even depends on the time the earthquake occurs (e.g., in the middle of the night versus at midday). Because of this variability, message creators should promote *situational awareness*—that is, for people to be aware of their environment and use their judgment in determining the action to take. Local people and organizations responsible for developing and delivering messages should aim to evaluate and understand their environment, and, with this information, agree on the content and delivery of messages to their target audiences. Local authorities and responsible bodies must be the ones to determine the best protective actions messages to communicate to their communities, rather than uncritically adopting messages from outside sources.

What Causes People to Believe the Message

The goal of any messaging effort is that people act on the message. For this to happen, people must believe the message and decide that they will take the recommended action. The

[29] IFRC (2013), p. 36.

background paper on risk communication[30] describes the Protective Action Decision Model in which people act based on their perceptions of:

(a) environmental cues, such as sights, smells, or sounds that indicate the onset of a threat;
(b) social cues, such as observations of others responding in a way that indicates there is a threat; and
(c) information received from social sources through communication channels that convey messages about the hazard and protective actions.

Messages are effective when the message giver has expertise, is trustworthy, has a responsibility for protecting people, and the audience perceives them as such.

Prior beliefs and experience are also factors. In the project survey of professionals responsible for safety messages, 76% reported that people held firm beliefs, or believed rumors, which created challenges for their messaging efforts. For example, in Afghanistan, there is a traditional belief that one should take seven steps away from danger. Understanding and addressing existing beliefs is an important component of message development efforts.

An effective strategy to educate vulnerable communities about protective actions to take during earthquake shaking must avoid two pitfalls: sending messages that are "contradictory, inconsistent, or unclear, resulting in public confusion, apathy, mistrust and inaction,"[31] and endorsing "uncritical adoption of messages across regions."[32] Instead, messages must be "standard and consistent, backed by a consensus of key stakeholders, and based on the best knowledge available at the time."[33] Messages should also convey the underlying logic behind using or not using a particular protective action.

Surveys of the general public in India, Peru and Turkey[34] show that people in each country reported receiving messages advocating a variety of protective actions, with the most commonly received message depending on the country. People receive information from both official and unofficial sources, causing most respondents to be exposed to multiple, often conflicting messages. A strong messaging program can help overcome the confusion of conflicting information: more than two-thirds of public survey respondents in Peru said they would heed the government's official message to go to a safe zone; the GHI survey results show that Peru's messaging program effectively communicated its message and was a trusted source.

Table 3 shows that people surveyed in India believe that running out is the most effective protective action, and people in Peru and Turkey believe that going to a designated safe zone is most effective. Note that neither Turkey nor India has a program to identify and mark safe zones, as Peru does. It is notable that those surveyed did not view Drop, Cover, and Hold On as

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[30] See Lindell (2014) for a description of the Protective Action Decision Model and principles of effective risk communication.
[31] IFRC (2013), p. 14.
[32] Ibid, p. 56.
[33] Ibid, p. 11.
[34] See Cedillos et al. (2014) in the companion volume for project survey methodology and all findings.

particularly effective; it ranks third from last in Turkey, next to last in India, and last in Peru (where it is not the official message). Both Turkey and India have had messaging programs promoting Drop, Cover, and Hold On, though these programs appear not to have been as widespread or effective as the Peruvian messaging program that advocates safe zones. However, people do view "Get under sturdy object"—a message to do essentially the same thing—as more effective than Drop, Cover, and Hold On. Also of note, the "Triangle of Life" message, which is rarely promulgated by official sources and has no data supporting its effectiveness (see Wood, 2014), is perceived as effective by many people. This result may be explained by the persistence of viral email messages that circulated following earthquakes over the past decade. The public survey results supported concerns by messaging professionals that incorrect information exists and poses a challenge to changing perceptions about what actions people should take.

Table 3. Results of general public survey about perceived effectiveness of different protective actions, assessed on a five-point scale in which 5 is "very effective" and 1 is "very ineffective". The highest score from each country is highlighted.

	India n = 188	Peru n = 204	Turkey n = 208	Total n = 600
How effective do you think each of these is in protecting you from harm during an earthquake?				
Go to designated safe zone	3.91	4.19	3.97	4.02
Triangle of Life	3.65	3.65	3.80	3.71
Get under sturdy object	3.86	3.07	3.77	3.57
Run out	4.14	3.65	2.57	3.43
DCH	3.37	2.70	3.41	3.16
Get in doorway	3.36	2.88	3.17	3.13

The survey of messaging professionals showed that the skills of communications professionals and social scientists are under-utilized when developing protective action messages. Communications specialists are involved only 26% of the time, despite communications being rated the second-most important activity for successful message development, after technical assistance to select the most appropriate message. (This guidance addresses the top finding.) Structural engineers (47%), emergency managers (44%), and seismologists (37%) were most often involved. While these disciplines are necessary, message development efforts need greater involvement by social scientists who can provide insight into human behavior and by communications specialists who understand how to communicate effectively in the local context.

Time Available to Take Protective Action

The time available to act begins when perceptible shaking initiates and ends when ground motion makes it difficult to take protective action, which this guidance defines as the point at which walking becomes difficult.[35] The amount of time depends on characteristics of likely earthquakes, primarily the distance and magnitude, as described in the subsequent section on Local Earthquake Hazard in Part I, Considerations for Message Content Development. Analyses conducted by Hough for this project[36] found that in most circumstances, the available time to act

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[35] An intensity of V on the Modified Mercalli Intensity (MMI) scale is considered the shaking intensity at which it becomes difficult to walk (discussed in the full definition, rather than the abridged version). This scale, and others such as the European Macroseismic Scale (EMS-98), use Roman numerals from I to XII to describe the intensity of shaking at a site and are commonly used when discussing earthquake shaking with the public. Intensity of shaking felt by the population is an entirely separate measurement from magnitude, which measures energy released.

[36] Based on an analysis described in Hough (2014) in the companion volume.

is likely to be at least five seconds. The five seconds to act is based on the likely locations of moderate to large earthquakes (which are much more likely than great earthquakes of magnitude 8 and above) with respect to population centers in active tectonic regions worldwide. The time to act will be more than five seconds in some earthquakes and less than five seconds in others. Approximately nine out of ten times, a damaging earthquake is likely to occur far enough away to provide five seconds between the first seismic wave arrival and the onset of strong shaking that makes taking protective action difficult. This analysis relies on global earthquake distributions and data, with reasonable scientific assumptions on where earthquakes originate; local jurisdictions could conduct their own, similar, analyses with local seismic sources and data if more refined local estimates are desired.

The perception that an earthquake is occurring, and the time it takes for people to decide to act, affects the amount of time people will have to implement their chosen action. People "mill" information and, when with others, look to them for cues when deciding how to respond.[37] Some people will freeze and be unable to take action, while others will act to protect children or other vulnerable family members. Household surveys after the 2011 Christchurch and Tōhoku earthquakes[38] show that, when asked about their first response to the shaking, only 5-15% reported taking cover (Drop, Cover, and Hold On), 30-40% reported they froze (the amount of time for which they froze is unknown), and 15-30% said they evacuated immediately (but these evacuations may not have been instantaneous). These data suggest that, even if there is a high level of earthquake preparedness (as in Japan) or recent earthquake experience (as in Christchurch), there will be major delays in response during the short interval between the initial seismic wave arrival and the time when strong shaking begins.

Past earthquake observations by structural engineers[39] indicate that building collapse often occurs very rapidly once the strength of shaking overcomes the building's capacity, in perhaps a few seconds (perhaps three to four seconds maximum, per Gulkan, 2014), though there is little data on the time it takes for collapse to occur. Almost all collapses occur after strong shaking begins. People will not have time to take action if they wait until the building begins to experience structural damage, because the buildings most vulnerable to collapse during earthquakes are types that tend to fail suddenly with little warning.

The seismological, behavioral, and structural engineering findings all indicate that rapid action at the first sign of shaking is necessary. The findings reinforce the importance of having individuals decide before an earthquake how they should respond in each of the locations they find themselves during the day.

[37] See background papers by Lindell (2014) and Wachtendorf and Penta (2014) for discussions of milling and how people make decisions to take protective action.

[38] See Lindell (2014) for a discussion of human behaviors in response to shaking based on studies of several earthquakes.

[39] See background paper by Gulkan (2014) for a discussion of the time it takes buildings to collapse.

The Process and Team to Create Messages

Who understands the community, and who understands its earthquake risk?

Before beginning a message development effort, those leading the effort must carefully consider their target audience. Messages developed through a participatory process, designed to build trust and support, will stand a greater chance of being well-received by the intended audience. The IFRC's guidance document on consistent messaging[40] also recommends a participatory process involving key stakeholders. Those participating will depend on the geographic area selected. Ideally, messages are developed and customized at the community level, but this is rarely practical, due to resource constraints. Consistency in messaging is also important, especially if many different groups, such as government agencies and NGOs, will be communicating earthquake safety messages to the public. The following sections describe recommendations for the process to achieve what everyone wants: messages that people believe and act on.

Designing the Process to Involve the Right People from the Beginning

Developing an appropriate message requires the efforts of many people who can speak for the technical disciplines and who understand the physical environment and the community fabric. Committees provide a structured process to develop and discuss the message that will be formally delivered. It is recommended that jurisdictions form a Message Development Committee responsible for developing the core message.

Specific groups of people and contexts may require a message that differs from the core message in the community. Subcommittees encourage representatives of all populations to participate, while the Message Development Committee can remain small enough to work efficiently and develop a message for the majority. It is recommended that jurisdictions create subcommittees to tailor the core message for the needs of people with unique functional and access needs and for high-occupancy or institutional settings such as schools, hospitals and health care facilities.

It is crucial to involve the right people in these committees from the beginning of the process. Subsections below describe the members of the main committee and subcommittees. In almost all countries with appreciable earthquake hazard, national technical experts have the requisite knowledge to provide input to the process. These people may be in professional practice, in universities, in the government, or in civil society. They may not be present in every jurisdiction, especially in smaller cities, but can be found within the country and encouraged to participate.

Ideally, the government agency with the mandate for safety message dissemination in the jurisdiction should convene the committees. It is helpful to begin with a unified approach at the national level (or, in large countries with variable earthquake hazard, at the state or provincial level). To reduce the possibility of different organizations providing conflicting messages to the public, the multiple officials and organizations advising the jurisdiction, such as national and local emergency managers, science and engineering professional societies and institutions, INGOs, UN agencies, and local NGOs should agree on a common message.

The Message Development Committee

This committee is charged with developing a core message that is considered "best" for the general population, keeping in mind that the committee will need to define how to determine the "best" message.

[40] IFRC (2013), p. 17.

The Message Development Committee should have representatives from relevant technical disciplines, including social scientists who can provide the facts necessary to determine whether certain protective actions are advisable or realistic. This committee must also contain representatives of the message-giving organization. The committee should have the members necessary to provide information and thoughtful consideration of majority community values and needs. Women are an equal portion of the population in any jurisdiction, and their perspectives should be adequately represented in the main Message Development Committee. Table 4 shows whom to select for this committee, based on their knowledge and expected contribution to the committee's task. Some committee members may fill more than one role listed below.

Table 4. Suggested members of Message Development Committee

Member Affiliation and Technical Background	Messaging Consideration	Contribution to Messaging	Examples
Organization(s) that will communicate the message	Geographic area or jurisdiction	Geographic area and national context, target area characteristics	Representative(s) of national, state or provincial disaster management agency or civil protection agency, local NGO, UN agency, or INGO
Social science	Beliefs, traditions, customs	Identify potential conflicts with proposed messages or that would affect a person's ability to take protective action; suggest strategies to address barriers	Academic, local leader, or specialist from NGO
Local demographics	Population exposure	Explain where people are located, and when	Local government planning employee; community representative
Structural engineering	Local buildings	Knowledge of building stock and earthquake vulnerability, building codes and enforcement, construction quality	Professional engineer or academic; may need more than one depending on how many types of buildings
Earth science	Local earthquake and related hazard	Up-to-date detailed information on local earthquake hazard and site conditions	Professional or academic; may need more than one to cover site conditions and tsunami, landslide hazard
Woman	Gender and age vulnerability	Issues faced by women, elderly and children, such as tendency to be in hazardous building type or cultural norms affecting ability to take protective actions	Woman representative of the local community
Communications/ Public Relations/ Marketing	Create and disseminate messages	Guide content into message forms; develop strategy to communicate in the community	Government public information officer, marketing or advertising professional; journalist
Local government	Major stakeholder	Explain government's concerns; support the messaging through input and outreach	Civil protection
Public health or medicine	Health effects of earthquakes	Understand how local buildings can kill or injure and interpret epidemiological and medical studies	Epidemiologist or emergency medicine/ trauma specialist

The importance of considering local customs and deeply-embedded beliefs

In some cultures, women and children leave home only in the company of a man in the family. However, the men may not be present when a strong earthquake strikes unexpectedly. In the October 2005 Kashmir earthquake, a disproportionate number of women and children died in collapsed structures. Even though most of these buildings were highly vulnerable and small enough to exit safely, women viewed evacuating on their own as unthinkable. What can be done to save more lives? If evacuation is a recommended protective action, the community must address this scenario according to its norms, and develop socially acceptable evacuation options for women and children.

Worth noting because this skill is often overlooked, the Message Development Committee should include members who can guide the process of transforming the message content into effective message forms, as Part II describes, and develop the strategy to communicate the message to the jurisdiction, as Part III discusses. Communications, public relations, and marketing professionals possess the skills necessary for these tasks. In smaller jurisdictions where these specialists may not be available, consider involving people who regularly communicate with the public, such as newspaper editors, radio and television news broadcasters, or religious leaders. In some cases, the committee may need translation support, if source materials are not available in the languages spoken by committee members. Efforts to develop the communication strategy should include representatives of the subcommittees described below.

Subcommittees to Address Specific Populations and Settings

The core protective action message may not work well with every sector in the population. Subcommittees have the critical task to adapt or modify messages to serve specific groups of people. Subcommittees need to contain members of the populations they represent or who can speak on their behalf. The number of subcommittees will vary with the local population and needs. Most communities will need the following subcommittees:

- **People with mobility, sensory, or cognitive limitations.** Involve individuals who work with people with the different functional and access needs present in the community, or members of the communities themselves. Representatives must be aware of the limitations and challenges that these populations could face during an earthquake.
- **High occupancy or institutional settings such as schools, large assembly buildings (e.g., places of worship, stadiums, theaters, shopping centers, large office and apartment buildings), and hospitals.** Involve a social scientist or specialist who can speak to people's behavior and instincts in particular circumstances, as well as in contexts with certain constraints (e.g., schools or large gatherings where mass behavior is possible; hospitals where people may not be able to take the same protective actions as in other locations). The government agencies responsible for schools and health care should be involved. Depending on the context, multiple subcommittees may be needed. In particular, schools will likely need their own subcommittee.

Political Context

Political considerations may influence any communication about protective actions during earthquake shaking. In some communities, certain messages might be interpreted in ways that cause political tensions or problems. For example, certain protective action messages might imply that some public buildings are unsafe. This could create public concern, which would put pressure on the government to deliver what it does not have the resources to accomplish, such as building new public housing or schools. In many ways it is good for people to demand safer buildings. However, depending on the political situation, the government may not view public pressure positively.

It is important to understand the political context and involve key government people in the process of developing the messages. Options include involving a government representative in the Message Development Committee or establishing a project advisory committee comprised of representatives from key government agencies. A strategy that includes a process for obtaining support from the "right" people, politically, should be developed. In developing this strategy, it is important to understand the underlying concerns, if any, of the government. Making sure the government is supportive is almost always necessary for successful long-term mitigation and preparedness efforts.

PART I. Considerations for Developing Messaging Content

What are the message content considerations for this school with crowded classrooms, scarce cover, vulnerable construction, and spiral exit stairs?

Part I describes factors that the Message Development Committee should consider when deciding what message to give the public about protective action to take during earthquake shaking. The first step is to define the geographic area under consideration. Next, there are several considerations about the population, the building stock, and the earthquake hazard. The graphic below (Figure 4) illustrates how the considerations described in this section lead to an appropriate message for the local context.

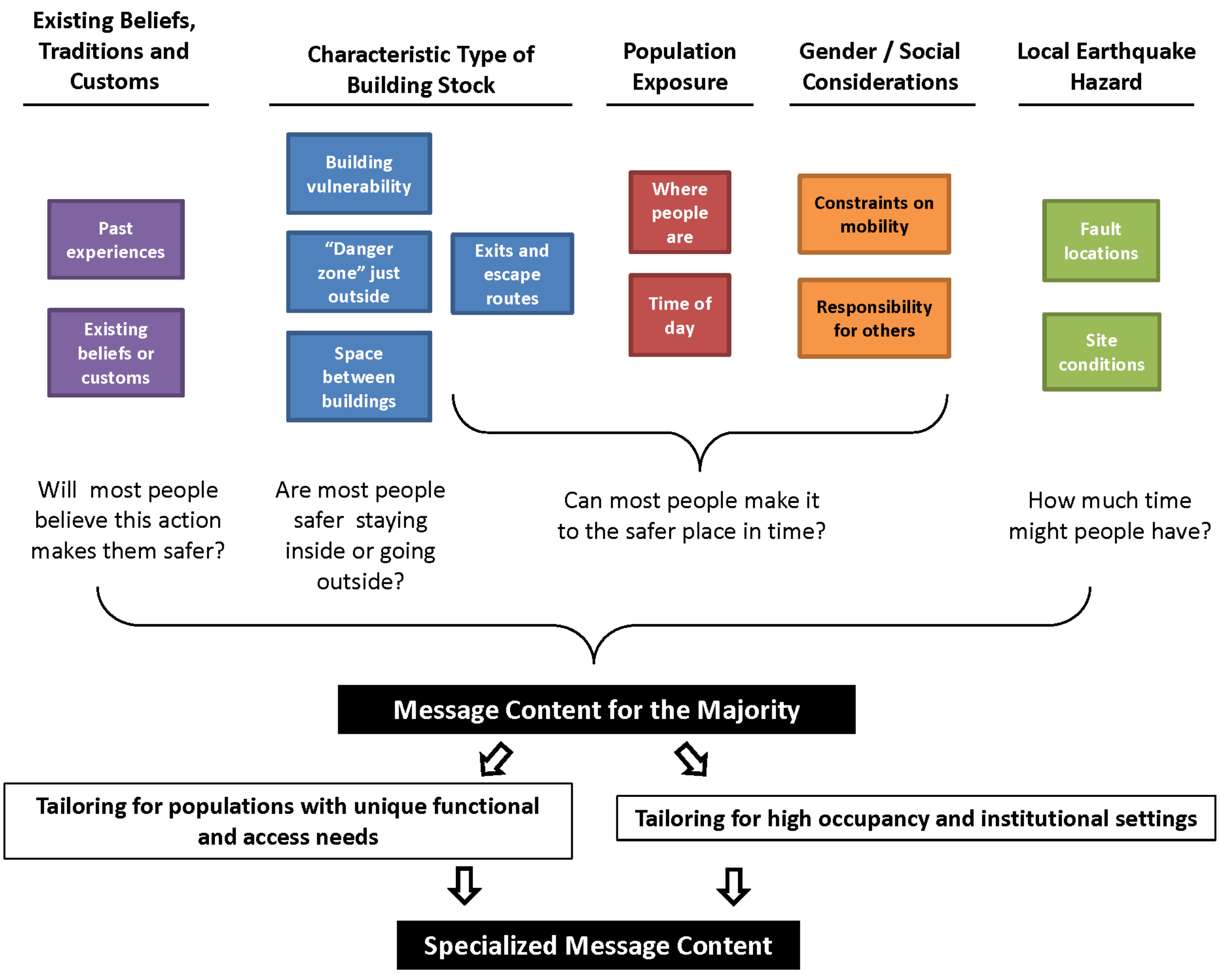

Figure 4. Considerations when determining protective actions message content for people inside buildings.

Geographic Area or Jurisdiction

The first step is to determine what geographic area or jurisdiction the message will target. Geographic areas are often defined in terms of political or administrative jurisdictions. Jurisdictions can also be areas of responsibility, such as schools. The appropriate message can vary significantly depending on the jurisdiction. As the size of the geographic area increases, and thus variation increases in the community, social issues, and building type, the difficulty of crafting one message greatly increases. Some examples of geographic areas at which messages can be targeted, in order of size, include:

- Small jurisdictions (i.e., rural villages or small cities) or thinly populated rural areas (may be large in geographic size). Developing an appropriate message might be simpler, as it is likely that there will not be many different types of buildings and the cultural norms are likely to be similar. For cost reasons, small jurisdictions may wish to rely on or adapt messages from larger jurisdictions.
- Medium-sized jurisdictions (i.e., cities or districts). The message becomes more complicated, as many cities have heterogeneous built environments with varying levels of vulnerability. However, local norms and customs are likely to be similar. These areas will have a higher number of high occupancy buildings that need special consideration (e.g., large commercial and apartment buildings, theaters, hospitals) and pockets where the likelihood of secondary hazards, such as a fire, is higher.
- Large jurisdictions (i.e., countries, states/provinces/departments, regions). The messaging will be the most complicated, as it will include rural and urban areas, a heterogeneous built environment, as well as varying cultural norms and customs.

Existing Beliefs, Traditions, Customs

It is very important, especially in areas where earthquake awareness is limited, to address existing beliefs, traditions, and customs, some of which may conflict with advice the jurisdiction could recommend. Beliefs, traditions, and customs may vary within a jurisdiction by age, religion, and neighborhood. One can develop what might seem to be the perfect message, but if community members do not truly believe that the recommended protective action will make them safer, they will not take that action during an earthquake. This defeats the goal of the message in the first place—that is, to protect as many people as possible from injury and death during earthquake shaking. The sidebar below provides an example of existing beliefs (fatalism) that professionals must address.

An important step for messaging professionals is to gather an understanding of prevailing earthquake knowledge within the jurisdiction. This could include conducting or reviewing studies of public perceptions and actions during earthquakes or discussion with jurisdiction leaders. Local community members on the Message Development Committee can provide insight into 1) the potential believability of new messages and 2) any existing beliefs, traditions, or customs of the population that might conflict with the new messages. If messaging professionals gather a clear understanding of existing beliefs, they can create messages and messaging strategies that counter ineffective existing knowledge and that promote more appropriate actions. Without addressing existing beliefs, any new messaging efforts can fail.

Existing beliefs or customs may be supportive of new messages. Message givers can harness and reframe some existing beliefs or common folklore to advocate for protective action. For example, the traditional Afghan advice to take seven steps away from danger could be repurposed to promote seven steps to earthquake safety.

One way to address fatalism

Some people may resist taking action because they believe that earthquakes—and whether they will personally survive—are "God's will" or unalterable fate. One presenter on earthquake safety countered some fatalistic members of the audience with the humorous story of a religious man and a flood.

> *'A storm came into a town and the local disaster management officials sent out an early warning that the river would soon overflow its banks and flood the town. They ordered everyone in the town to evacuate immediately. A very religious man in the town, who prayed ten times a day, heard the warning but decided to stay, saying to himself, "I trust God, and if I am in danger, God will send a miracle to save me."*
>
> *As the man stood at his front door watching the water rise up the steps, a man in a small boat rowed by and called to him, "Hurry and come into my boat, the water is rising quickly!" But the man again said, "No thanks, my God will save me."*
>
> *The waters rose higher, flooding his home, and the man had to retreat to the higher floor. A rescue motorboat came by and saw him at the window. "We will come and rescue you!" they shouted. But the man refused, waving them off saying, "Save others who need help! I have faith that my God will save me!"*
>
> *The flood waters rose higher and higher and the man had to climb up to his rooftop to save himself. A helicopter saw him and dropped a rope ladder. A rescuer came down and pleaded with the man, "Hold this rope and let us winch you up." But the man still refused saying, "Don't worry about me! My God will save me!"*
>
> *Soon after, the waters swept away the man and he drowned. By the time he met his God, he was surprised and angry. "God! I prayed ten times a day, every day. I put all of my trust in you during this flood. Why didn't you come to save me?"*
>
> *God looked up and asked gently "If I remember correctly, I had sent you a warning, two boats and a helicopter. What more did you want?"*

The presenter concluded the story and told the fatalists, "Today's presentation conveys God's message that you need to get prepared to protect yourself and people under your care. So, please start today! This is the boat that God is sending you. Will you take it?"

Local Earthquake Hazard

Is the earthquake hazard high enough to warrant giving the public a protective action message at all? The public needs messages in areas where the seismic hazard is appreciable, particularly if buildings are vulnerable to damage. Regions that have not experienced a damaging earthquake for many years, or even centuries, may still have significant earthquake hazard. Message givers should provide protective action messages in jurisdictions with low, moderate, or higher levels of seismic hazard, as shown on global or regional hazard maps such as the Global Seismic Hazard Assessment Program (GSHAP) map[41] or on comparable hazard maps in the country's building code. In areas of very low seismic hazard, or where expected shaking is too weak to cause life-

[41] The Global Earthquake Model (GEM) Foundation (globalquakemodel.org), the Global Seismic Hazard Assessment Program (GSHAP) (http://www.seismo.ethz.ch/static/GSHAP/), and the seismology literature are sources of hazard maps.

threatening damage, communicating a protective actions message may not make sense given limited resources for preparedness. Knowing the earthquake hazard is a critical step in developing protective actions messages and for the broader earthquake safety and preparedness efforts to which these messages belong. Seismologists who have studied the local geologic environment and earthquake history should provide this expertise.

The Message Development Committee should review specific components of the local earthquake hazard: time available to take action, local site conditions, and secondary hazards. Each is detailed below.

Time Available to Take Protective Action, Based on Geologic Environment

The nature of earthquake waves allows scientists to estimate the amount of time people will likely have for taking protective actions. The window for action begins when people can first feel shaking and ends when shaking becomes strong enough that it is difficult to walk. The varying travel velocity of different types of seismic waves from the earthquake source provides a natural warning before the strongest shaking begins. The initial seismic "P-wave,"[42] which is usually felt for potentially damaging earthquakes but is still moderate enough that one can walk, travels more quickly and arrives first. The "S-wave" that creates the potentially damaging shaking moves more slowly and arrives later (see Figure 5).

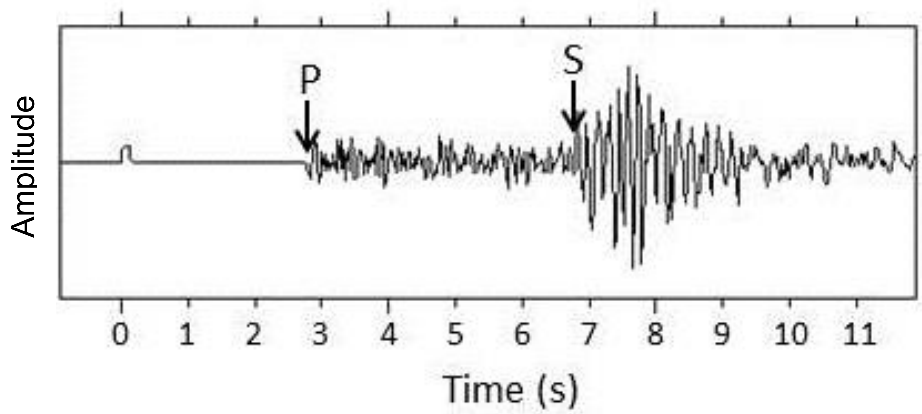

Figure 5. Illustration of a typical seismogram from a small earthquake, showing the time separation between the initial P wave and the later, larger S wave. In this example, the S-minus-P time is approximately 4 seconds.

This time lag between the P-wave's arrival and the S-wave's arrival (often called the S-minus-P time) is one of the two primary factors governing the amount of time between the initiation of shaking perceptible to humans and shaking strong enough to make initiating protective action difficult. (Note that shaking that makes walking difficult may not begin precisely with the arrival of the S-wave; thus the time available to take action includes the S-minus-P time plus the time between the S-wave arrival and strong shaking, which is typically a second or two.) The other factor is the nature of the rupture process as the fault breaks and releases earthquake waves. In

[42] P-waves are also called primary waves, compressional waves or longitudinal waves. They compress and stretch rock and soil as they pass. S-waves are also called secondary, shear, or transverse waves. They create side-to-side, or shearing, motion as they pass.

simplistic terms, the further away the source, the longer the time lag.[43] It is impossible to predict the location of an earthquake; however, in general, the farther a populated area is located from a seismic fault, the longer is the S-minus-P time and the weaker is the shaking that can be expected. Earthquake-prone areas can be categorized into "geologic environments" that have different types of earthquake-generating faults, at different distances, with different expected time lags (see Table 5).

Table 5. Estimates of likely time lag for various geologic environments, for use in determining protective action messages.

Likely time lag	Geologic Environment	Key Characteristics	Examples
About 5 seconds	Areas with seismic sources nearby. Examples:		
	• Along major fault	Earthquakes can nucleate at many points along the fault	Istanbul, Turkey
	• Local faults near active plate boundary	Smaller faults create local hazard	Delhi, India
	• Offshore subduction zone AND also local or major faults	Local or major faults will provide a shorter time lag, therefore one should plan for less time	Padang, Indonesia
	• Intra-plate regions very close to source	Faults in the interior of plates rather than at the boundaries	Bhuj, India
Meaningfully longer, about 10 seconds or more; More choices for protective action*	Areas where adequate scientific studies have concluded S-P time is significantly longer than 5 seconds. Examples:		
	• Subduction zones with NO significant local faults	Usually offshore and some distance from populated regions	San Juan, Puerto Rico
	• Intra-plate regions that are distant from faults	Distant sources	Ahmedabad, India
	• Areas with deep soft soils that amplify distant earthquakes	Distant sources	Mexico City, Mexico

Assumptions: 1) Typically, P-waves create much weaker shaking than S-waves do. However, P-wave shaking intensity will be strong enough to be felt, but not strong enough to make taking protective action difficult, for most earthquakes strong enough to cause structural damage, 2) for brevity, S waves and surface waves are grouped together, because within distances where earthquakes typically cause damage these two waves do not have significantly distinct arrival times, but rather arrive as part of an extended S-wave group.
* Includes areas with robust earthquake early warning (EEW), which can provide a few to tens of seconds of advance warning; earthquake early warning systems exist in very few areas (i.e., Mexico City, Mexico) and are not a feasible alternative in most places in the near future; see discussion in Hough (2014).

[43] An approximation of S-P time in seconds can be obtained by dividing the fault-to-site distance in kilometers by 8. See the background paper by Hough (2014) for a detailed explanation of time lag estimates.

Calculations in the project background paper on seismology[44] show that in most earthquake-threatened areas, the likely length of time available to take protective action can be assumed to be about five seconds. Though there might be more time or less time in a specific earthquake, those developing messages should NOT assume more time is available unless there is specific, robust scientific evidence from hazard studies. Local earth scientists can conduct specific studies, based on the faults that generate local seismic hazard, to determine the amount of time people are likely to have. In a worst case, the earthquake would occur directly beneath a city, and people would not have even five seconds to act. Such direct hits are very rare because in most settings, earthquakes can originate in a variety of possible locations on multiple faults, the vast majority of which are not directly under a city. Local earth scientists can advise on whether such a scenario is likely, or even possible, in the jurisdiction. Most importantly, message givers should recognize that the time available to act will be short, that people need to act immediately, and that they need to practice beforehand.

The likelihood that people may only have five seconds to act places significant constraints on the types of protective actions people can feasibly take. Actions taken in the first few seconds can make people safer. Messages should convey the need to take action immediately when shaking begins, and they should help people understand the need to react appropriately without having to think about what to do in the moment.

Local Site Conditions and Effects

Site conditions, such as certain soil layers and their characteristics, can amplify shaking significantly. In past events, this amplification has been up to 10 times[45] on soft soil when compared to the shaking on hard rock within the same region. Local phenomena, such as basin effects (when earthquake waves reverberate in a natural basin), can amplify shaking and cause the duration of shaking to last longer than it would otherwise. Liquefiable soil can also have a significant effect on the behavior of structures during earthquake shaking. Even well designed and appropriately constructed structures are susceptible to significant damage if their foundations are not designed for liquefiable soil. Buildings constructed on susceptible local sites, whether liquefiable or soft soil, should be of particular concern. Areas over deep soft soils, such as Mexico City, Mexico, can experience damaging levels of shaking that nearby areas on rock or stiff soil sites will not experience. Those evaluating the earthquake hazard must account for how site conditions could affect potential shaking. Geotechnical engineers or engineering geologists familiar with local conditions can provide the necessary technical expertise.

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[44] See background paper by Hough (2014); calculations are based on reasonable assumptions of earthquake origin with respect to population centers, based on data for active tectonic areas worldwide. Calculations are for moderate to large earthquakes of magnitude 6 to 7.5; larger earthquakes are very rare in most locations, and smaller earthquakes are less likely to cause damage.

[45] In the 1985 Michoacan, Mexico earthquake, shaking on Mexico City's soft lakebed sediments was up to 10 times stronger at the fundamental period of the soil column (~2 seconds) as on rock sites in the foothills; see Kramer (1996) p. 314-315 for a discussion. Buildings with fundamental vibration periods similar to the soil column suffered heavy damage; those that were much stiffer or much more flexible did not.

Secondary Hazards

The potential for secondary hazards that could follow an earthquake, such as landslides, fire, tsunami, or hazardous materials releases, should be identified. If message creators identify a risk for any secondary hazard, the message delivered should be sequential. That is, the recipient should do action X during the earthquake shaking itself, and then do action Y after shaking stops, to protect oneself from the secondary hazard. For example, a message given in a tsunami-prone region could be to shelter within the building during earthquake shaking but to evacuate to high ground immediately after earthquake shaking stops.

Local Buildings

Several attributes of typical buildings in a jurisdiction affect recommendations for protective actions: vulnerability to collapse, lethality of collapse, comparatively safer areas, and corresponding "danger zones." Danger zones created by falling parapets, inadequately anchored cladding materials, glass, planters, infill masonry walls, and loose masonry are common just outside buildings and have claimed many lives and caused many injuries, as discussed in the Findings section. In buildings highly vulnerable to collapse, the floor most likely to collapse (e.g., the open ground story), or the entire building, could be considered a danger zone.

Several factors in buildings impact the effectiveness of different protective actions:

- Structure type and size, age and earthquake vulnerabilities[46]
- Occupancy type
- Code compliance and enforcement of good construction practices
- Building condition
- Proximity of neighboring buildings
- Typical building damage and collapse patterns, including potential to generate dust that can cause asphyxiation
- Potential for falling objects inside and outside
- Comparatively safer places
- Comparatively unsafe places (e.g., danger zone right outside buildings, weak ground floor of a multi-story building with open store front)
- Availability of cover such as sturdy furniture
- Condition of escape routes

Damage observations following hundreds of earthquakes have allowed structural engineers to understand typical building damage and collapse patterns and to identify the safer and the more dangerous places for most types of construction throughout the world. For example, past earthquakes have shown that weak earthen and unreinforced brick, stone and concrete block masonry buildings, as well as concrete frame buildings not designed for earthquakes and with certain particularly vulnerable features, tend to suffer more damage and collapse more often in earthquakes than other building types.

[46] When looking at an entire stock of buildings, engineers often use building construction type, age, and size as proxies for typical levels of earthquake vulnerability.

The expected earthquake behavior of buildings in the geographic area is a key factor in determining what types of protective action are most appropriate. In particular, the main considerations are: vulnerability to collapse and potential to kill people during a collapse (e.g., heavy buildings are more lethal than light buildings during collapse; heavy roofs, floors, and walls are more lethal), presence of exterior danger zones, and vulnerable adjacent buildings. Even within common types (such as brick masonry) buildings can differ enormously in vulnerability to collapse, collapse patterns, and lethality. For this reason, including a structural engineer knowledgeable about local buildings in message development is crucial.

The Concept of Characteristic Building Stock

Because protective actions messaging on a building-by-building basis typically is not feasible, one message is generally given to an entire jurisdiction. The concept of characteristic building stock is a way to classify the set of buildings in a jurisdiction based on their type, proximity to each other, and vulnerability to collapse. This approach is most successful if the local building stock consists of a limited number of building types with well-understood seismic behavior. (Building stock simply means all the buildings in a jurisdiction.) A modest number of types of characteristic building stocks comprise many, if not most, rural and urban contexts around the world, in terms of damage that is meaningful for deciding which protective action(s) to recommend. For instance, small vernacular (built according to common construction practices rather than designed by an architect or engineer) adobe houses that predominate in rural Peru, and small vernacular rubble stone masonry houses that predominate in areas of rural northern Pakistan, are likely to collapse in large numbers in a strong earthquake and are also likely to have safe open space outside. Similarly vulnerable vernacular unreinforced masonry and earthen houses exist in rural settings around the world. With these collapse-prone, rural buildings, evacuation from the building during shaking, if possible, will likely protect the most people. (Note that vulnerable unreinforced brick, stone and block masonry, and earthen buildings should not be confused with more earthquake-resistant vernacular building types that include substantial amounts of timber.[47])

The concept of characteristic building stock can help message formulators move from understanding the likely damage to individual building types to understanding what action is likely to make the most people the safest. Table 6 describes some characteristic building stock seen throughout the world and corresponding safer places as well as danger zones, based on past earthquake observations and professional engineering judgment. This list is not exhaustive. Advice on safer locations and danger zones is based on both the predominant building type(s) and prevailing outside conditions.

In locations where a substantial fraction of buildings are of different types and will have different expected damage (such as types 7, 8 and 9 in Table 6), *situational awareness* becomes an important safety strategy. For these contexts, message creators may want to recommend actions for specific building types and outside conditions. Fortunately, the types of buildings that are most vulnerable to collapse AND possible to quickly exit are easy to identify: small vernacular unreinforced brick, stone and concrete block masonry and earthen buildings, and buildings with

[47] See Gulkan (2014) for a discussion of vernacular construction, including some specific types of earthquake-resistant vernacular construction.

an open "weak" or "soft" ground story. A message that advocates evacuation from these buildings may differ from a message for other buildings in the community; such a message would encourage individuals to be aware of their surroundings and recognize the best action for their location.

Table 6. Example types of characteristic building stock, and corresponding safer locations and danger zones

No.	Description of Characteristic Building Stock	Prevailing outside conditions	Location	"Safer" Places, from safest to least safe	Danger Zones
1	Dispersed, unreinforced masonry and earthen buildings	Outside open spaces available	Usually rural areas	Open space outside -------------- Doorway, if structural frame (lintel & post). Note: only better than corner if lintel & posts on doorway ------------ Under sturdy furniture ------------- Interior corner formed by cross-walls	Inside -------------- Directly below gable walls -------------- Outside, near exterior walls
2	Closely spaced unreinforced masonry or earthen buildings	Outside open spaces not easily or quickly accessible; most dangerous falling hazards are from building collapses	Urban areas with narrow streets between buildings ------------------ Rural villages with closely spaced buildings	Upper levels ------------- Interior corner formed by cross-walls	Outside in narrow streets -------------- Directly below gable wall -------------- Near exterior walls
3	Light frame buildings with no severe vulnerabilities (usually timber, bamboo, or light metal)	Varies	Usually areas of low-rise residential buildings in countries where traditional or common modern construction uses lightweight materials	Under sturdy furniture	Near unreinforced masonry chimneys, if present
4	Dense areas comprised of taller buildings (more than 3 stories; typically reinforced concrete but some unreinforced masonry)	Outside open spaces are not easily and quickly accessible; most dangerous falling hazards are from building façade, glass, cladding, collapses	Typically larger cities	Upper floors (open ground story buildings especially) ---------------- Under sturdy furniture --------------- Next to dense object unlikely to topple In unreinforced masonry buildings: structural door frames (lintel & post); interior corner formed by	Near exterior walls -------------- In street near buildings ---------------- On balconies ---------------- Staircases, especially with precast stairs or thin brick infill walls

No.	Description of Characteristic Building Stock	Prevailing outside conditions	Location	"Safer" Places, from safest to least safe	Danger Zones
				cross walls	
5	Multi-story buildings with open ground floor (often reinforced concrete)	Outside open spaces available	Cities	Open space outside ---------------- Upper floors	In open ground story --------------- Near exterior walls
6	Multi-story buildings with open ground floor (typically reinforced concrete)	Outside open spaces are not easily and quickly accessible	Cities	Upper floors	Ground level ---------------- Near exterior walls ---------------- Close proximity to buildings
7	Mixed urban context with numerous collapse-risk buildings (varying building types and heights)	Open spaces, few exterior hazards	Cities	Open space outside ----------------------- Upper floors ----------------------- Under sturdy furniture ----------------------- Next to dense object unlikely to topple	Close proximity to buildings
8	Mixed urban context with numerous collapse-risk buildings (varying building types and heights)	No open spaces, many exterior hazards	Cities	Upper floors ----------------------- Under sturdy furniture ----------------------- Next to dense object unlikely to topple ----------------------- In unreinforced masonry buildings: interior corner formed by cross walls	Outside ----------------- Staircases, especially with precast stairs or thin brick infill walls ------------------ Near exterior walls ------------------ Balconies
9	Mixed urban context with few collapse-risk buildings (varying building types and heights)	Few open spaces, many exterior hazards	Cities; typically with strong codes and enforcement	Under sturdy furniture	Outside ------------------ Staircases, especially with precast stairs or thin brick infill walls ------------------ Near exterior walls ------------------ Balconies

See the background paper on building collapse (Gulkan, 2014) in the companion volume and other sources[48] for more information on seismic vulnerabilities of common building types. The technical rationale for safer places in some common building types is described below.

In unreinforced masonry and earthen buildings, *interior* corners where cross walls intersect are often stronger, and therefore safer, because the walls brace each other in both directions. In contrast, *exterior* corners tend to be some of the first locations to suffer damage during shaking, because the walls are braced in one direction—inward—and almost nothing holds them together when they move outward. Door frames in smaller masonry buildings may provide minimal protection, if they have both a lintel and posts that are timber or reinforced concrete (the lintel and posts are typically visible and identifiable to occupants). Standing in a doorway can be problematic for other reasons, such as having fingers or other body parts injured by a swinging door; when there are too many people in the room to fit in the door frame; or if other people decide to evacuate the building.

In buildings with a weak or soft open ground story, people are typically safer in upper stories or outside. A building may have few (or no) walls in the ground story, because of shops or parking, but many walls in the housing above. Figure 6 illustrates how damage tends to concentrate in the weaker, more flexible open story, making that particular story much more likely to collapse, and meaning that there is often modest damage in floors above the open story. A small number of buildings have more than one open story or an open story higher up in the building rather than at ground level.

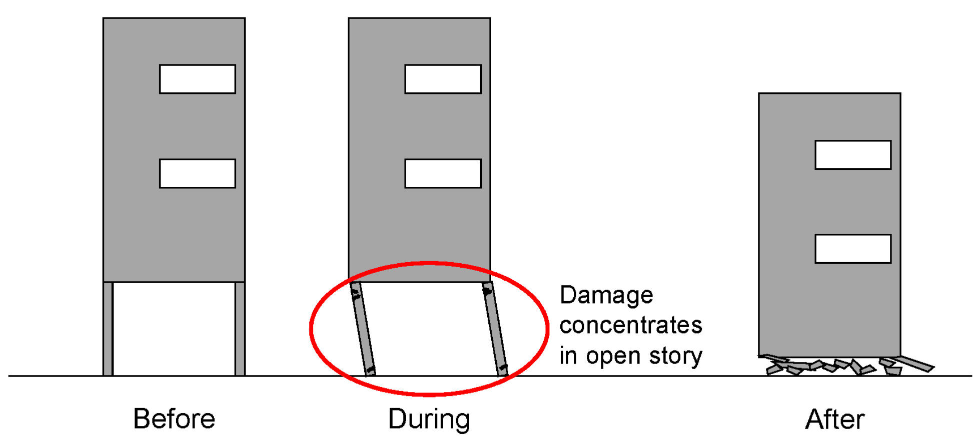

Figure 6. How open ground story buildings collapse during an earthquake. (Source, Janise Rodgers, GeoHazards International)

[48] The World Housing Encyclopedia tutorials on adobe, stone masonry, reinforced concrete and confined masonry, available at worldhousing.net, and GHI's guidance document on infill buildings, available at geohaz.org, provide summaries of the seismic behavior of these commonly-encountered building types.

Population Exposure

The physical location and density of people at varying times of the day, week and year should be taken into account. Consider the physical location and density of people at any of the following times:

- During a workday. Adults are usually at work, children are at school, people are walking, riding in vehicles, or driving. Many people will be in commercial buildings and schools, or outdoors, depending on the predominant occupations in the jurisdiction. In some communities, many people will be in religious buildings at certain times of the day.
- At night. Most people are asleep in their beds in residential buildings. This situation is especially important because sleeping people will probably not be able to immediately react to earthquake shaking, and it will be dark. Electrical power outages occur frequently in damaging earthquakes.
- Weekend/Holidays. This will vary depending on context. One should determine where people spend the majority of their time over the weekend. This might be, for example, at home, in religious buildings, in theaters, or outside.
- Seasons. One might consider season as it affects the weather (e.g., in extreme cold weather, people will be reluctant to go outside) and as it affects the number of people in the area, such as an influx of tourists unfamiliar with the area during high season, or a festive season when many return home.

Message givers may choose to provide multiple messages that advise people to take different actions at night than they do during the daytime. Or, message givers could provide messages that earthquakes can happen at any time and recommend that people evaluate their typical locations (e.g., in bed, at work, outside) for what they would do in each situation.

Consider whether certain occupations place people in more dangerous locations. Discussions on population exposure provide an opportunity to identify particularly hazardous locations (e.g., mines, factories) that may warrant development of a tailored message by an added subcommittee.

Social and Gender Considerations

Within the local population, some people may be more vulnerable to injury and death from earthquakes than others, even if they have the same amount of time to act and are in the same building type. For example, physical and mental capacity may limit some people's options, and social norms and customs may place constraints on the protective actions considered acceptable by different groups.

Norms and customs around gender pose earthquake vulnerability issues in many parts of the world. Are men and women in different locations or in different types of buildings during workdays, on weekends, or during certain seasons? In some communities, men may be primarily outdoors during the day, while women may be primarily indoors in homes. In other communities, both men and women may be outdoors during the day. In some communities, women (and children) do not leave the home without a male family member. In this situation, many women would not consider evacuation during earthquake shaking, even if it was recommended and they knew it was the wiser decision. Typical clothing or footwear (e.g., sandals or high heeled shoes) may constrain how quickly women or men can move and will help determine whether evacuation is a feasible option. Childcare and eldercare are predominately women's responsibilities, and thus women's protective actions may be delayed due to efforts to secure the safety of others.

The safest action for the majority is typically governed by factors such as the population density and vulnerability of people, the seismic hazard, types of buildings, and distance to safety. **Therefore, the basic core message is likely to remain the same except in very particular cases.** Social and gender considerations are likely to play a larger role in developing the form of the message and the strategy for communicating it, as discussed further in Parts II and III.

Social and gender considerations should be discussed to determine whether the message itself should differ (e.g., recommend that women go to the safest place in the home, such as the center of an interior courtyard), or whether the form and communication strategy should be tailored to address the potential constraints (e.g., find a local leader to communicate a message that has cultural implications). A person's ability to take protective actions varies based on age (e.g., the elderly may be less able to crawl under a table) as well as functional and access needs. Physical and mental capacity may affect whether people can take the protective actions recommended for the majority.

Populations with Unique Functional or Access Needs

In almost any jurisdiction, certain people will either not be able to take particular protective actions or may need assistance to do so. It is important to plan for these members of the community, especially if they make up a significant portion of the population. Because taking protective action can be more difficult for these people, making their home and work spaces safe prior to an earthquake is important. Safety measures include anchoring or relocating objects that can fall or otherwise create hazards. One or more subcommittees should address the issues around tailoring messages to the following:

Mobility Impediments

People with mobility impediments, such as those in wheelchairs or who are bed-bound or frail, will be unable to take certain protective actions during earthquake shaking, even if they recognize the signs that an earthquake is occurring. Specific actions that are possible depend on context and individual mobility impediments, but most people will need to shelter in place, rather than move very far, and protect their head and neck as well as they can. For those in wheelchairs, one option is to lock the wheels and remain on the seat while protecting the head and neck until shaking stops.[49]

Neurologic or Sensory Impairments that Affect Physical Reactions

People whose physical reactions are impeded by neurologic conditions that do not affect cognition or greatly restrict mobility, such as limited hand-eye coordination, may have difficulty performing certain protective actions. People who have difficulty hearing or seeing are likely to be able to take certain protective actions; however, they may have more trouble evacuating a

[49] From guidance developed by the Earthquake Country Alliance in the United States.

space. Aspects of their environment that they rely upon for routine information may be unavailable or inaccessible during the moments of initial shaking.

Cognitive Impairments

People with cognitive impairments, such as Alzheimer's disease and certain autism spectrum disorders, may face challenging circumstances during an earthquake. They may not understand that an earthquake is occurring, and their ability to take certain protective actions on their own may be limited. A caretaker or guardian should be prepared to aid these people during earthquake shaking. However, it is important to recognize that many people with cognitive impairments can help themselves with tailored messaging and preparedness. Those who are part of or know these communities best can advise about capacities for action and learning.

High Occupancy and Institutional Settings

The number of people in a building, or the type of work done there, can affect the feasibility of different protective actions. Depending on the types of occupancies present in the communities under consideration, subcommittees should tailor the core message to some or all of the settings listed below.

Schools

Schools in many countries can have thirty to fifty students, or more, in a single classroom. The children vary in size, strength, and mobility. Older classrooms in many countries have a single door that opens inward, which keeps doors from swinging into narrow corridors but also impedes quick evacuation. Multi-story schools may have a single staircase or few exits. These conditions severely constrain evacuation. Mass behavior, in which people do not have a choice in how they respond because of the crowd around them, becomes a concern if evacuation is attempted in certain school conditions. The possibility of stampedes in crowded schools with limited exits should be considered when developing a responsible protective action message.

Many schools throughout the world are particularly vulnerable to collapse. Many schools also lack sturdy desks to protect students who Drop, Cover, and Hold On. School safety elicits strong opinions, and disagreements persist as to the best course of action during shaking. The limitations of protective actions during shaking come into particularly sharp focus when school buildings are vulnerable to collapse. The best way to keep students safe during an earthquake is to make school buildings safe before the earthquake strikes.

Large Buildings Where Many People Assemble

Many, if not most, communities have one or more large buildings or structures where people assemble in large numbers. Examples include places of worship (e.g., churches, mosques, prayer halls, synagogues, and temples), stadiums, gymnasiums and multi-purpose halls, university lecture halls, and theaters. Mass behavior and stampede is of concern in these types of buildings. In addition, these buildings may have large rooms with limited options to shelter in place. Certain protective actions will not be feasible, given the potentially high number of people in these structures and the lack of cover. Buildings with seating (e.g., theaters, some places of worship) provide more options than open rooms do, because people can gain some protection by crouching between rows of seats.

Hospitals

Hospital patients may be incapacitated and unable to protect themselves well during earthquake shaking. To improve patient safety during an earthquake, the hospital must prepare in advance by keeping patient areas free of objects that may fall and by bracing equipment. Staff members can be trained to protect themselves and to recognize and fix potential earthquake safety hazards.

Laboratories and Kitchens

Laboratories, kitchens and similar environments contain many hazards such as dangerous chemicals, glass bottles and ceramics, and open flames. Staying in these rooms during shaking is in many cases more dangerous than moving elsewhere. People should be advised to move to safer areas that are quickly accessible. Messages that emphasize situational awareness can help people recognize and determine what to do in these situations.

Developing Message Content: Bringing Together All Considerations

After gathering information and discussing considerations described in the previous sections, it is time to determine feasible protective actions. Potential ways to do this include answering a series of questions or using a flowchart or a logic tree.

One way to begin forming the message content is to determine what people already believe and whether people are likely to believe that any of the feasible protective actions will make them safer. National or local attitudes might influence the final message content. For instance, societies vary in the extent to which they are comfortable relying on individuals' situational awareness and judgment to determine the best/safest protective action for their circumstances. Also, existing customs, traditions, and beliefs will affect how readily people will adopt a new message. People may have a more difficult time believing and acting on a message that differs significantly from what they believe will make them safer. Communication strategies will need to take this into account.

How much time will people have to find a safer place? This is a key question when determining which actions are feasible and which are not. The geologic environment determines how much time message creators can reasonably assume people will have to act. Message creators should assume that people might have only a few seconds to act—perhaps five seconds—in almost all cases. In certain rare cases, it may be possible to reasonably assume that more time will be available if there is high quality, specific earth science evidence that clearly demonstrates that there are no nearby sources of appreciable hazard. The time people take to process cues that an earthquake is occurring and decide to act, especially when in groups, will reduce the time available. Message givers should consider including in the message content—though perhaps in a message longer than a slogan—that the time available to take action may be very short, so they should act immediately. In jurisdictions very comfortable with relying on individuals' situational awareness, judgment, and preparedness measures, message content might simply be, *wherever you go, find the safest place you could reach in five seconds after shaking starts.*

Jurisdictions may want to provide people with more specific guidance, especially on the crucial decision to remain inside the building, or to evacuate, and under what conditions. Figure 7 shows a thought process to answer the question: will most people inside buildings be safer if they remain inside or if they move outside?

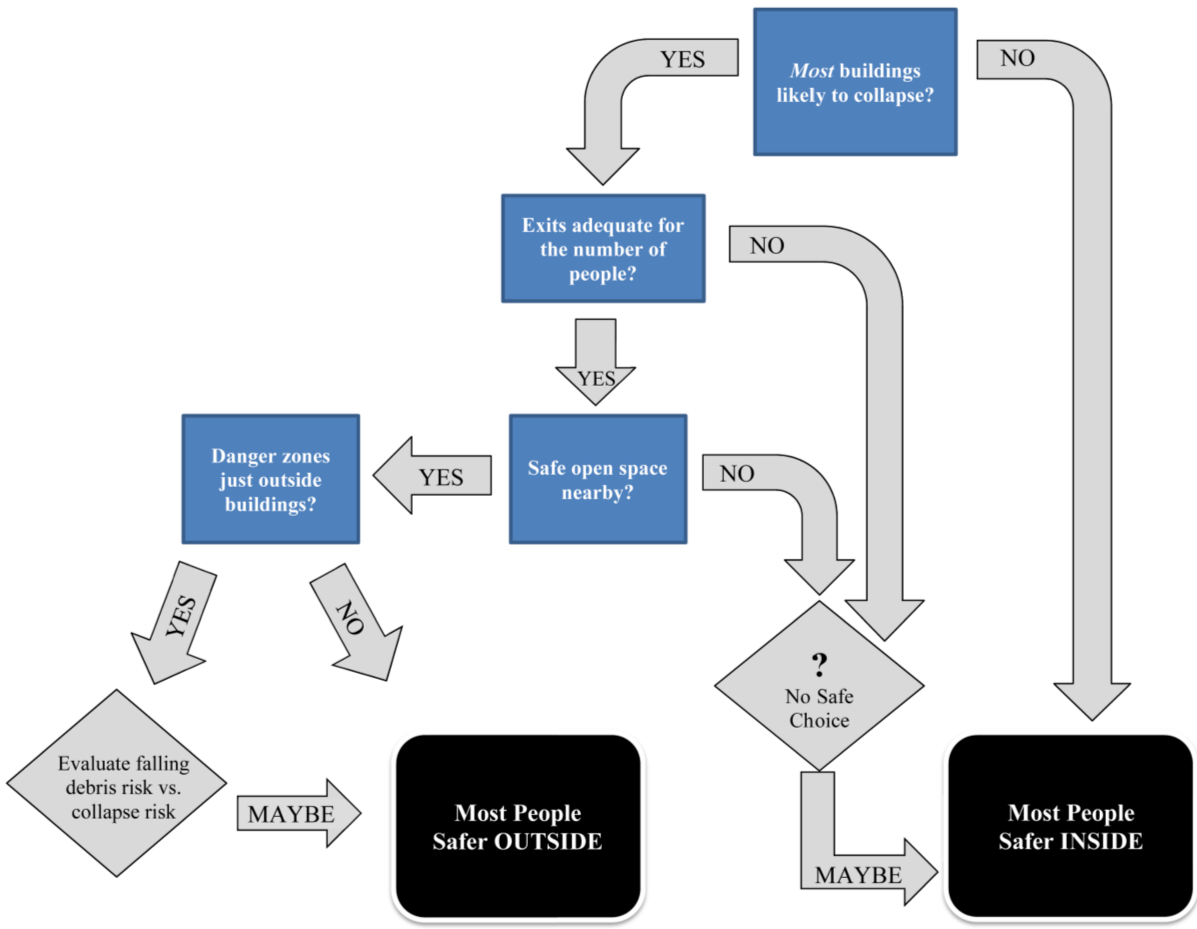

Figure 7. Flowchart to determine whether most people are likely to be safer inside or outside.

If most buildings are not vulnerable to collapse, people will typically be safer inside. If a majority of buildings are of types that are highly vulnerable to collapse, such as unreinforced masonry or earthen construction, then it is necessary to determine whether people are likely to be safer outside or inside. Typical collapse patterns for local buildings, and how lethal collapses are likely to be, are important to determine. For example, some types of unreinforced masonry buildings are more likely to have one or more exterior walls fall away from the building, while some types are more likely to completely collapse. Inside a building, sturdy furniture can provide some protection from falling bricks or stones, while people outside buildings are not likely to have any protection. Clearly, if the building is likely to collapse *and* there is no place to escape deadly falling debris outside, then there are no good options and protective actions have limited value. If there is safe open space on the other side of a narrow danger zone close to the building perimeter, it may be less risky to transit the danger zone quickly than to remain in a collapsing building. Again, this is a situation in which there are no good options. In these two situations, the only viable course of action would be to mitigate the risks of building collapse and exterior falling hazards before the earthquake strikes.

After determining whether most people are likely to be safer inside or outside, the next question is whether most can reach a safer place in time. In most cases people cannot count on having enough time to move very far. Message creators will need to account for this by restricting the set of protective actions being considered to those that are feasible in the time available. Table 7 shows one way to help narrow the options, based on the geologic environment (Table 5), type of characteristic building stock (Table 6), and the results of the flowchart in Figure 7.

Table 7. Determining whether most people are likely to reach a safer place in the time available to act, based on characteristic building stock and geologic environment

Type of characteristic building stock (and location, if applicable)	**Are most people safer INSIDE or OUTSIDE?**	**Can most people reach a safer place in time?**	
		About 5 seconds before strong shaking begins	**10 or more seconds** before strong shaking beings
• Resistant light frame • Mixed urban with mostly resistant buildings and exterior falling hazards; open space *not* available • Dense urban with mostly tall buildings • On upper floor of multi-story buildings with open ground floor	Safer INSIDE	YES	YES
• Dispersed, rural, small URM • On ground floor of multi-story buildings with open ground floor; open space *is* available (if risk of exterior falling hazards less than collapse risk)	Safer OUTSIDE	YES	YES
• Mixed urban with numerous collapse-risk buildings and few exterior falling hazards; open space *is* available	Safer OUTSIDE	NO from upper stories; YES from ground story	YES
• Closely spaced small URM; open space *not* available	Safest location uncertain, but may be safer INSIDE	YES	YES
• On ground floor of multi-story buildings with open ground floor; open space *not* available • Mixed urban with numerous collapse-risk buildings and many exterior falling hazards; open space *not* available	Safest location uncertain, but may be safer INSIDE	NO from upper stories; YES from ground story	YES

URM = unreinforced stone, brick or concrete block masonry or earthen (adobe, rammed earth, etc.)

The best action to take in a vulnerable multi-story building, or in a large-footprint single story building, depends on the person's location in that building; in some locations, one action will be safer than others, and no single message will keep everyone safe. For example, consider the options for people on the upper stories. With only seconds to act, people are unlikely to reach a safe outdoor space in time. And to reach safety outdoors, they may need to cross a danger zone next to the building, where objects falling from the exterior of the building are likely to land. A weak, open ground story in some multi-story buildings, and sometimes the story above, may collapse when the upper stories do not,[50] so it is likely more dangerous to evacuate from an upper story to these lowest stories than to stay in the original location during the strongest shaking. Also, descending stairs during strong shaking is dangerous, especially if the stairs are precast (which can collapse) or have masonry infill (which can fall). The situation is different for people who are in the open ground story of a multi-story building; they are safest if they run outside to a safe open space. However, if there is no safe open space outside, it may be safer to ascend at least one level upward than to remain in the most dangerous story in the building or risk injury from falling debris outside. The range of risks in a vulnerable multi-story building highlights the importance of situational awareness messages that guide people to the best action for their immediate risk.

There is little information on how quickly people can move during shaking. The assessment presented in Table 7 assumes that people move during the interval after the P-wave and before the S-wave arrives, when shaking intensity is low. Table 7 assumes that an average, healthy adult can run 100 meters in 20 seconds or less,[51] meaning they might cover up to 20 meters on flat, unobstructed ground in five seconds. Children and less fit or less healthy people might be able to go 7 to 10 meters in five seconds. Going down stairs takes more time than is available in most situations, an average of 48 seconds per floor in a high-rise building with thousands of evacuees according to a recent study,[52] though people in smaller buildings with less crowded stairwells will be able to move more rapidly. Table 7 assumes people will be able to descend stairs at 15-20 seconds per floor, because most multi-story buildings are smaller with fewer people. However, even this optimistic evacuation time is still too long for people to try to go down even one story of stairs and out in most cases. People will also tend to move more slowly in large groups than if they are in small groups or alone.[53] This means that most people are likely to be able to exit buildings only when the distance is short and the exit pathway unobstructed. Others will need to shelter inside the building, lest they put themselves in a more dangerous situation while trying to reach a safer place.

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[50] See Gulkan (2014) for a discussion.

[51] At a jog, average healthy adult men under 100m in 27 seconds, and women cover 100m in 34 seconds. When running from a building assumed to be dangerous, presumably people will run more quickly. For comparison purposes, fast humans cover 100m in 13-14 seconds. Source: The Telegraph http://www.telegraph.co.uk/sport/olympics/athletics/9450234/100m-final-how-fast-could-you-run-it.html. Average walking speed is 3 miles per hour, meaning one minute 14 seconds to cover 100 meters. Some evacuation messages encourage walking, such as Oaxaca, Mexico's "Don't scream, don't push, don't run" directive for schoolchildren evacuating schools (M. Maza, personal communication, 2015).

[52] Study of One World Trade Center evacuation (Santos and Aguirre, 2004) during the September 11, 2001 terror attacks.

[53] Santos and Aguirre (2004) found that physical factors affect groups trying to evacuate, but so do social factors, such as "milling"—people seeking information about what is happening and looking to others for cues on how to react. In groups with high social cohesion, group members can delay evacuation while trying to find each other.

Information on population exposure—meaning where people are at different times of day—will help determine the options for feasible actions. Typical locations of people in buildings, the speeds at which they can move, and adequacy and safety of exit pathways are all considerations for determining whether people can reach safer places, either outside or in upper floors of a building (in the case of open ground story / soft story buildings with no safe open space outside). In cases where people are in vastly different environments during the day and night (for example: outdoors in safer places during the day, in collapse-risk buildings at night), message creators may wish to consider providing two messages, one for daytime and one for nighttime.

Do gender or social considerations affect people's mobility and ability to reach safer places? If so, the feasible protective actions should accommodate these mobility constraints, or a communication and advocacy strategy to change prevailing attitudes should be considered. At this point, message formulators should be able to define a set of feasible protective actions and can begin the process of determining which one(s) to recommend.

Suggested Protective Actions for Common Contexts

Based on the considerations above, the project team and those consulted during the workshop reached general agreement on the following protective actions guidance:

- *Evacuate only if it is significantly safer outside AND most people can make it out in time.* People may only have a few seconds—perhaps five—though perhaps more time in certain situations. In a rural area, evacuation from a vulnerable building is possible for those close to an exit and open space. In more urban areas, evacuation is possible for those close to an exit in a building with an open first story that is soft or weak if there is open space outside, and 1) no danger zone exists just outside the building, or 2) the risk of quickly passing through the danger zone is less than the risk of remaining inside.
- *Shelter inside the building if inside is safer than outside (e.g. if the building is built to earthquake-resistant standards).* Examples of safer inside locations include the higher stories of a taller building (if lower stories are weaker) and a building that is not vulnerable to collapse (to identify seismically robust buildings, consult an engineer).
- *Wherever you go, look for the safest place you could reach within five seconds after the shaking starts*. Though the specific actions that are likely to save the most lives will differ with context, this guidance underlies most choices.

Specific institutional and high-occupancy settings may require different actions, or adaptations to the community's primary protective actions. Suggestions include:

- *Schools.* Shelter-in-place during shaking, with Drop, Cover, and Hold On being preferable. Exceptions: the building is highly vulnerable to collapse and evacuation is feasible OR occupants are in a chemistry lab (danger of falling glass bottles containing chemicals) and a safer, previously identified area is quickly accessible—in which case move to this area. Mass behavior and stampede are concerns with crowded classrooms and limited exits.
- *Large assembly buildings (churches, mosques, stadiums, prayer halls, theaters).* In most cases, shelter-in-place actions will be the only actions feasible for the majority, because of the limited time available to exit and the potential for stampede. It usually takes more time than available during earthquake shaking to evacuate large buildings.

- *Hospitals.* Staff and others who can move easily (e.g., outpatients, visitors) should Drop, Cover, Hold On, unless in a hazardous room and it is possible to move to a safer place that has been previously identified. Inpatients should typically remain in bed and protect their head and neck. Because inpatients are often incapacitated, it is important to ensure patient areas are free of items that can fall during shaking, rather than rely on protective actions.
- *Laboratories, kitchens, other facilities with hazardous materials.* Extinguish open flames. Go to a previously identified safer area nearby.

Other situations may require different actions. Suggested actions for these situations include:

- *Driving*. Slow down and find a safer area away from bridges, flyovers/overpasses and overhead wires, and pull over and stop at the side of the road. Stay in car during shaking.
- *Unfamiliar situations/environments*. Always be aware of relatively safer places and the surroundings. Make an effort to identify safer locations in unfamiliar environments. If in a particularly hazardous area, move to a safer area, if previously identified.
- *Nocturnal earthquake*. In most cases, stay in bed and protect head and neck with a pillow. In some situations, it could be safer to crouch next to the bed, making the body small and protecting the head and neck.
- *Outside.* Remain outside and move to a safe location away from buildings, overhead wires, and other potential sources of falling objects. Drop to the ground and protect the head and neck.

Choosing Protective Actions to Recommend for People Remaining Inside Buildings

As Table 2 shows, there are several potential options for protective actions to take when remaining inside a building, and the Message Development Committee will have to decide which to recommend. The options vary in the extent to which they rely on individual judgment and situational awareness (that is, understanding the hazards and the safest option for the context). In the Peruvian messaging program, areas of buildings considered to be structurally safer are marked with signs and people are told to go there and stay until the shaking is over. The safest action while in the marked zone is left to the judgment of the individual. The effectiveness of this type of program relies greatly on the competence of engineers identifying and marking safer areas and on each individual's situational awareness. Another approach would be to provide more guidance on specific action, such as by telling people to Drop, Cover, and Hold On. The Message Development Committee can determine a single preferred protective action, a preferred hierarchy of protective actions within the building (based on safer locations determined by building type and availability of cover), or whether to recommend a specific action at all and rely on the judgment of individuals instead.

Generally, message givers should advise people to pre-identify safer and less-safe locations in the places in which they spend the majority of their time. Safer and less safe locations inside buildings will depend on the probable type of damage as well as the contents, as discussed in the earlier section on buildings. Table 6 lists safer and less safe places for commonly encountered characteristic building stock, based on hazards created by structural and architectural shell damage.

Buildings have interior hazards created by contents or architectural elements such as masonry partitions and window glass. Though studies of the effectiveness of typical protective actions are limited (as previously discussed) available evidence and logic indicate that some protective actions are more effective than others at protecting people from interior hazards. Sheltering under sturdy furniture can protect people from being struck and injured by falling objects. If cover is not available, an option is to make oneself small next to dense furniture that is unlikely to topple (e.g., a sofa or armchair is better; a tall bookshelf is likely to fall). Making oneself small and protecting the head and neck can reduce the chances of being struck and injured. Moving out of hazardous rooms such as kitchens or laboratories protects people from chemicals, open flames, and broken glassware. Unsafe zones to avoid include right under gable walls and next to exterior walls and single wythe brick partitions (i.e., walls that are only one layer of brick in thickness).

People should be aware of their environment and take steps to make places where they spend the most time safer. Messages should inform people how to identify sturdy furniture to shelter underneath and how to secure typical objects that can injure people if they topple, fall, or slide. (The variability in building contents means that people will need to assess their individual situation as part of a broader preparedness effort. Message givers can consult numerous available resources[54] to create messages on identifying and mitigating hazards from building contents.)

Examples: How to Determine Message Content Based on Local Considerations

Three hypothetical examples of common contexts show how the considerations discussed so far can be combined to generate the content of a protective action message. These examples are for illustration purposes only; message content for locations similar to those below must be determined by local authorities and may differ from what is described below.

Example 1 – Area of high seismic hazard dominated by rural, vernacular masonry buildings

Many countries have large numbers of affordable vernacular unreinforced masonry or earthen buildings (i.e., built according to common construction practices rather than designed by an architect or engineer), despite also having high seismic hazard. Many of these buildings are located in rural areas and house one family, who often farm adjacent land and build their homes from materials available nearby. Though builders in some regions of high hazard have developed more earthquake-resistant types of timber and masonry vernacular construction,[55] many buildings are completely unreinforced. These unreinforced masonry and earthen buildings are prone to collapse in large numbers during strong shaking, as past earthquakes around the world have demonstrated. Adobe, rammed earth, and unreinforced stone, concrete block, or brick masonry buildings are all vulnerable.

In this hypothetical setting, most buildings are small stone masonry dwellings with plenty of safe open space outside. Many buildings are single story and have few objects that can fall from the exterior. People will be safer outside, and most buildings will not have a danger zone near the building exterior unless the building collapses. The region is mountainous, and local seismic

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[54] PreventionWeb (preventionweb.net) contains numerous resources for different areas of the world.

[55] Examples of vernacular timber laced masonry occur in Turkey, the Himalayas, Europe, and Latin America. See Langenbach (2009) and Gulkan (2014) for details.

sources exist. In our hypothetical case, a thrust fault, which dominates the seismic hazard, lies beneath a large part of the nation. Local faults also exist. It is reasonable to assume that people may have five seconds to reach a safer place after the P wave and before strong shaking begins.

Without a robust seismic strengthening program, the logical protective action would be to immediately evacuate buildings as soon as any shaking begins. People believe that one should run out of a building when shaking starts, so local customs would not impede taking this action. The Message Development Committee decides that rapid evacuation is the recommended protective action for single story masonry and earthen homes. The committee also decides to emphasize that people should act immediately when they feel shaking and to provide additional guidance that those outdoors should remain outdoors.

Example 2 – Dense urban area along fault with many open ground story buildings
In many urban areas, residential reinforced concrete buildings often have an open ground story to accommodate shops, public space, or parking. This open story is typically weaker, and earthquake damage concentrates there, often leading to collapse of the ground story. Upper stories do not typically collapse. In the hypothetical city under consideration, the urban area has narrow streets and few open spaces. Objects that can fall from the building exterior abound: unreinforced masonry infill walls in concrete buildings, unreinforced bearing wall masonry additions on the roof, rooftop water tanks placed close to the building edge for ease of running pipes along the exterior wall, sizeable ceramic flower pots perched on balcony railings, and brick roof parapets and balcony walls. A large fraction of the city's concrete buildings have open ground stories. In these buildings, the ground story is not safe, but it is not safe outside either.

The city lies along a major earthquake fault, with associated smaller faults nearby. With input from the local seismologist who is part of the Message Development Committee, the committee realizes that 1) people may only have five seconds to act between the beginning of shaking and when the strongest shaking occurs, and 2) the shaking is likely to be strong enough to damage or collapse numerous open ground story buildings.

After much discussion, the Message Development Committee decides to tell people to Drop, Cover, and Hold On if they are in the upper stories of a building, and to go up to the second story if on the ground story of an open ground story building, unless there is outdoor open space nearby. The committee judges that the risk of falling while climbing up stairs is less than the risk of being crushed if the open ground story collapses. Committee members also begin to discuss a retrofit program with the city. As an interim measure, they recommend that all stairs in open ground story buildings without safe open space nearby be clearly marked with signage, both at the ground story and in the upper stories. The clearly marked exits improve safety in other ways as well, such as helping people to evacuate in case of fire.

Example 3 – Island with offshore subduction zone and traditional timber buildings
In a number of island states, timber is the traditional building material. In this hypothetical example, most people continue to live in small lightweight timber buildings that have reasonable earthquake resistance due to well-fastened exterior wood boards. These buildings are not likely to suffer lethal collapses, though they might slide off their post foundations. Because buildings are elevated about a half a story height (see Figure 8), people must traverse stairs to exit.

Figure 8. Typical timber buildings characteristic of the building stock in Example 3 (Credit: Janise Rodgers, GHI)

The island has a subduction zone offshore that is likely to generate a tsunami. There are local faults, but geologists have not been able to secure the funds for the studies needed to determine whether the faults are active. The Message Development Committee concludes that areas near other subduction zones around the world have active faults onshore, so it would be prudent to assume the local faults may be active, in the absence of scientific information to the contrary. This means people might not even have five seconds to find a safe place once shaking begins.

The Message Development Committee decides that people will be safer sheltering inside buildings, rather than trying to navigate the stairs during shaking. They decide to recommend that people should Drop, Cover, and Hold On, or take shelter next to sturdy furniture. The Committee also decides that people need a second message: if the shaking is strong or long, they should evacuate to higher ground as soon as the shaking stops, because of the tsunami hazard. A subcommittee for schools recommends that school children Drop, Cover, and Hold On under their desks.

PART II. Forming Effective Messages

How can messages be worded so that they compel people to act?

Forms of Messages

Messages can come in several forms that provide increasing levels of detail. A slogan alone does not provide enough information. The best form to use in a particular situation depends on factors such as the medium that will deliver the message, the audience, and how much time the message needs to deliver its information. Although the content of each form of message should be consistent, each has a slightly different goal. Message-giving organizations should plan to have a communication campaign (described in Part III) that uses all of the message forms described below.

The Slogan

The slogan uses short phrases to communicate protective actions in a catchy, easy to remember manner. Some existing examples of this include: "Drop, Cover, and Hold On" (used in many parts of the world) and "Prepárate, Ubícate, Evacúa" (literally means "prepare yourself, situate/locate yourself, evacuate," which is used in Peru). A slogan should be concise, to the point, and easy to remember. A slogan may rhyme, or make use of word or sound patterns such as alliteration, assonance, or consonance, to make it easier to memorize and repeat. It should be clear and convey the same meaning to everyone. It should use commonly understood words and avoid technical jargon. Simple graphics may accompany the slogan to illustrate how to take the recommended protective action. The slogan should be repeated in the 60-second and 60-minute messages, so that it is remembered.

The 60-Second Message

This message provides more detailed information than the slogan and gives more specific information for different contexts (e.g., at night, while driving). The message need not be exactly 60 seconds, but should clearly convey essential information in a succinct format, such as a one-page awareness document or flyer or a one-minute (or shorter) radio or television piece. Assume that a significant fraction of the public will rely on the 60-second message, because they will not make time for the 60-minute message. The 60-second message should also succinctly describe how to identify safer and unsafe areas and encourage people to identify them in locations where they spend the most time. In areas where the protective action to take may differ by building type, the 60-second message should provide guidance on identifying the relevant building types. Graphics can help illustrate building types and safer/unsafe places. This message should also point to resources for additional information for particular situations (e.g., for people who are mobility impaired, hospitals, or schools).

The 60-Minute Message

This message provides detailed information on how to identify safer and less safe areas in the places where people spend the most time (e.g., home, work) and for particular situations (e.g., those with children at home, those with limited mobility). This message also gives guidance on making places safer (e.g., anchoring heavy furniture; putting heavier objects on lower shelves of bookshelves; ensuring that no heavy furniture is located near exits; and inspecting premises from a child's perspective, if the location has children).

What All Forms of Messages Should Contain

The following principles will help make all messages effective:

- Be consistent, harmonized and echo the same underlying principles;

- Include some explanation of why this action makes sense and the underlying logic (i.e., the "why we are doing what we are doing"); for slogan messages, simple graphics can help explain why;
- Allow for variability in local implementation;
- Be specific and actionable, give clear guidance;
- Be stated with confidence and certainty;
- Consider compatibility with global messages given elsewhere (if people are unsure about your message, they might look for other resources online);
- Communicate in simple language or with visuals, which will help make information accessible to a wider range of people;

In addition, the 60-second and 60-minute messages on protective actions should:

- Promote the importance of mitigation, for example by emphasizing the need for safe buildings and the need to find interior hazards and fix them to create safer spaces;
- Promote situational awareness in which people know their environment and safer/less safe locations;
- Encourage acting immediately upon feeling shaking, as there will not be much time to react before the strong shaking begins, and
- Encourage people to practice protective actions in the places where they spend the most time.

The importance of explaining "why"

A seismologist colleague in Tajikistan trained his children on what to do if an earthquake strikes while they are home. They were to stand in a place in the house that the seismologist had identified as the safest place and hold on until the shaking stops. When an earthquake did strike one day, his children were playing outside. They duly ran inside and stood in the designated safe spot. What was wrong with the father's message? He focused on the risky location and had not anticipated that they might already be in a safe place. He needed to explain the hazards, but also why the actions should be taken.

As the earlier parts of this document demonstrate, jurisdictions that contain different environments may have a common overall approach but recommend starkly different protective actions in each different environment. It is important to explain the rationale and logic behind the recommended action, because people in our globally connected world may seek information from sources outside their jurisdiction or country, such as via internet searches. Messages that emphasize situational awareness can help people understand the range of contexts they may encounter, and empower them to determine appropriate actions.

Developing a Slogan for Protective Action

A slogan may be more memorable and compelling if it is developed directly in the local language, rather than translated word-for-word from another language. Keeping that in mind, the examples of slogans listed in Table 8 below are for illustration purposes only. These examples demonstrate how the principles described previously have been used to create slogans for earthquakes and other hazards. The slogans aren't necessarily recommended for the local context and may not translate to local situations.

Table 8. Examples of protective actions slogans for a variety of hazards

Slogan	**Language and translation**	**Hazard**
Drop, Cover, and Hold On	English	Earthquakes
Drop, Cover, Hold On and Count	English	Earthquakes and tsunamis
Prepárate, Ubícate, Evacúa	Spanish; literally translated means "prepare yourself, situate/locate yourself, evacuate"	Earthquakes
No corras, No empujes, No grites	Spanish; translated means "don't run, don't push, don't shout"	Building evacuation, used for multiple hazards
Go Out, Stay Out	English	Building evacuation
Stay Upstream, Uphill, and Upwind	English	Chemical release
Stop, Drop and Roll	English	Individual's clothes catch fire
Turn around, don't drown	English	Flood (when driving)
Examples based on situational awareness:		
If you see something, say something	English	Terrorism
React, Evaluate, Decide (RED)	English	High-rise building fire

When crafting a slogan that describes a protective actions message for sheltering inside a building, a slogan like "Drop, Cover, and Hold On" is better wording than "get under sturdy furniture" even though getting under sturdy furniture is the preferred action when one drops, covers and holds on. Drop, Cover, and Hold On is more memorable, provides more specific direction on the steps to take, and encourages individual judgment regarding where to find the best cover in a specific situation. Communications and marketing professionals can be of great assistance in creating a slogan.

Effective Messaging

The social context in which a message is given affects how people will receive it. In order to develop an effective message that people are likely to believe and actually adopt, certain people should be consulted and principles should be kept in mind. Here are some of the most important:

- Consult with diverse groups that are representative of the population that is being targeted to help ensure that no part of the population is marginalized.
- Draw on people's existing belief and value system (e.g., family, community, tradition/respect, religious values, culture, behavioral norms). Most communities value all of these things, but in varying degrees. It's important to identify what are the most important beliefs and values for the target jurisdiction.
- Consider social context and level of risk perception. Age, gender, education, income, and social characteristics (i.e., how people relate to each other) will influence how people hear and respond to messages.
- Understand how people may interpret or misinterpret environmental cues. For example, some people with limited earthquake experience might not recognize the initial shaking as an earthquake and therefore respond inappropriately. It is also important to understand

if people, in general, feel that their buildings are safe. This will strongly influence what protective actions they believe will actually make them safer.

- Identify barriers to adopting the action, and develop strategies to address them. For example, if working in a jurisdiction where many people are illiterate, using images and drawings might be helpful. When working in areas that are religiously devout, consult with the religious leader to determine if certain protective actions would be accepted and adopted by all members of a jurisdiction. Other common barriers include fatalism, apathy, lack of resources, and tendency to discount local agencies.

Social scientists who work in or have studied the local context can provide expertise on how these principles specifically manifest in the jurisdiction. Messages, and the strategies and programs to communicate them, must be in the local languages. In areas with many languages, translation efforts may be substantial, and programs should plan for translation time and costs. IFRC recommends that bilingual experts familiar with the subject matter translate the messages, and that two trusted bilingual speakers familiar with international risk reduction terminology review the translation.[56]

Community Values

Values are what people care about and rely on to make some decisions, to set priorities, and to evaluate the potential consequences of their actions.[57] Values are revealed through judgments and actions. Messages regarding protective actions will be more influential if they account for the values held by the target audience. Some examples of how earthquake safety can be framed in terms of community values, adapted from Keeney (1992):

- This community places value on helping people who are less able, older, younger or impaired;
- Culturally, it is important for individuals to be brave, selfless, and dependable;
- Actions should be appraised in terms of safety consequences;
- It is better to act than not act during earthquakes; and
- Earthquakes threaten everyone with devastating injury, but acting correctly can improve safety.

Values can help determine priorities—for example, determining that the safety of children, spouse and parents is more important than personal safety, and that safety is more important than saving property. It is also important to understand value tradeoffs—is seeking safety less or more important than modesty, embarrassing family or self, or saving animals? Framing messages in terms of shared values can make people more receptive to taking the actions the message recommends.

Social Context and Considerations

The social context in which people find themselves will affect their reaction to earthquake shaking. Some jurisdictions will have populations that might need to be addressed in a particular way. Here are some examples:

[56] IFRC (2013), p. 17.

[57] Keeney (1992); see pages 6 and 7.

- Household context. Families might be together during earthquake shaking. If a small child is present, it is likely that the parents' immediate reaction will be to go to their child. This should be taken into consideration.
- Group context. If people are with others, they might be hesitant to immediately react, unless a leader motivates action. This leader can be any person who decides to be the first to react or someone like a teacher in a classroom.
- Immigrants. This population might be familiar with the environment, but they might face other challenges, such as language and cultural barriers, to receiving and adopting messages.
- Transient populations, including tourists and temporary workers. These people are not familiar with the environment and might not be familiar with earthquake hazards. They may be less likely to react immediately to environmental cues that an earthquake is occurring.

A local sociologist should advise on how to address social considerations in the jurisdiction.

Level of existing awareness and how that impacts people's reactions to earthquake shaking

When a moderate earthquake struck Virginia, in the eastern USA in 2011, many people interpreted the shaking through the lens of the September 11, 2001 terror attacks and assumed that another attack was occurring. Their impulse was to rapidly evacuate buildings rather than to find cover from falling objects, despite the moderate level of shaking. The solution is to alert people to what an earthquake feels like, and to recommend what to do.

PART III. Developing a Communication Strategy

How will the message reach all the people?

Communication Program Design

Protective actions messages will commonly be part of a broader earthquake (or multi-hazard) safety messaging and awareness/preparedness program. The communication program design should allow for different strategies in order to most effectively reach different audiences. However, it is important to ensure that there is consistency in the messages. The same message should reach people through various channels (e.g., media campaigns, school, and work). The messages, in whatever form they are delivered, should be consistent, clear, and communicate the same underlying principles. They should be backed by a consensus of key stakeholders in order to avoid public confusion, apathy, distrust and lack of action. As with message development, creating communications in the local languages is essential. Communications professionals fluent in the local language(s)—ideally, native speakers—are an excellent resource and should lead communication strategy development whenever possible.

The background paper on risk communication (Lindell, 2014), located in the accompanying volume, provides a detailed discussion of recommendations for the design and implementation of an effective risk communication program. IFRC (2011) also provides practical recommendations for public awareness programs. This section provides a very brief overview.

Channels for Communicating the Message

People receive information through different channels, including person-to-person interactions, brochures and printed material, and broadcast media such as radio and television. The most effective channels for communicating messages might vary depending on target audience. For example, the channels to communicate messages to the majority of the population will probably differ from those targeting immigrants or transient populations.

Information Sources

People will be more likely to act on a message if they trust its source. It is important to first identify existing information sources and to determine if they have any contradictory information. If they do, the contradictory statements should be addressed. The effectiveness and use of these information sources should be investigated. If they are already effective in delivering messages to the public, it might be worthwhile to deliver the protective actions messages via this same information source, if possible. Other information sources should be investigated, especially when addressing different types of audiences.

Types of Audiences and Trustworthy Spokespersons and Leaders

Having highly respected and trusted spokespersons is very important. These spokespersons should be identified for different types of audiences. In the process of identifying the ideal spokesperson, an audience's characteristics should be considered (e.g., gender, age, and their level of resources).

Recommendations for Future Work and References

Recommendations for Future Research to Support Protective Actions Guidance

The project team and collaborators identified a number of recommendations for future work during the process of developing this guidance document. These include the following topics.

- Asphyxiation due to dust created by collapsing buildings is poorly addressed in current messaging. Researchers should test the effectiveness of potential self-protection measures and develop recommended directives.
- Better understanding of seismic hazard and how that hazard affects the amount of time people will have to go to a safer place. For example, in the few contexts where people are likely to have 10 seconds, this knowledge will lead to more effective messaging.
- Better understanding of how long it takes people to recognize that an earthquake is occurring and decide to take action.
- Surveys of protective actions in recent earthquakes (what did people do and what was the outcome?) would add valuable data. Few rigorous surveys of protective actions in low- and middle-income country contexts exist. Agreeing on methodology for post-earthquake investigations of protective actions effectiveness would also help provide consistency and facilitate comparisons between earthquakes and contexts.
- Epidemiological studies of the causes of deaths and injuries in areas with a variety of highly lethal building types, particularly vernacular masonry buildings and reinforced concrete buildings, would improve the currently incomplete understanding of how damage and collapses of these building types kill and injure.
- More accurate methods for determining the likelihood buildings will collapse or suffer other forms of potentially life threatening damage (including objects falling from the building exterior) at various levels of shaking. Detailed damage data correlated to shaking levels are necessary for developing such methods.
- A systematic protocol for documenting rescue and recovery efforts, along with a mechanism for making the data available to researchers, would improve understanding of how people survive building collapses. Search and rescue professionals are a potentially rich source of data on where survivors and fatalities are found within collapsed buildings.
- Determining underlying factors that contribute to people retaining or ignoring certain protective action beliefs in the face of conflicting information would help message creators design more effective messaging programs.

References

The project background papers, located in the companion volume, contain a large number of additional references.

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