



Report on the 2010 Chilean Earthquake and Tsunami Response



Open-File Report 2011-1053, version 1.1

U.S. Department of the Interior
U.S. Geological Survey

Cover: The Alto Rio 15-story apartment building in the city of Concepcion that collapsed during the Maule earthquake. Photo courtesy of Jorge Arturo Borbar Cisternas.

Report on the 2010 Chilean Earthquake and Tsunami Response

By the American Red Cross Multidisciplinary Team

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FRONT COVER

The Alto Rio 15-story apartment building in the city of Concepcion that collapsed during
the Maule earthquake. Photo courtesy of Jorge Arturo Borbar Cisternas.

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1.0 Executive Summary

In July 2010, in an effort to reduce future catastrophic natural disaster losses for California, the American Red Cross coordinated and sent a delegation of 20 multidisciplinary experts on earthquake response and recovery to Chile. The primary goal was to understand how the Chilean society and relevant organizations responded to the magnitude 8.8 Maule earthquake that struck the region on February 27, 2010, as well as how an application of these lessons could better prepare California communities, response partners and state emergency partners for a comparable situation. Similarities in building codes, socioeconomic conditions, and broad extent of the strong shaking make the Chilean earthquake a very close analog to the impact of future great earthquakes on California. To withstand and recover from natural and human-caused disasters, it is essential for citizens and communities to work together to anticipate threats, limit effects, and rapidly restore functionality after a crisis.

The delegation was hosted by the Chilean Red Cross and received extensive briefings from both national and local Red Cross officials. During nine days in Chile, the delegation also met with officials at the national, regional, and local government levels. Technical briefings were received from the President's Emergency Committee, emergency managers from ONEMI (comparable to FEMA), structural engineers, a seismologist, hospital administrators, firefighters, and the United Nations team in Chile. Cities visited include Santiago, Talca, Constitución, Concepción, Talcahuano, Tumbes, and Cauquenes. The American Red Cross Multidisciplinary Team consisted of subject matter experts, who carried out special investigations in five Teams on the (1) science and engineering findings, (2) medical services, (3) emergency services, (4) volunteer management, and (5) executive and management issues (see appendix A for a full list of participants and their titles and teams). While developing this delegation, it was clear that a multidisciplinary approach was required to properly analyze the emergency response, technical, and social components of this disaster. A diverse and knowledgeable delegation was necessary to analyze the Chilean response in a way that would be beneficial to preparedness in California, as well as improve mitigation efforts around the United States.

By most standards, the Maule earthquake was a catastrophe for Chile. The economic losses totaled \$30 billion USD or 17% of the GDP of the country. Twelve million people, or $\frac{3}{4}$ of the population of the country, were in areas that felt strong shaking. Yet only 521 fatalities have been confirmed, with 56 people still missing and presumed dead in the tsunami.

The Science and Technology Team evaluated the impacts of the earthquake on built environment with implications for the United States. The fires following the earthquake were minimal in part because of the shutdown of the national electrical grid early in the shaking. Only five engineer-designed buildings were destroyed during the earthquake; however, over 350,000 housing units were destroyed. Chile has a law that holds building owners liable for the first 10 years of a building's existence for any losses resulting from inadequate application of the building code during construction. This law was cited by many our team met with as a prime reason for the strong performance of the built environment. Overall, this earthquake demonstrated that strict building codes and standards could greatly reduce losses in even the largest earthquakes. In the immediate response to the earthquake and tsunami, first responders, emergency personnel, and search and rescue teams handled many challenges. Loss of communications was significant; many lives were lost and effective

coordination to support life-sustaining efforts was gravely impacted due to a lack of inter- and intra-agency coordination.

The Health and Medical Services Team sought to understand the medical disaster response strategies and operations of Chilean agencies, including perceived or actual failures in disaster preparation that impacted the medical disaster response; post-disaster health and medical interventions to save lives and limit suffering; and the lessons learned by public health and medical personnel as a result of their experiences. Despite devastating damage to the health care and civic infrastructure, the health care response to the Chilean earthquake appeared highly successful due to several factors. Like other first responders, the medical community had the ability and resourcefulness to respond without centralized control in the early response phase. The health care community maintained patient care under austere conditions, despite many obstacles that could have prevented such care. National and international resources were rapidly mobilized to support the medical response.

The Emergency Services Team sought to collect information on all phases of emergency management (preparedness, mitigation, response, and recovery) and determine what worked well and what could be improved upon. The Chileans reported being surprised that they were not as ready for this event as they thought they were. The use of mass care sheltering was limited, given the scope of the disaster, because of the resiliency of the population. The impacts of the earthquake and the tsunami were quite different, as were the needs of urban and rural dwellers, necessitating different response activities.

The Volunteer Services Team examined the challenges faced in mobilizing a large number of volunteers to assist in the aftermath of a disaster of this scale. One of the greatest challenges expressed was difficulty in communication; the need for redundancy in communication mechanisms was cited. The flexibility and ability to work autonomously by the frontline volunteers was a significant factor in effective response. It was also important for volunteer leadership to know the emergency plans. These plans need to be flexible, include alternative options, and be completed in conjunction with local officials and other volunteers.

Recommendations for California.

1. Conduct comprehensive exercises (including joint Government, private sector, NGO, emergency responder, and community exercises) before the event.
2. Empower people to be prepared.
3. Educate the population, comprehensively and continually, about what will happen during the event.
4. Emergency and earthquake professionals should work with representatives of print and broadcast media before the disaster to determine how to best serve the community.
5. Emergency plans need to be redundant, flexible, and detailed to handle the unexpected in very large disasters.
6. Recognize the competing personal and professional demands that will be made on staff after a disaster and include this in emergency plans.
7. Organizations need to plan for nonstructural damage and the potential need to evacuate even without structural damage.
8. Recognize vulnerabilities in our communications systems and make comprehensive backup plans to avoid complete communication collapse.
9. Explore mechanisms to encourage building owners to adhere rigorously to existing building codes.
10. Collect all possible data about each disaster when it happens.

The Executive/Red Cross Management Team took a broad look at the impacts of the earthquake and the implications for California. Some of the most important preparation for the disaster came from relationships formed before the event. The communities with strong connections between different government services generally fared well. The initial response and resilience of individuals and communities was another important component. Communication system failures limited the ability of a central government to assist impacted communities, or to issue tsunami warnings. It also delayed the response since the government did not know (in some case for several days) the impact and needs of local governments. In general, plans for congregate care shelters existed but were little used as most people chose to stay at damaged homes or with relatives. Looting was a surprise to response officials as well as social scientists, but both public and private sector organizations, including NGOs (Non-Governmental Organizations), must consider security for damaged businesses as a priority in California's multihazard planning. Class and ethnic divisions that become heightened during some cases of actual or perceived injustice may also emerge in natural disasters in California.

Several factors contributed overall to the low casualty rate and rapid recovery. A major factor is the strong building code in Chile and its comprehensive enforcement. In particular, Chile has a law that holds building owners accountable for losses in a building they build for 10 years. A second factor was the limited number of fires after the earthquake. In the last few California earthquakes, 60% of the fires were started by electrical problems, so the rarity of fires may have been affected by the shut down of the electricity grid early in the earthquake. Third, in many areas, the local emergency response was very effective. The most effective regions had close coordination between emergency management, fire, and police and were empowered to respond without communication with the capital. The fourth factor was the overall high level of knowledge about earthquakes and tsunamis by much of the population that helped them respond more appropriately after the event.

2.0 Introduction

At some point in the future of the United States, we will be faced with a very large and potentially catastrophic earthquake. The American Red Cross recognized the February 27, 2010, Maule earthquake in Chile as an opportunity to learn and prepare for what we will face in our country after a similar disaster. In partnership with the Multi Hazards Demonstration Project of the U. S. Geological Survey, whose mission is to use hazards science to improve community resilience to natural disasters, the American Red Cross created a delegation of earthquake disaster specialists to go to Chile in order to learn lessons from that earthquake. They brought experts in emergency management and response, volunteer management, medical services, seismologists, and engineers. This report of that delegation on the successes and challenges that Chile faced in responding to their disaster is intended to aid both the American Red Cross and other facets of American society to be prepared for our future disasters.

While the earthquake is inevitable, the magnitude of the human disaster is not. We know that the degree to which we are prepared before a large earthquake will dictate how well we are able to survive and thrive after the event. The challenge to those in disaster prone regions is to understand the consequences of the largest events before they happen, even though, by definition, those events happen so infrequently that they are not in the living memory of most residents. The most effective solution to this problem is to learn from other regions that have experienced similar events. It is essential to appropriately extrapolate what the factors are that correspond between one disaster and another. What are the general lessons we can draw from societies that have experienced a major disaster? What did they do that helped improve their resiliency? In hindsight, what could have feasibly been done to lessen the negative impact of the disaster?

The delegation was structured into five teams: Health and Medical Services, Emergency Management, Volunteer Management, Executive/Red Cross Management, and Science and Technology (see appendix A). Each team had a different function and role on this trip. The Health and Medical Services team had the goal of understanding the medical disaster response that occurred in Chile after the earthquake. The Emergency Management team sought to get a better handle on the timeline of emergency response, as well as what went well and what went poorly in Chile's response. The Volunteer Management team intended to better understand the role of the Chilean Red Cross and to see how volunteers were handled during the earthquake and tsunami aftermath. The Executive/Red Cross Management Team went to Chile with the intent of broadly observing the disaster there and noting similarities to events that the American Red Cross, its State response partners, and other organizations in California might face. The Science and Technology team served as a resource to the other teams to help understand the science and engineering sides of the earthquake and tsunami. All teams went to Chile in order to learn from the strengths and weaknesses of the Chilean response, with the goal of taking lessons back to the United States to increase our preparedness.

The following sections detail the findings of the different subject areas addressed by the delegation.

3.0 Science and Technology

The Science and Technology Team compiled the scientific and technical findings about the Chilean earthquake to provide a context for comparing this event to future events in California and elsewhere. The Team met with representatives of Chile's National Seismological Service and university-based structural engineers and visited multiple sites of damage.

3.1 The Earthquake

The moment magnitude 8.8 Maule earthquake began at 3:34 a.m. on Saturday, February 27, 2010. The epicenter of the earthquake was offshore from the Maule Region, approximately 105 km (65 mi) north-northeast of Chile's second largest city, Concepción (U.S. Geological Survey Earthquake Program, 2010a). Since the earthquake was in the middle of the night on a weekend, most people were asleep in their homes. Injury due to falling debris or damaged roadways, bridges, and highways was minimized due to the time and day of the earthquake. 521 people were killed, and 56 are still considered missing. A brief summary of Chile's losses in this event can be seen in table 1.

Table 1. Summary of damages and losses from February 27, 2010, earthquake and tsunami (Comité de Emergencia, written communication, 2010)

Deaths	521 people
Missing Persons	56 people
Homes destroyed or damaged	~370,000 (11% of the total in the area)
Hospitals destroyed or damaged	73
Schools destroyed or damaged	3,049 schools, housing 1.25 million students
Bridges destroyed or damaged	221
Villages and rural and coastal communities affected	More than 900
Estimated economic losses	U.S. \$ 30 billion. 17% of GDP

A major tsunami struck the coast nearest to the epicenter within minutes of the *M*8.8 earthquake. The earthquake occurred in the Chilean subduction zone, where a section of the earth's crust called the Nazca Plate is subducted under the South American Plate.

The size of an earthquake is proportional to the area of the fault plane that moves in an earthquake, multiplied by the amount one side of the fault moved with respect to the other. The section of fault that moved in this earthquake (see fig. 1) was 450-500 km long (280-310 miles) and around 100 km wide (60 miles). The rupture began at the epicenter and propagated both north, towards the capital city of Santiago, and south of the second largest city of Concepción.

In spite of the large magnitude, the intensity of shaking was lower than in some other similarly sized earthquakes because the fault plane was mostly offshore. The Modified Mercalli Intensity scale (MMI) describes the intensity of shaking in an earthquake on a scale of I to XII, the categories of which are defined in table 2. A map of the intensities

experienced in the Chile earthquake is shown in figure 2. The highest intensity, MMI IX, was recorded at the town of Constitución on the coast, just north of the epicenter. Concepción received Intensity VIII shaking, while intensity VI was recorded for the capital of Santiago. By comparison, the most intense shaking in the 1994 Northridge, California, earthquake was MMI IX in much of the western San Fernando Valley, while Pasadena received MMI VI shaking in that event.

The Modified Mercalli Intensity scale, composed of different levels of intensity that range from barely felt shaking to catastrophic destruction, is split into 12 increasing levels of damage, which are ranked by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects of ground shaking.

The Modified Mercalli Intensity value assigned to a specific site after an earthquake provides a more meaningful measure of severity to the nonscientist than the magnitude of an earthquake. Intensity refers to the effects actually experienced at that location, rather than earthquake magnitude, which does not describe the damage that was experienced.

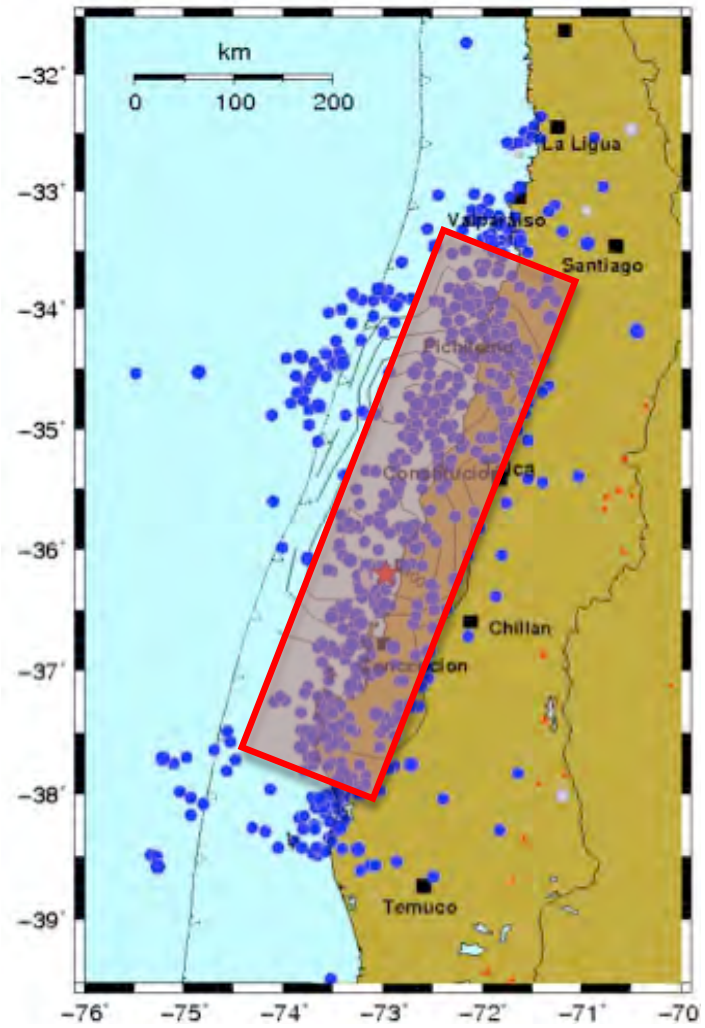


Figure 1. A map of $M > 4.7$ aftershocks from the February 27, 2010, Chile earthquake. The epicenter of the $M 8.8$ earthquake is marked with a red star. The contour lines represent the amount of displacement at the boundary between the Nazca and South American Plates. Maximum displacement reached values of 12-14 m (National Center for Earthquake Information). The red box outlines the fault plane that ruptured in the earthquake. (Image courtesy of Sergio Barrientos.)

Table 2. A description of Modified Mercalli Intensity categories. These categories are based on observation, and not measurements made by instruments (U.S.G.S. Earthquake Program, 2010b).

Intensity	Description of Shaking/Damage
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

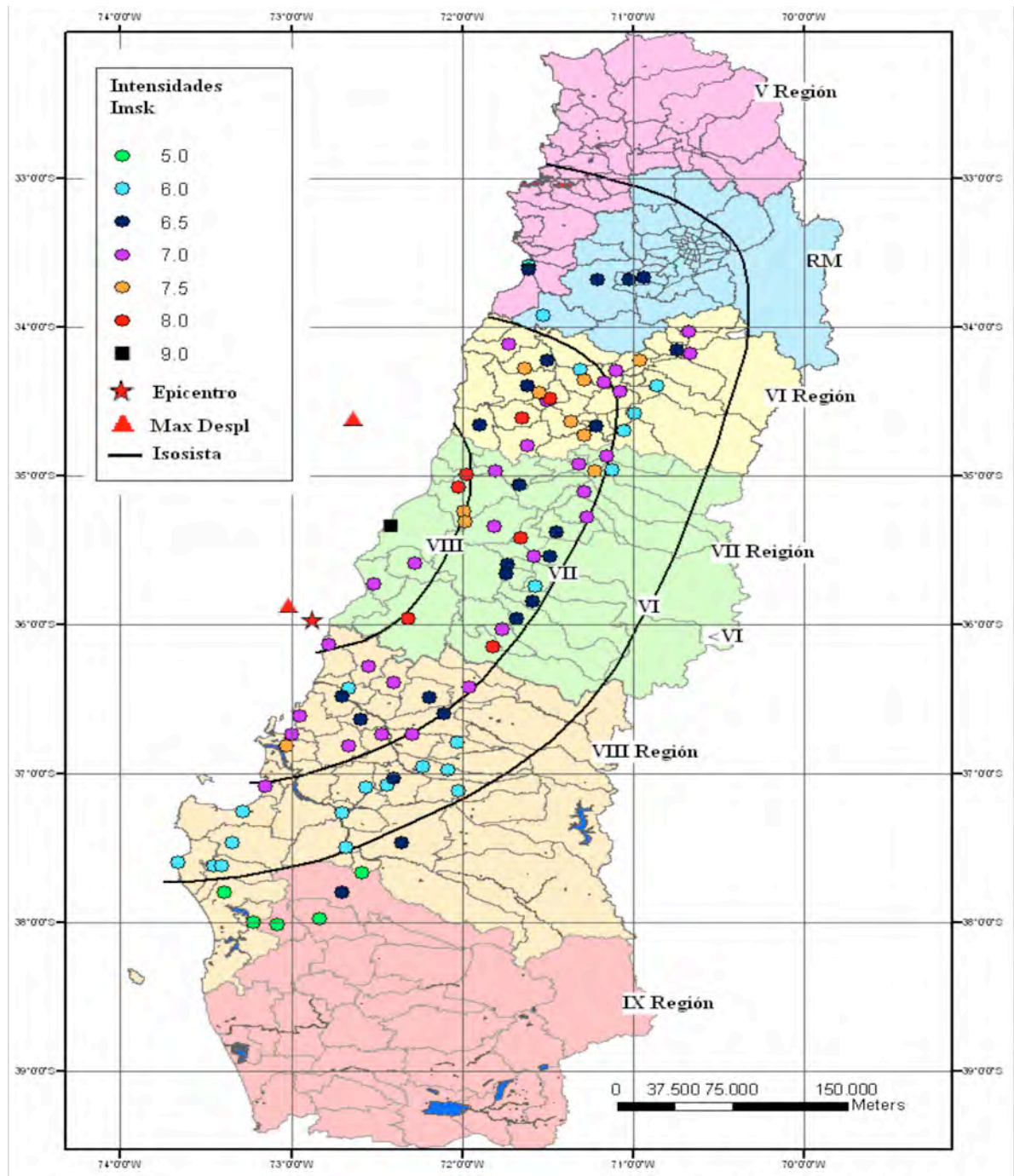


Figure 2. Isoseismal map (intensity map) produced after inspecting 98 localities throughout the length of Chile. According to the 2002 Chilean Census, 12,202,858 people live in this broad area, representing 79.5% of the population of the country. The locations visited by Astroza and coworkers. are distributed over the length and breadth of the country achieving an almost complete coverage of the earthquake damage zone. Villages at the foot of the Andes were not visited; many of these areas are far from the rupture plane and no damage was reported. Some villages along the coast that were affected by the tsunami were also not visited. It was difficult to differentiate what damage was caused only by ground motion, which is a fundamental piece of information when determining the degree of seismic intensity. (Image from Astroza and others., 2010.)

3.2 The Tsunami

A tsunami is a large series of waves that travel through the ocean, which can cause great destruction upon impact at the shoreline. Tsunamis travel across the ocean at speeds comparable to commercial airplanes (500-650 miles per hour), but waves slow down when they approach the shoreline. Subduction zone earthquakes produce the largest tsunamis.

The change in sea height recorded on the coast of Chile on February 27, 2010, is shown in fig. 3. Note how the tsunami waves continue for more than 12 hours. The later pulses decay with time, but the tsunami signal is superimposed on the tides. For this earthquake, high tide occurred about 3-8 hours after the earthquake (depending on the location of the tide gauge), so the highest water occurred in many locations around 7 a.m-1 p.m.

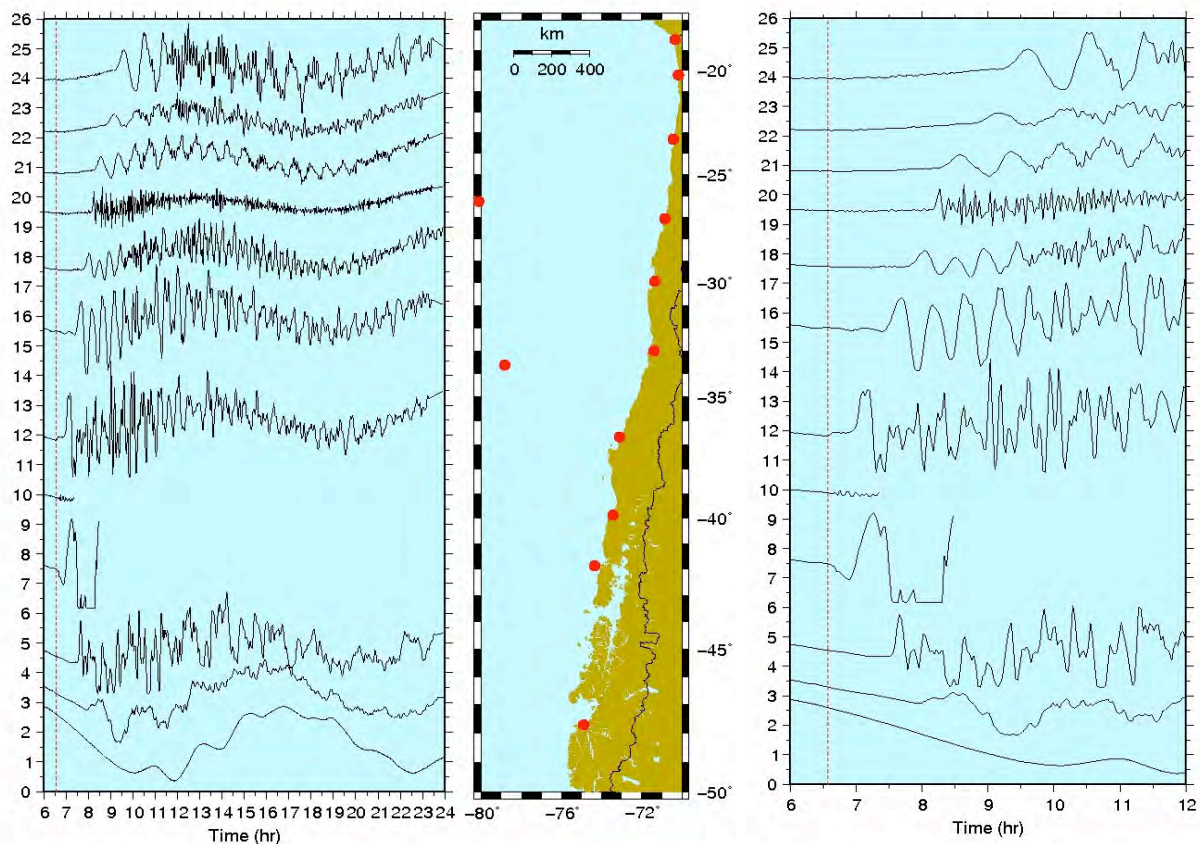


Figure 3. Water level recordings for tide gauges along Chilean coastline. The red dots on the map in the center show the locations of the hydrographs. The graphs on the left show water levels over 18 hours after the earthquake (the red line is the time of the earthquake). The graph on the right is on an expanded time scale to see the first 6 hours. Note that sea level fluctuations occurred all day, not just immediately following the earthquake. The tsunami hit as neap tide was approaching, which is when the lowest-low tides occur. Therefore, the largest tides came in when high tide was approaching, 3-8 hours later in some places. (Image courtesy of Sergio Barrientos.)

3.3 Impact of the Earthquake

Estimates from the Chilean Government suggest that over 370,000 housing units were damaged or destroyed in the February 27th earthquake. Table 3 lists the Government of Chile's estimates of housing damage (as of March 29, 2010) (GEER, 2010). In 6 of 15 of Chile's regions, a "state of catastrophe" was declared. The Government of Chile states that more than 12.8 million people in the most affected regions were impacted by the earthquake and resulting tsunami.

Table 3. Estimate of housing damage (as of March 29, 2010). From the Geo-Engineering Extreme Events Reconnaissance Team Report (GEER, 2010)

	Housing Units Destroyed	Housing Units Significantly Damaged	Housing Units with Minor Damage	Total Housing Units
Coast	7,931	8,607	15,384	31,922
Urban Adobe	26,038	28,153	14,869	69,060
Rural Adobe	24,538	19,783	22,052	66,373
Multi-unit Public Housing	5,489	15,015	50,955	71,459
Multi-unit Private Housing	17,449	37,356	76,433	131,238
Total	81,444	108,914	179,693	370,051

(Source: Government of Chile)

An earthquake can damage structure (for example, buildings), infrastructure (for example, lifelines and roadways), and non-structural entities (for example, furniture inside of a building). Chile has very strong building codes. Structures in areas that experienced strong shaking had less damage than they would have if building codes were worse. Buildings in Chile are built to be rigid, as opposed to the more flexible construction used in southern California structures. The apartment building in figure 4 (the Alto Rio building in Concepción) did not collapse in a pancake-style, but rather fell over during the shaking. This structural response is a product of rigid building design.

Chile's strong building codes saved many lives in this earthquake and are probably the most significant factor in the low mortality level. Simply because a country has strong building codes, however, does not mean that they will be enforced. Another possible factor in Chilean buildings' widely successful response to the earthquake is Chilean Law 458: the General Urbanism and Construction Law. This law requires compensation to be given by the original construction company to those who suffer loss in the wake of partial or complete destruction of a building. Compensation will only be given out if building codes were not adhered to. The General Urbanism and Construction Law discusses the liability of the construction company. If this company followed and respected the building codes, they are not the responsible for providing compensation. If they did not build according to the building code, they are the responsible for the damages in the building that were due to a failure during the construction process.

Article 18 of the law declares that the original owner is responsible for all severe damage that occurs within the first 10 years of the building's existence. (The law scales, so the owner is not liable for certain damages after a given period of time.) The law does not discriminate

whether these failures are due to errors in the construction process or from adjustments made after the building was constructed. If the building (apartment or house) is insured, the insurance pays for the people who were injured. These compensations may last up to 30 years.



Figure 4. The collapsed Alto Rio apartment building in Concepción. Eight people were killed when this building fell over.

In the region that experienced the highest intensity shaking, infrastructure, including roads, bridges, airports, ports, utilities, and communication networks, sustained significant damage. The most severe damage occurred along the coast and in parts of Chile's central valley. The earthquake disrupted the major industries of the region (fishing, shipping, mining, refineries, forestry, winemaking, and agriculture). The Chilean Government estimates economic losses to be approximately \$30 billion USD, which is 17% of Chile's GDP (Oral communication, Comité de Emergencia, 2010). Restoration of telecommunication and electricity systems varied greatly. Shaking induced electric shutoffs in some power stations; this had a domino effect and shut down the entire electric system within about 30 seconds of the start of the earthquake. We received reports of power being restored to many areas within 2-3 days. Telecommunications were also rapidly restored in some areas. In Concepción, we received reports of cell phone use being restored within two hours. Based on reports from many individuals we spoke with, water, sewage, and transportation damages took much longer to

repair. Prolonged damages can significantly raise business interruption losses and strongly impact overall recovery time.

It appears that there were fewer fires following this earthquake relative to the population exposed to strong shaking than has been seen in California. It is not possible to be quantitative about this, because none of the people we spoke to knew of any documentation of the number or extent of fires. It is clear that there were fires, some significant, such as the large fire in a chemical factory outside of Santiago. It is also clear that there were no conflagrations that could not be controlled. Possible contributing factors include the complete shutdown of the national electricity grid within the first 30 seconds of shaking and the widespread use of propane for cooking so that gas pipelines were limited outside the cities.

3.4 Comparing the Chilean Earthquake to the January 12, 2010, Haiti Earthquake and to Large Earthquakes on the San Andreas Fault in California

Figure 5 maps the distribution of intensity for three earthquakes, the February 27, 2010, $M8.8$ Chilean earthquake, the January 10, 2010, $M7.0$ Haiti Earthquake, and a hypothetical southern California earthquake, the $M7.8$ ShakeOut scenario. All three are shown at approximately the same scale. The ShakeOut and Haiti earthquakes are both on vertical, strike-slip faults that reach the surface of the earth in populated areas. The Chilean earthquake occurred on a fault that was almost horizontal, that comes to the surface in the

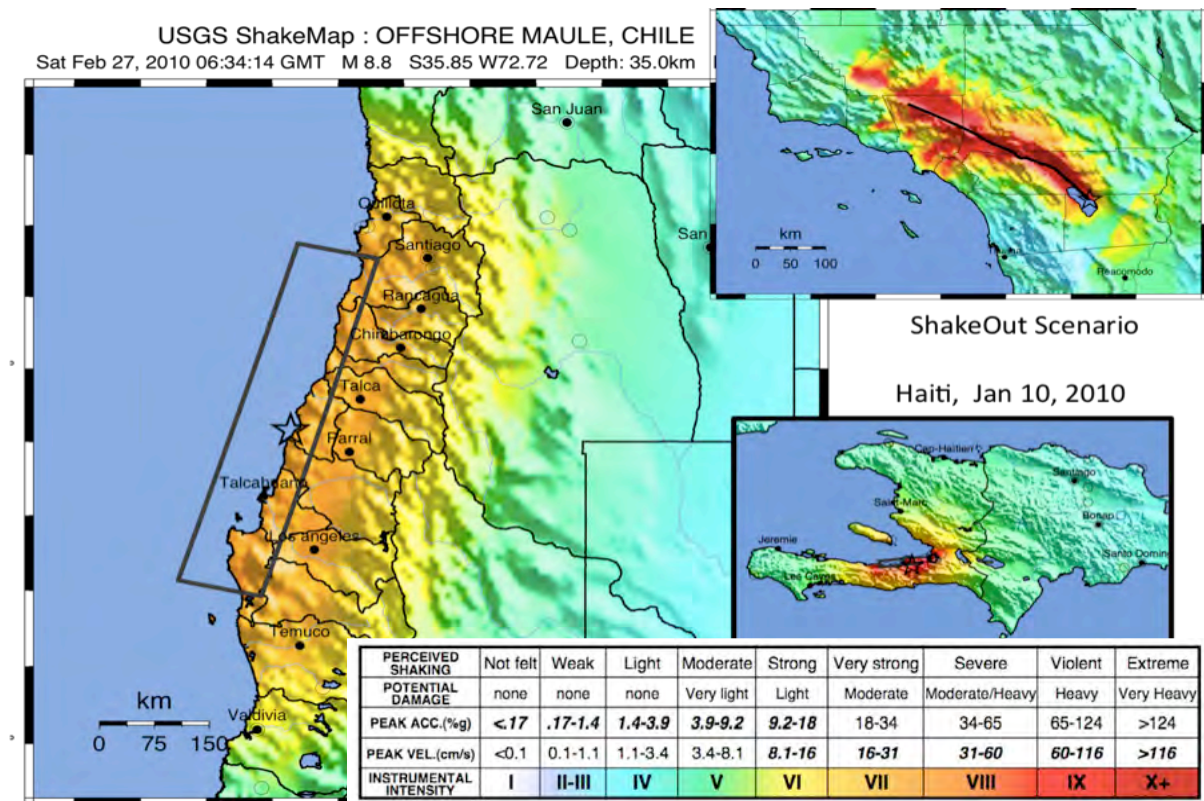


Figure 5. Maps comparing the intensity of shaking during three earthquakes: the February 27, 2010, $M8.8$ Chilean earthquake (left), the January 10, 2010, $M7.0$ Haiti earthquake (lower right), and a hypothetical southern California earthquake, the $M7.8$ ShakeOut scenario (upper right). Colors show the level of shaking as Modified Mercalli Intensity (Images courtesy of USGS).

seafloor. The area of the fault determines the magnitude of the earthquake. The area of the Chilean fault is 20 times the area of the ShakeOut fault and almost 200 times the area of the fault in Haiti. Since the Chilean earthquake began in the middle of the fault and ruptured in both directions, the duration of the rupture was shorter than if it had begun at one end. Estimates of the duration are about two minutes, which is comparable to the ShakeOut earthquake (which ruptures from the southern end of the San Andreas northward). The Haiti earthquake rupture lasted for about 15 seconds.

Thus the Haiti earthquake had a lower level of shaking for a shorter period of time than either Chile or the ShakeOut. The extremely high death toll and level of damage in that earthquake is directly attributable to the poor quality of buildings in the area. The Haiti experience, therefore, does not provide a basis for comparison to either the Chilean or ShakeOut earthquakes.

Compared to the expected San Andreas earthquake in California, the Chilean earthquake occurred on a longer and wider fault, with fewer people near the fault. This means the type of damage caused by being located near the fault (from very high frequency shaking) would be more prevalent in California compared to the Chilean earthquake. The type of damage that comes from the very large, low frequency waves of a great earthquake will dominate the Chilean damage. This is the type of damage that will be more prevalent in a big San Andreas earthquake than in other previous California events, such as the Northridge and Loma Prieta earthquakes.

These examples highlight the fact that magnitude alone does not determine what the experience of an earthquake will be. The intensity of shaking at any one moment does not grow significantly at the largest magnitudes. Rather, the duration of the shaking increases, and the area exposed to the strong shaking gets larger. The population exposed to the shaking, however, is equally important. Many of the Chilean officials interviewed by this delegation said that they were surprised by the extent of the devastation because they know they had already experienced the largest earthquake in recorded history (the magnitude 9.5 event in 1960), and they thought that they should have been able to handle anything else that came along. However, the 1960 event was in the southernmost part of the country, which has a limited population, and did not approach the population exposure of the 2010 earthquake, which was located near Chile's second largest city. Similarly, California should recognize that a magnitude 7.4 on a fault that extends under most of Los Angeles would be much more devastating than the same size earthquake on a fault located in a more rural area. Magnitude, proximity of population, and local soil conditions all play a role in determining the level of damage in an earthquake.

3.5 Science and Technology Key Findings

1. The law that requires building owners to compensate for damages caused by failure to adhere to the building code was repeatedly cited as an incentive for more conservative construction. Some method to encourage personal responsibility by building owners in California would increase our resiliency.
2. Lives were saved because most of the local population knew about the risk of tsunamis and moved quickly away from the coast after the earthquake. It is not clear if lives were lost because not everyone realized that a tsunami is not one wave but a

series superimposed on the tides thus the highest surge could be several hours later when the tide is highest. Comprehensive and continuing education about earthquake and tsunami risks could save lives in California.

3. Not many fires were triggered by this earthquake. The degree to which this was affected by electrical systems that were shut down before strong shaking arrived needs to be better understood.

4.0 Emergency Management

The Emergency Management Team evaluated earthquake and tsunami preparedness and response by collecting information through meetings with National and local government officials, Chilean Red Cross personnel, the United Nations International Coordination Officer, and *Bomberos* (firefighters), and through individual interviews with disaster survivors. These meetings took place in the cities of Santiago, Talca, Constitución, Concepción, Talcahuano, Tumbes, and Cauquenes between July 19 and July 27, 2010. Pre-scheduled meetings with government and Chilean Red Cross personnel included presentations and group discussions, each with question and answer periods. During meetings, interviews, and conversations the Emergency Management Team sought to collect information on all phases of emergency management actions (preparedness, mitigation, response, and recovery), and determine what did and did not work.

4.1 Government and Structure of Emergency Management in Chile

4.1.1 Chilean Political Structure

Chile has an area of approximately 303,000 square miles, twice the size of California, but has a population of only 16.8 million, 6.5 million of whom live in Chile's capital of Santiago. The earthquake's greatest impact was on the most heavily populated central region of the country, which includes the second largest urban area of Concepción-Talcahuano (population 840,000) as well as Santiago. Chile is one of the more prosperous nations in South America, with an annual GDP of \$173 billion and an annual growth rate of 3.2% based on mining, manufacturing, and exports of copper, seafood, and agricultural produce and wood products. Per capita income is \$14,688, and the adult literacy rate is 96%.

Chile is a republic with executive (president), legislative (bicameral legislature), and judicial (Constitutional Tribunal, Supreme Court, courts of appeal and military) branches. Administratively, Chile is divided into 16 regions under the authority of *intendentes* appointed by the president. Within each region are provinces, each with an appointed governor; provinces are divided into districts or municipalities administered by popularly elected mayors. Within this governmental structure, the principal emergency response organizations are Oficina Nacional de Emergencias, Ministerio de Interior (ONEM), firefighters, and armed services.

4.1.2 Oficina Nacional de Emergencias, Ministerio de Interior, or National Office of Emergencies, Ministry of the Interior (ONEMI)

ONEMI is the agency responsible for “Civil Protection, understood as protecting people, property and environment in a situation of collective risk, whether naturally occurring or generated by human activity is performed in Chile by a system composed of Organizations, Services & Institutions both of the public and private sector, including voluntary agencies and community organizations under the coordination of the National Emergency Office of the Ministry of Interior, ONEMI” (March 12, 2002).

ONEMI (see fig. 6) is roughly comparable to the Federal Emergency Management Agency (FEMA) in the United States and has some common functions such as training, promoting preparedness and hazard mitigation, and coordinating with other agencies of government and the private sector in emergency response and recovery. But ONEMI also has responsibility for alert and warning, functions performed in the United States by the U.S. Geological Survey for earthquakes and the National Oceanic and Atmospheric Administration’s (NOAA) National Weather Service for Tsunamis.

In addition, as Chile’s main civil protection agency, ONEMI performs some of the coordination and mutual aid functions associated with state government in California through emergency response committees at the regional, provincial, and municipal levels.

4.1.3 National Volunteer Fire Services

Fire services in Chile are provided by 38,000 volunteer firefighters (*Bomberos*),

a fact that astounded many of the members of the U.S. emergency management team who traditionally associate volunteer fire fighting with small towns and rural areas. There are no paid professional firefighters in all of Chile, including Santiago, an international city of 6.5 million inhabitants. There is support from the National government, which equips local fire departments in a total of 345 districts and operates a national fire academy to train Chilean firefighters as well as those of other South American nations. The only paid functionaries associated with fire services are dispatchers and drivers. The President of the *Bomberos* has administrative responsibility for regional fire authorities. The regional fire authorities serve as coordinators of fire services and act as mutual aid providers at the provincial and municipal levels.



Figure 6. American Red Cross Delegates meet with ONEMI officials in Santiago.

The responsibilities of Chilean fire agencies are similar to those handled by firefighters in the United States. They are responsible for fire suppression, hazardous materials management, emergency and medical response, and search and rescue (see fig. 7). In addition, they conduct safety inspections of buildings following major emergencies, a function performed by volunteer engineers and building officials in California under a program (ATC-20 Safety Assessment Program) administered by the California Emergency Management Agency.



Figure 7. Chilean firefighters distribute water to a local community after the earthquake.

In spite of their unpaid status, fire agencies in Chile appear to have little difficulty in recruitment and retention of personnel. The long tradition of volunteer firefighting in Chile spanning 160 years has witnessed the evolution of mechanisms to ensure adequate numbers of new volunteers. These mechanisms include a youth program that begins firefighting training at the age of 12 and results, at age 18, in sufficient prerequisite training to be admitted to the fire academy. Further, there is significant cultural prestige associated with being a firefighter such that recruits are drawn from all social classes, including professionals. A testament to the status of firefighting in Chile is the fact that there is not a law mandating the release of *Bomberos* from their paid jobs, only the sense of community responsibility on the part of employers.

4.1.4 Armed Forces

Chile's armed forces are subject to civilian control under a Ministry of Defense and the President of the Republic. Commanders of the armed forces are appointed by the President for 4-year terms and serve at the discretion of the President. The Chilean Army consists of 45,000 soldiers and is organized into seven divisions located at bases throughout the country and headquartered in Santiago. Chilean armed forces also include an Air Brigade in Rancagua and a Navy. A key responsibility of the Navy's Hydrographic and Oceanographic Service is to monitor the Pacific Tsunami Warning Center and issue tsunami warnings for Chile.

4.2 Emergency Management Findings

The following paragraphs summarize the key points pertinent to emergency management. During meetings and interviews, the emergency management team sought to collect information on all phases of emergency management (preparedness, mitigation, response, and recovery) and determine what worked well and what did not work. Below is a summary of the data received related to each response phase.

4.2.1 Preparedness / Mitigation

Several of those who discussed preparedness with the Emergency Management Team expressed an opinion that Chile was not adequately prepared for the effects of a disaster the size of which occurred on February 27, 2010. This opinion was shared by National and local government personnel, the Chilean Red Cross, as well as individual disaster survivors that were interviewed.

ONEMI acknowledged that the communications systems and plans that existed at the time of the event clearly failed, meaning they did not perform as expected, leaving the agency initially unable to communicate with the impacted areas. ONEMI indicated that the absence of any major disasters in Chile for over 20 years and the resulting reduction in their profile and funding were contributing factors to this failure. An additional element was the belief by many that Chile had already experienced and survived the most powerful earthquake of the 20th Century, a *M*9.5 in August of 1960, and therefore was at little risk for another major earthquake.

Fire department officials in the town of Concepción also described challenges that impacted the execution of their and other response efforts. Two significant issues in plan coordination were noted with the fire response. In Concepción, even though there was a plan for how off-duty *Bomberos* would first ensure their families' safety and then respond to the earthquake, on-duty fire crews were not part of these plans. In the aftermath of the quake, this led some of the on-duty personnel to deviate from their assigned response duties in order to check on their families and property. Second, their plan identified a specific location outside of the tsunami threatened area as a muster point for fire crews and equipment. Due to damage to roads, responders were unable to reach these muster point. Since no back-up site was identified in the plan, many *Bomberos* were unclear on their next steps.

Preparedness at the local level appears to have been effective. For example, the ONEMI Regional Emergency Management in Talca reported that most coastal communities practiced evacuating the coastal area during drills every other month. This activity contributed to the high level of successful evacuation achieved by the communities ultimately hit by the tsunami.

A number of mitigating factors appear to have limited the human losses due to the earthquake and tsunami. During several meetings the Emergency Management Team learned about the "earthquake culture," or "culture of preparedness" that has developed in Chile based on the history of regular, and at times very large, earthquakes. This "culture" proved to be most valuable in the tsunami-hit areas; the generation that survived the 1960 *M*9.5 earthquake had instilled a belief that anytime an earthquake was large enough to make it difficult to walk, people should quickly move to higher ground. During meetings with government officials, Chilean Red Cross, and individuals who were in the area when the tsunami hit, all expressed a belief that most individuals who were physically able to seek higher ground, did so. In the coastal areas, the population knew through previous exercises and information shared about past earthquakes that they needed to get to higher ground. A common assertion was that casualties on the coastal areas were low because the population acted independently and did in fact seek higher ground. Another cultural mitigating factor is the community spirit of the Chilean people. The responders and individuals interviewed in the impacted areas described how people shared resources such as food and shelter with

family and neighbors. The fire chief in the town of Constitución described how people shared food, water, and shelter in the days before outside government resources arrived. The first outside food to arrive in Constitución came two days after the event and was brought in by family members who drove from the city of Talca. Although three disaster shelters were opened in the first few days, they quickly closed as the displaced population moved out, as they had primarily sought housing with family or friends.

Chile's method for delivering food to their needy populations also helped to mitigate potential food shortages after the earthquake. Food is stored in "4x4" boxes in a central distribution warehouse. These boxes contain non-perishable items that can feed four people for up to four days. During non-disaster times these boxes are used to feed people who cannot afford to buy their own food. During the disaster, local communities, supported by ONEMI at the National level, were able to access and expand this existing system to deliver food to the earthquake and tsunami impacted areas.

4.2.2 Response

The initial response to the earthquake and tsunami varied based on location and several other factors. We will discuss local and community response, including the Chilean Red Cross, followed by the National/Regional response.

4.2.2.1 Local/Community Response

In the first hour and days following the earthquake and tsunami(s) the local and community response was dependant on local resources, local first responders, and individuals within the community—with very little outside assistance. Descriptions of the length of time it took to receive outside assistance varied depending on the location and the individual you were speaking with. Perspectives indicated that the local government response to the quake focused initially on search and rescue, medical support, and provision of food and water. However, for example, fire officials in Concepción said that many fire stations were damaged, which significantly impacted the response (see fig. 8). Effectiveness of the limited fire department resources was further complicated in Concepción by looters who in some areas barricaded the streets, making it difficult to put out fires. Fire officials also reported that some fire and ambulance personnel left their shifts to check on their family and property.

Members of the Emergency Management Team received repeated reports of the independent actions by residents within the impacted areas in response to the quake and tsunami. Individuals assisted others by rescuing them from damaged buildings, providing first aid, and providing and sharing food, shelter, and other resources. Since there was, at least initially, little communication with ONEMI



Figure 8. Damaged Firehouse in Talcahuano, near Concepción.

or other agencies outside the heavily impacted areas, this individual and community response was vital and critical.

4.2.2.2 The Chilean Red Cross Response

Prior to this earthquake and tsunami, the Chilean Red Cross' role had primarily been medical emergency response (paramedics); they had not been considered a "major player" in disaster preparedness and response. Chilean Red Cross personnel reported that their disaster preparedness role has been increasing since 2006. They expressed the belief, shared by many others with whom we met, that the damaging effects of this event were larger than anyone had anticipated. When the earthquake occurred, National Chilean Red Cross in Santiago was invited to participate at senior level meetings with the National government within three hours. After three days, Chilean Red Cross withdrew their participation because they felt they were not getting useful information and that this collaboration limited their ability to respond effectively using the resources that were becoming available to them. The Chilean Red Cross decided to focus instead on local and regional activities. Unlike the American Red Cross (ARC), the Chilean Red Cross is not responsible for congregate care sheltering. Local government has that responsibility and is supported by non-governmental organizations (NGO's) as necessary.

The Chilean Red Cross focus on response at the local level initially occurred without any coordination with the national government. Chilean Red Cross reported that very little information came from the government in the first few days. Their immediate priorities were focused on assessing impact, helping people, and providing temporary housing. They distributed coats, tents, food, and water and helped with basic recovery services.

Chilean Red Cross reported that very few shelters were opened. Most people remained with their property or stayed with friends or family. Chilean Red Cross sent volunteer assessment teams into the communities to first assess needs, and then later returned to deliver basic food and other items. Some of these deliveries were made house by house, some through bulk distribution sites. The Chilean Red Cross delivered 5,071 food boxes that contained a supply for 5 people for 15 days. They also assisted in the distribution of other government-supplied food boxes. Chilean Red Cross also assisted with providing health and sanitation support services.

During a visit to a temporary housing village outside of Constitución where 170 families were housed, residents informed our team that their first assistance after the tsunami came from the Chilean Red Cross. Also while at the village, the Emergency Management Team observed a food vendor drive through the village with fruit, vegetables



Figure 9. A truck sells food to displaced persons in *Mediasaguas* 'village' outside of Constitución.

and fish for sale to residents (see fig. 9). Local Chilean Red Cross officials told us that these deliveries were a daily occurrence and alleviated the need to drive, or find a ride to travel the 2.5 km to town to purchase food.

The International Federation of Red Cross and Crescent Societies (IFRC), the German Red Cross, the Spanish Red Cross, and others supplemented the Chilean Red Cross response. Overall, the quality of the Chilean Red Cross response to the earthquake, which all observers agreed was crucial, positively influenced the reputation of the organization in the eyes of the Chilean government and amongst the public.

4.2.2.3 National Government Response

The initial National response to the event was marked by confusion and a lack of clear situational awareness. Immediately following the earthquake, there was confusion about whether or not a tsunami would follow. It was reported that the outgoing president, based on misinformation from the Navy's Hydrographic and Oceanographic Institute, initially announced that there was not a threat of tsunami, and then minutes later warned that there was a threat. Few people in the tsunami-impacted areas heard either announcement since communications with Santiago were lost. The confusion over a tsunami warning (or lack thereof) was not a contributing factor in how coastal communities fared. According to officials from the City of Talca, the first wave hit before a tsunami warning could have been issued.

Several individuals interviewed reported that the outgoing president was also slow to involve the military in the response. Although the military is not normally involved in civilian emergencies in Chile, the president can declare a "catastrophic event" and utilize the military for disaster response. Responders expressed the opinion that the decision to declare a catastrophic event in this case took longer than would have been preferred. Many officials believed that looting became more widespread due to a delay in mobilizing the army to assist with local law enforcement and security. When the military began to arrive more than 48 hours after the event, the looting quickly subsided.

Reports and interviews, particularly discussions with United Nations officials, suggested that the government could have taken advantage of offers of assistance from other nations more quickly. This was a source of frustration for many international aid and coordination organizations. Many nations and international groups offered to send assistance or to play their traditional role of coordinating the international response; the repeated reply from the Government of Chile was that they were not needed at that time. When the government eventually asked for



Figure 10. American Red Cross team meeting with Cristobal Lira Ibañez, Executive Secretary of the Comité de Emergencia (President's Emergency Committee).

international assistance, several organizations reported that they were surprised by what was requested. The initial list was very limited and was not modified until the new government assumed power on March 11.

The perception of local officials was that the National response improved after the initial days of the event, and especially after the installation of the new government. The new president formed an emergency committee to oversee the response and recovery at the national level (see fig. 10). The committee brought together government officials with the goal of overseeing the response and recovery. In the committee's plan, the military played a key role in this response strategy.

The military role was divided into two stages. The goal of the first stage was to control looting and assist local police in the heavily impacted areas. The goal of the second stage (which began on March 31, 2010) was to assist with logistical support, debris removal, and construction of temporary housing. In order to meet these goals, the army was given administrative control of the National response.

The Army deployed and operated in cooperation with other ministries and organizations. They report to the Commander-in-Chief of the Army, who is located in Santiago. The Army also provided communications for the emergency response effort until public utilities could be restored. According to the fire chief of Constitución, the army arrived on day five and their presence had an immediate calming effect on the city. The army established order and took control of operations. This included taking control of the remaining shelters, erecting field hospitals, and providing food and water to survivors.

4.2.3 Shelter / Feeding / Hydration

Of particular note is that the use of congregate care shelters was very limited in this event. This is in spite of the fact that estimates of upward of 800,000 people were displaced by the earthquake and tsunami. Several communities opened shelters that were not used at all or were used on limited bases for only a few days. People either sheltered in or near what remained of their dwelling, went to stay with family members, friends, or found shelter in other areas within or outside of the impacted areas.

The government utilized several methods to assist those displaced by the earthquake. For individuals and families who required shelter, the government built what they call



Figure 11. *Mediasaguas* 'village' outside of Tumbes.

Mediasaguas (see fig. 11). These are 3x8 meter wooden structures (cabins). It should be noted that the *Mediasaguas* are traditionally used in Chile to house portions of their homeless population, making them initially less than acceptable for those displaced by the earthquake and tsunami.

In the areas where the army established order and took control of operations, it

included taking control of the remaining shelters and providing food and water to survivors.

The government provided food boxes to the population. The existing food box system normally used for the needy was augmented and used for disaster survivors. Delivery was made via all available routes, including helicopters. Some food boxes were delivered to bulk distribution sites; others were delivered directly to homes in remote locations by the military and other non-governmental organizations such as the Chilean Red Cross.

Caches of food boxes were warehoused by ONEMI at the national, regional, and local levels. Each municipality had a small store of food boxes at the city hall. These boxes were rotated prior to the earthquake through periodic distributions to the poor.

4.2.4 Recovery

The new president charged the Emergency Committee with three tasks:

1. Provide basic needs such as food, power, and sanitation within one month.
2. Ensure that everyone had a roof over his or her head before winter (June 1 was the target date)—planning for this began immediately.
3. Find definitive solutions to deal with housing, debris removal, demolition, and restoration of basic services.

It was reported that each of these tasks was progressing as designed. Most utilities were restored well before the one-month goal. In the City of Talca, some water service was restored within a week, although as of July 2010, up to 10 percent of the city still had no water service.

Since the earthquake and tsunami, the government has built approximately 65,000 *Mediasaguas* (as of July 2010). The wooden components of these structures were manufactured at several locations, transported to the impacted area, and then assembled by the army, volunteer agencies, or the survivors themselves. The majority of these structures were placed on land next to a damaged or destroyed home. Others were built in large camps, called *Aldeas* (villages). Most of the inhabitants of the *Aldeas* were those who lost everything due to the tsunami. Communal toilets and showers were installed as the camps were constructed. Electricity was provided to the inhabitants much later. The survivors living in the *Aldea* outside of Constitución reported that they received electricity in May. These buildings and camps are meant to be temporary.

Land for these *Aldeas* was secured from public and private sources. The *Aldea* near Constitución was constructed on land owned by an adjacent sawmill. The Chilean Navy provided land for the *Aldea* near Tumbes, a small town on the peninsula north of Talcahuano.

For longer term housing, other programs have been developed. Those who had repairable damage to their home were eligible for an \$800 grant to buy tools and supplies to repair their own homes. About 50,000 homes were repaired through this program. Others who need to rebuild completely are eligible for \$25,000-\$30,000 in the form of vouchers that can be utilized to rebuild a house following certain government requirements. The government plan is to organize recipients of the vouchers into the form of a co-op so that they can secure better terms from the local building contractors.

The National central government, through the Ministry of Housing, is in the process of developing plans to redesign communities in the tsunami-impacted areas. The government

has worked with architects, planners, and engineers to develop plans that will permanently remove housing from tsunami-threatened areas, and in their place will create parks and other non-residential uses for this land. Several prototypes have been developed and local communities are being asked to choose the preferred plan for their community.

The Government of Chile is attempting to improve emergency response capabilities following this disaster. ONEMI personnel reported that since the quake, their intra-agency structures and processes are being updated. They acknowledge that their plans and systems in place at the time of the quake were not sufficient to meet the challenges of this event. According to the Director of ONEMI, improvements will include new legislation, possible elevation of ONEMI to a higher level in the government, and strengthened international planning, (including participation in California's 2010 statewide ShakeOut earthquake exercise).

The Chilean Red Cross also told our team that they are utilizing lessons learned during the event to improve their capabilities. They are continuing to increase their role in disaster preparedness and response. They also feel that this event has led to an opportunity for a stronger relationship between Chilean Red Cross and ONEMI. The new government has included Chilean Red Cross in strategy discussions, and they now feel that ONEMI is listening to them. The new president has also proposed legislation giving ONEMI more responsibilities that, for the first time, include the role of Chilean Red Cross.

4.3 Analysis of Key Findings for Emergency Management

4.3.1 Overall Performance

The meetings and visits with government, Chilean Red Cross, fire department, and individuals allowed the Emergency Management Team to come away with a strong feeling that the efforts of individuals and the community was a major contributing factor in the successful emergency response. Individuals knew what to do in the tsunami-impacted areas. In all locations, people assisted others with rescue and first aid, as well as care and shelter.

The initial response of the central government was problematic. Delayed decisions, miscommunication, communication failures all contributed to a serious impact on the success of the initial response. The government declining initial offers of assistance from other nations delayed some response efforts and support. Despite initial difficulties, the government ramped up and overcame these issues within a few days; they were then able to supply basic services and temporary shelter to those affected by the event. The creation of the Emergency Committee by the new president appears to have enhanced the response as well as begun to address longer term recovery issues. The use of *Mediasaguas* and innovative housing repair and rebuilding programs also were successful.

The Chilean Red Cross response was a strength area. Although their disaster role has traditionally been limited in Chile, and they were not well integrated into the government disaster response plans and efforts, Chilean Red Cross volunteers were among the first to assist people in the impacted areas. Their response involved a wide range of activities, including: the provision of health services, food, water, clothing, tents, and sanitation support services.

Local fire departments and the police in the impacted cities and towns appear to have worked heroically and effectively, even with limited resources, personnel, and initially no outside support.

4.3.2 Perception of Readiness

Prior to the earthquake, officials at all levels and even survivors in the impact area held the belief that since Chile had survived the largest earthquake in recorded history in 1960, the country would be prepared for any subsequent earthquake that may strike. The breadth and scope of the February 27th earthquake and subsequent tsunami, as well as perceived weaknesses about the national and local response to the disaster, were an unpleasant surprise to many.

Because there is frequently an interval of several decades between these large events, much of the hard-earned emergency management experience gained by officials at all levels will be lost or forgotten unless the lessons learned are captured and translated into new laws, plans, and procedures.

While the “culture of preparedness” and public education programs clearly contributed to a lower than expected death toll, the loss of lives among visitors to the coast, particularly in Constitución, reveals that tsunami education and disaster preparedness, in general, must expand to all Chileans. The Chilean Red Cross, local ONEMI officials, and other organizations that teach response readiness must incorporate the lessons learned from this event to ensure that the culture of preparedness is maintained and enhanced.

4.3.3 Different Impacts of Earthquake and Tsunami

The response and recovery issues faced by survivors and government officials in the tsunami-affected areas varied from those in areas solely affected by the earthquake. The destroyed or damaged residences in the inland areas still had available land on site or nearby where the inhabitants could subsist. In most cases, some or all of their possessions could be recovered from the structures.

The tsunami not only destroyed or damaged structures, but also made the immediate area uninhabitable or inaccessible for the survivors who wished to return. Furthermore, the water carried away or ruined many of the possessions that the survivors had left behind (see fig. 12).

4.3.4 Differing Impacts in Urban and Rural Areas

The response and recovery issues faced by survivors and government officials in the affected urban areas varied from those in rural areas.



Figure 12. Earthquake and tsunami damage in the coastal city of Constitución.

The size and complexity of the problems facing the fire chief in the large, urban metropolis of Concepción were much different from the problems for the fire chief in the relatively rural province of Cauquenes.

4.3.5 Communication Systems

The communication systems that were in place before the earthquake were not built to a standard that would withstand an event of this magnitude. Many of the radio systems were built with a single point of control. Although plans were developed to work around the failures, by using amateur radio operators to relay information, systems will need to be developed for such events.

Cellular telephone systems were reported to have failed for two hours to days after the event. Many of the cell systems became overloaded. As Emergency Management utilizes cellular telephone for daily emergency management events, planning for such failures and having alternate systems available is a priority.

4.3.6 Emergency Planning

The emergency plans in Chile lacked the necessary detail, scope, redundancy, and flexibility required to effectively and efficiently respond to an event of this magnitude. The Chilean national disaster plan does not specify the roles and responsibilities of the federal agencies in the event of a disaster. The plan implies, but does not state, that the national agencies will act at the direction of the President once information as to the scale and the scope of the disaster is received from the affected regions.

The national plan outlines in detail the process by which the provinces and regions will report the affects of the disaster to the national government. The February 27 earthquake severed almost all communication between the capital and the affected areas, so an important component of the plan was crippled from the onset of the disaster.

4.3.7 Little Local/State/Federal Friction

The fact that the regional *Intendente* and the provincial Governors are appointed by the President of the Republic resulted in less local/state/federal friction than is customary in the United States. Once the national government mobilized their response, and the considerable resources of the military were brought to bear, the local communities began to receive outside assistance. In some communities, however, this assistance did not arrive until five days after the event.

There was some evidence of friction and potential duplication of response/recovery efforts between the Chilean Red Cross and local government. The friction was evident in the provision of disaster services by the Chilean Red Cross and local government in the areas of field hospital setup and staffing, small grants to disaster survivors and disaster supply provision. The problems were attributed to the lack of experience in working together and the lack of clear guidelines regarding Chilean Red Cross and local government functions in a disaster.

4.3.8 Community Response: Both Adaptive and Maladaptive

Consistent with the social science disaster response literature, the Emergency Management Team learned that the communities in Chile impacted by the earthquake and tsunami were an asset in the disaster and contributed to the overall response by providing much of the initial search and rescue; sharing food, water and other necessities with neighbors and the larger community; transporting the injured to hospitals before the arrival of organized response agencies; putting out fires at their origins; and providing moral support and encouragement to those who have experienced significant losses. Unfortunately, some members of the community took advantage of the absence of social control to take things from damaged stores, pharmacies, and liquor stores that were beyond the necessities that are reasonable considering the privations caused by the disaster. Looters set some fires, such as the one that destroyed the supermarket pictured in figure 13.



Figure 13. A supermarket in Concepción, which was destroyed in a fire set by looters.

Much of what has historically been described as looting by formal agencies of disaster response and the media are instances in which survivors of the disaster enter damaged grocery stores and pharmacies and take food, water, diapers, and other necessities—items that would be purchased if the stores were open for business. In some cases, business owners, themselves survivors of the natural disaster, are viewed with suspicion when they reenter their damaged facilities to assess damage to the structure and their inventories. In other instances, those who are not members of

organized search and rescue teams but are spontaneous volunteers attempting to assist those trapped in the debris of collapsed buildings may be mistaken for looters. Looting has become associated with disasters as a basic assumption or stereotypical image mainly by agencies of social control and the media. The media, when reporting on a disaster, sometimes express surprise when looting does not happen, further perpetuating the assumption that it typically does occur.

There may be instances when looting does occur, often in situations in which a segment of the population (for example, an ethnic group or a social class) harbors grievances based on actual or perceived injustices. This collective sense of injustice may be expressed in looting behavior in situations that validate group perceptions such as the exoneration of white police officers in the Rodney King beating trial that set off rioting that included looting in Los Angeles in 1993. Though looting is rare in the aftermath of natural disasters, looting may

occur as an expression of historical or long-standing grievances by groups that have experienced discrimination, abuse, or economic hardship.

4.3.9 Widespread Use of Propane for Cooking

The widespread use of propane for cooking, in both rural and urban areas of Chile, alleviated many of the mass feeding issues that might be faced in California. The government's mass care feeding plan, with an emphasis on the preparation and distribution of food boxes to individuals and families who cooked their own meals, was very successful. Relatives and friends who brought food into the impact area augmented this plan. Private catering companies also assisted in the effort on their own initiative.

As Chile transitions and modernizes, this feeding model may not function in a future event. Newer apartment buildings, for example, have the propane centralized in large tanks, with the fuel distributed through pipes to the individual units. As this "modernization" of the fuel supply spreads through the urban areas of the country, food boxes may not be the sole solution for mass feeding.

4.3.10 This Event Was Not Chile's Worst-Case Scenario

An earthquake focused on the metropolitan Santiago area is Chile's worst-case scenario and the one to which their new emergency plans should be addressed. A common refrain stated by Hurricane Katrina survivors in southern Mississippi was, "The water never got this high during Camille." For the inhabitants of the region Hurricane Camille, a Category 5 storm that struck the region in 1969, became the benchmark "worst-case scenario" against which they prepared their emergency management plans. The government of Chile and the Chilean people must not use the February 2010 earthquake as the standard for their preparations for the next event. In any future event that strikes the Santiago metropolitan area, the issues facing the local officials will be like those encountered in Concepción, only amplified by the greater population in the capital.

4.3.11 Temporary and Long-Term Housing

The new national government moved quickly to implement a temporary housing solution and has developed creative strategies to address the long-term housing problem. Displaced persons are being given two options: stay on their property, or move to an *Aldea*, or temporary housing village. For both options, displaced persons were relocated to *Mediasaguas*, or temporary housing structures. We visited two such *Aldeas*, with each housing between 250 and 500 people. These structures are meant to be temporary. Other options for long-term housing have been developed. Grants for tools and supplies have been distributed to those working on repairing their homes.

4.4 Recommendations for California

The lessons learned from the Chilean earthquake are not unique; each has been a lesson learned from most if not all preceding major disasters. These included: communications failures, inadequate plans, inadequate pre-disaster coordination and slow or poor initial leadership by government officials. Each of these issues clearly has implications for California. Although none of these areas are new, each should be freshly analyzed and compared with existing plans, communication systems, and coordination in California. Each

applicable lesson should be addressed in current catastrophic planning efforts underway in California, as well as future plans and exercises.

1. The initial response and resilience of individuals and communities is something we can learn from. Expanding and enhancing efforts in California to make individuals, communities, towns, and cities better able to survive the first few days of a catastrophic event is critical. The American Red Cross (ARC) and other NGOs are vital to this capability in California. The already strong ARC partnership with state and local governments should be maintained and enhanced when possible. Since it may take several days for outside assistance to arrive following a catastrophic event, this point cannot be overemphasized.
2. Communication system failures limited the ability of a central government to assist impacted communities and NGOs to coordinate their mass care resources. This limited the ability of the government to communicate tsunami warnings and other information. It also delayed the response, since the government did not know (in some case for several days) the impact and needs of local governments. California needs to develop, maintain, enhance, and regularly test primary and back-up communications systems.
3. It appears that Chile believed it was prepared for a large earthquake. They had lived through a *M*9.5 quake in 1960 and felt they were ready for another large quake. Their plans were not adequate for the effects of this earthquake. They also lacked backup plans when primary plans failed. The implication of this for California reinforces what we already know. Plans need to be scalable and flexible to meet all hazards and all sizes of events. Backup and redundancy need to be incorporated into overall plans, and Continuity of Operations/Continuity of Government (COOP/COG) plans need to be regularly exercised.
4. Unique methods were required to meet the care and shelter needs of the displaced population. Although plans for congregate care shelters did exist, very few were used. People instead stayed in their damaged dwellings (sometimes due to fear of being looted), stayed with family, or traveled to other parts of the country. Delivery of food, water, and the maintenance of sanitation had to revolve around the large number of people sheltering in place. This needs to be further analyzed, as it may need to be reflected in plans in California. American Red Cross and local communities are prepared to support people in congregate care shelters. More recent catastrophic planning has begun to address the provision of support to people sheltering in place in damaged homes. These efforts may need to be enhanced.
5. The looting that occurred in Chile was a surprise to response officials as well as social scientists but both public and private sector organizations, including NGOs, must consider security for damaged businesses as a priority in California's multihazard planning. Clearly, the class and ethnic divisions that become acute in specific cases of actual or perceived injustice may also emerge in natural

disasters, particularly in California's urban areas, which have historically experienced unrest. While it is unlikely that looting will be overlooked in disaster planning, Chile's experience merits a reaffirmation of the need to rapidly respond in securing damaged businesses and critical infrastructure.

5.0 Health Services

5.1 Introduction

The primary goal of the Health and Medical Services Team was to understand the medical disaster response strategies and operations of Chilean agencies for the earthquake on February 27, 2010, including:

- Perceived or actual failures in disaster preparation that impacted the medical disaster response;
- Post-disaster health and medical interventions to save lives and limit suffering; and
- Lessons learned by public health and medical personnel as a result of their experiences.

Despite devastating damage to the health care and civic infrastructure, the health care response to the Chilean earthquake appeared successful due to several factors:

1. The ability and resourcefulness of the medical community to respond without centralized control in the early response phase
2. The dedication of the health care community to maintain patient care under austere conditions
3. The capacity to rapidly re-establish utilities and transportation infrastructure that supported health care in most areas
4. The rapid mobilization of national and international resources
5. The expectation of the Health and Medical Services Team, and the Red Cross delegation as a whole, was that many of these lessons would be transferable to California's disaster planning and response.

5.2 Methodology

The Health and Medical Services Team conducted interviews in Chile with members of the Ministry of Health, Pan American Health Organization, Chilean Red Cross, and hospital directors in Santiago and the regions that suffered the most damage from the earthquake. Interviews were scheduled with individuals identified as responsible for disaster response planning and/or operations within the Ministry or health care institutions. In-person interviews lasted between 60 and 90 minutes. Personnel from national, regional, and local levels of the health care system were represented, as well as the national response agency and national and regional Red Cross.

The investigators conducted semi-structured interviews. Although the team did not employ a validated outline or tool, the interviews explored common themes, including:

- The respondent's professional responsibilities for disaster planning and response and tenure in their current position (this had particular relevance due to the change in government 10 days after the earthquake)
- Pertinent emergency response planning related to written plans, implementation of drills, and provision of training conducted by the institutions or outside sources
- The respondent's actual experiences during the disaster and how these compared to prior planning for communications, management of resources, patient care and evacuation, injury epidemiology, and factors related to resiliency of the health care system and recovery activities.

The Health and Medical Services Team also asked respondents to describe the strategies to prepare for a future disaster event. Lastly, respondents were invited to review their system disaster response, identifying specific strengths and concerns related to future disaster preparation.

Interview notes were transcribed into Word files to be later used for content analysis. Investigators verified impressions for accuracy. Themes and data were then organized into a final report.

5.3 Chilean Medical Organizational Structure

The Ministry of Health of Chile (Ministerio de Salud de Chile, also known as MINSAL) is a cabinet-level administrative office in charge of planning, directing, coordinating, executing, controlling, and informing the public health policies formulated by the President of Chile. The ministry is divided into two sub-components: (1) public health and (2) health care. An Undersecretary directs each component. The Ministry of Health oversees the health care delivery system of clinics and hospitals, as well as the public (FONASA) and private (ISAPRE) insurance systems. One other division is responsible for purchasing pharmaceuticals and equipment. The country is divided into nine administrative regions; each has a Director who reports to the national Ministry of Health. The regions are further subdivided to form a total of 28 districts. The Health Ministry supports and manages 180 public hospitals and 3,000 primary care health clinics across the country. The majority of health care (for approximately 80% of the Chilean population) is provided through this public system.

MINSAL coordinates funding, supplies, administration, transportation, and bed control. The Ministry also coordinates special programs such as nursing or convalescent homes, dialysis programs and a home ventilator program. In 2009, in response to the H1N1 pandemic, the Ministry started a computerized bed control program in order to coordinate bed utilization between the largest public hospital facilities and private hospitals. The system posts available critical care beds in both sectors, prioritizing the least expensive beds.

There are also private hospitals/clinics in Chile that are regulated by the Ministry of Health. These are concentrated in the larger population centers of Santiago, Valparaiso, and Concepción and provide healthcare to a more affluent segment of the society. The private sector has no internal organization and does not coordinate emergency preparedness planning with the public sector. After the earthquake, MINSAL used beds in the private sector facilities to accommodate patient transfers from impacted public hospitals. There was

precedence for this, since MINSAL routinely leases beds from the private sector for use by public sector patients for surge capacity during the winter respiratory illness season.

MINSAL includes a Chief of Preparedness and Response and a Director for Hospital Recovery—a new position since the earthquake. Each regional director is responsible for coordinating preparedness and response within their jurisdiction.

5.4 Disaster Response Overview

Disaster response in Chile is managed through a centralized federal agency (ONEMI), which could be considered the equivalent of FEMA at the national level and the California Emergency Management Agency (CalEMA) at the California state level, that coordinates response across various agencies and among federal, regional, and local jurisdictional levels in Chile. The Ministry of Health (MINSAL) is responsible for health and medical response, which is an Essential Support Function (ESF 8) in the United States National Response Plan (REF). International assistance is supported and coordinated by the Pan-American Health Organization (PAHO), the regional agency of the World Health Organization.

5.4.1 Disaster Plans

The team was consistently told that emergency response plans were inadequate and failed at all jurisdictional levels for the response to the February 27th earthquake in Chile. Even federal officials and those inside the agency readily admit that ONEMI response to this incident was inadequate. Within the health sector, regional and local representatives stated their plans were inadequate and never “taken off the shelf,” since the plans did not deal with a disaster of this magnitude. Planned response was further disrupted because many emergency response facilities were destroyed and unusable; for example, in Talca, the main fire station, Red Cross headquarters and police station were all on the coast and rendered inoperable by the tsunami. The regional emergency operation center for the Health Ministry in Concepción was severely damaged, and all their communication equipment was destroyed or inaccessible, including satellite phones, computers, and radios.

5.4.2 Command and Control

Initially, there were no communications throughout Chile. During the first 24 hours there was very little situational awareness and the local responders and hospitals were, for the most part, on their own. Therefore, command and control was initially based at the local level but expanded to include federal and regional levels of support and coordination as situational awareness and communications improved. To develop situational awareness, the central Ministry of Health sent representatives to the regions on the first day after the quake. Situational awareness gradually increased over the second and third days, but coordinated situation status in one region was not fully achieved for nearly 10 days.

The individual medical center/hospital directors had a large degree of autonomy in managing the medical response in their institutions and communities. Once communications were re-established, situation status reports and resource requests went from the local level to both the regional level and directly to the federal Ministry in Santiago. Over time, federal and regional offices of the Ministry of Health coordinated federal resources and resolved specific issues raised at the local level, such as support for dialysis units, patient transfers, and allocation of resources such as field hospitals and volunteers.

5.4.3 New Government

Especially challenging was the change of administration in Chile 10 days after the earthquake, resulting in new personnel at the federal and regional levels. This provided an opportunity for the new government to modify the response structure. For example, an Emergency Committee was formed and assigned to provide direct executive command and control over the response.

Given all these challenges, the response at all levels was surprisingly rapid, resourceful, and successful.

5.4.4. Pertinent Timeline for Response Coordination

Day 1: characterized by a chaotic local response with no communications and many response capabilities, offices, and equipment destroyed.

Days 2-3: characterized by local response only with no outside supplies.

- Initial organization of services on site with likely shortages of equipment or supplies.
- Communications improved but minimal overall situation status.

Days 4-5: characterized by improving communications, situation status, and organization;

- Outside resources begin to arrive

Day 6 and beyond: significant outside resources and help arrive to support local responders.

- Begin to establish field hospitals.

5.4.5 Pertinent Statistics

- Approximately 80% of Chile's population of 16 million persons was located in the earthquake impact area.
- There were 131 hospitals in the southern five Chilean regions most directly affected by the quake. This is approximately 70% of the hospitals in Chile. Portions of 59 hospitals received irreparable damage, an additional 16 hospitals were judged unusable. By some estimates, more than 4,000 hospital beds were lost (of which 70% were occupied at the time of the earthquake), requiring relocation of thousands of hospitalized patients.
- 17 field or temporary hospitals were erected between one and three weeks after the earthquake.
- Private hospitals were not significantly impacted because they are centered primarily in Santiago and Valparaíso, with some in Concepción.
- There are approximately 3,000 primary care centers in Chile providing outpatient services, and most were intact post-disaster.
- To date, there are 521 confirmed deaths and 56 persons missing; half of the deaths were due to the tsunami and most others due to collapse of adobe/brick style houses.
- No statistics are available regarding increased mortality due to evacuation of hospitals, loss of power, or other impacts on the health care system.

5.5 Immediate and Early Response

5.5.1 Instinctive Response

In the absence of organized, functional response plans, the actual response to the Chilean earthquake by many individuals was based on “instinct.” The team was repeatedly told that Chile has a “seismic culture” in which everyone knows what to do in an earthquake. The common lore is that after an earthquake strong enough to throw one down, one should run out of the building when the shaking stops (and go to high ground if near the coast).

Initial search and rescue efforts were also instinctual and done by first responders (Fire) and by members of the community (see fig. 14). In one community hard hit by earthquake and tsunami, all victims found alive were rescued during the first 24 hours, before any outside assistance was available.

The most notable example of the instinctive response in the health sector was the rapid evacuation of hospitals. Two medical directors from different hospitals went to their hospitals immediately following the quake, arriving in less than 30 minutes to find the facilities fully evacuated. This was accomplished because the staff and patients did not wait for orders from any centralized command structure or the person in charge, but immediately helped patients out of the building. Patients helped other patients out. Due to the debris in corridors, it was impossible in most cases to wheel



Figure 14. Search and rescue efforts atop the collapsed Alto Rio apartment building in Concepción. (Photo courtesy of Jorge Arturo Borbar Cisternas.)

patients in beds or wheelchairs, so they were carried or walked out. One hospital the team visited had a full census of 140 patients at the time of evacuation, but none in critical care. The other evacuated hospital in Santiago had 275 patients on seven floors, including critical care areas. After two days in a nearby parking structure, some patients were placed in non-damaged parts of the hospital and about 200 patients were transferred to other hospitals or discharged home.

5.5.2 Hospital Evacuation and Engineering Evaluation

Many, if not most hospitals in the two most highly impacted regions (Bio-Bio and Maule) were initially evacuated due to structural and non-structural damage. After structural evaluation, one-third of all public hospital beds were lost in these two regions. In Santiago, only one hospital was seriously damaged and evacuated. Evacuation of patients from the impacted areas was used to decrease health care demand in those regions.

Initially, damaged hospitals evacuated all patients immediately following the earthquake. Decisions to evacuate were made by doctors and other staff on duty in the middle of night. They could not assess the true extent of damage, but fallen ceiling tiles and wall panels, broken windows, and cracks in walls were widespread in many facilities. Subsequently, many patients were relocated to undamaged or minimally damaged parts of the hospital.

Engineers responded locally, and others were dispatched by the Ministry of Health days after the earthquake from Santiago. Decisions to move patients back to relatively undamaged areas of the hospital were likely made prior to official seismic engineering evaluation. On the other hand, one official observed that many hospitals were deemed destroyed, when in fact they were determined to be repairable after more definitive engineer evaluation; initial assessments may have, in some instances, been completed with the intent of replacing old or outdated facilities and equipment.

5.5.3 Utilities

Power was restored in some areas within hours and in most areas within seven days. Generally, hospitals were not evacuated solely for lack of utilities. The team was told of only one hospital that evacuated due to lack of utilities, but patients were repatriated within about 24 hours. Hospitals used power generators that were on site or provided by the Pan American Health Organization or by local emergency services. Ministry of Health coordinated with responders and power companies to ensure that hospitals received priority for electrical power.

There was widespread primary disruption to the water delivery system in the impacted regions. It was reported that several hospitals had wells that continued an uninterrupted supply of water to specific facilities. Other hospitals received water transported by truck and placed in large emergency water tanks or bladders for storage. No one was aware of written plans for rationing a limited supply of water, but priorities were given to patient care and staff hygiene, supplemented by alcohol hand sanitizer. PAHO, Ministry of Health, and Red Cross all provided consultation for water treatment and evaluation of water supplies.

5.5.4 Patient Evacuation

The Ministry of Health estimates about 2,000-3,000 patients were transferred between hospitals; however there are no figures available yet for the number and type of patients evacuated or their geographic distribution. Very few patients were evacuated by air (rotary wing). Most planned evacuations were done by ambulance, within 3-7 days after the earthquake, and consisted of previously hospitalized patients. Fortunately, most major traffic routes in the country remained passable.

Locals related that many patients were transported in any available vehicle, including military transport, trucks, and private vehicles, which is consistent with the limited numbers of ambulances in the regions and the prolonged transport times; in optimal conditions, it is six hours from Concepción to Santiago. Some patients were taken to nearby hospitals, only to find them incapacitated, and had to go hours further to unaffected hospitals in other regions. Normally, inter-hospital transfers are coordinated through a web-based bed tracking system run at the central Ministry in Santiago. As Internet services were re-established within days after the earthquake, this system was used to coordinate; however, the team was unable to

determine if evacuations were coordinated early on and how destinations were determined, considering the variable road and hospital conditions.

5.5.5 Surge Capacity

Surge capacity is the ability to provide care to accommodate a sudden increase in the number of patients. Surge capacity involves hospital beds, but also includes staff, supplies, and the decision-making process. Consistent with the general sense of failure of planning for such a catastrophic event, no one interviewed described following specific pre-event plans for how to manage the increased patient load; however, many components of normal procedures and emergency planning were used.

The Ministry of Health claims that there was little health care surge, either inpatient or outpatient, following this disaster. Local facilities, however, reported an outpatient surge; one unofficial estimate from the Red Cross was approximately 60,000 (mostly ambulatory) injuries that resulted from the earthquake.

5.5.5.1 Beds

Procedures utilizing a web-based database existed for coordinating bed control and patient transfer (see section 5.5.2, Hospital Evacuation and Engineering Evaluation, above) but were not initially available due to disruption of power and communications. Decisions to use intact or lightly damaged portions of hospitals and the strong inclination to maintain and treat patients within the community greatly helped maintain existing capacity, despite large losses in bed availability. Evacuation out of the impacted regions was used to relieve pressure on the health care system, but data regarding numbers of patients transferred are not available. The private care system provided surge capacity in unaffected regions through leasing beds to the public sector. By days 5-7, some field hospitals were established, eventually numbering 17. About half of the field hospitals were supplied from international donors, while others came from the Chilean military and Red Cross. Many are still in use and being replaced by temporary hospitals, consisting of modular trailer-like or container units expected to be in use for several years while the hospitals are rebuilt.

5.5.5.2 Staff

Since the earthquake struck at 3:34 a.m. Saturday morning, staffing in most facilities was at a minimum. Many staff reported to their work sites soon after the earthquake and others reported at the morning change of shift, after being assured of the safety of their family. With many houses destroyed or heavily damaged (nearly one-third of those in the Maule region), some staff were unable to report for duty. Tragically, the looting that occurred in the Concepción area in the first few days before security was established by the military resulted in more staff staying home to protect their household and family. Experience of PAHO in Latin America, and in this earthquake, are that most health care workers stay on the job or report for work. Because most medical personnel are employed by the public health care system, they are able to move and practice freely between hospitals during an emergency; in many cases, staff was directed to other facilities where the need was greater.

5.5.5.3 Volunteers

The volunteer response was early and strong. Volunteers from the community showed up at the hospitals, but many had no health care skills, so were of limited use. Other medical volunteers were sent from Santiago and other parts of the country. The Ministry of Health set up a volunteer system for this disaster with web registration. The Chilean Red Cross plays a major role in supplying volunteers for health care facilities and providing direct health care. Their response took several days to become coordinated, but subsequently mobilized significant numbers of volunteers.

International response to the earthquake was strong, but assistance was initially declined by Chile until the scope of the disaster and needs were fully appreciated. Spanish volunteers, including medical specialists and psychologists arrived within 72 hours. After seeing images on television, an Argentinean group traveled overland to provide care at a local community hospital. Another hospital received a Japanese surgical team on day four. Other medical teams arrived from Russia, Cuba, Spain, and Italy. International response was coordinated through the federal government and PAHO/WHO. Except for mental health, the need for volunteer medical personnel was of limited duration.

5.5.5.4 Military

The Chilean military played a key role in supporting many aspects of the response, including health care and patient movement, but were not immediately mobilized. The military supplied, erected, and maintained some of the 17 temporary field hospitals in the impacted locations. There was initial reluctance to deploy the military, but their support and performance generated uniform praise.

5.5.5.5 Supplies

Initially, hospitals had to depend on existing supplies. One health care provider described the fear during repeated trips into the severely damaged building during the first few days to gather supplies. However, a lack of supplies was not described as one of the major problems following the earthquake, perhaps due to local and regional stores of supplies provided regularly by the national Ministry of Health. Food was one commodity initially in short supply for the community and for hospitals, and was exacerbated by the initial looting of stores in Concepción. Resource requests after the earthquake were made to the regional and central Ministry. Medical and food supplies from Santiago began arriving on days 3-4 into most of the impacted areas in the southern region. Additional supplies such as vaccines for Hepatitis A and H1N1 were sent from Santiago. In some areas, donated supplies became a problem, especially medications that did not meet Chilean requirements like labeling in Spanish. Private companies are not integrated into the national response plan but donated goods and supplies spontaneously.

5.5.5.6 Crisis Care

Crisis care refers to care under austere conditions with resource shortages that requires a change from the usual standards of care and necessitates allocation of resources based on providing the most care to the most people. This is not a term or concept that the team encountered in Chile. No one spoke of legal concerns or ethical dilemmas of care that are persistent and pervasive concerns in the United States. Much of the health care resiliency in

this catastrophic situation can be attributed to the initiative of local facilities and emergency responders and to the flexibility of medical staff to provide care under disaster conditions.

Another likely factor for the Chilean resiliency was acceptance of the austere conditions as the only alternative after this disaster. Hospitals, especially older facilities in small towns, suffered considerable damage, resulting in patient care being provided in the parking lots or under very crowded conditions in the limited safe areas and ongoing treatment in tent-style field hospitals in their community. Health officials are confident that everyone received needed care, although occasionally at facilities some distance from their communities, and no one was denied care.

The surge of ambulatory patients following the earthquake was handled wherever usable space was available, often outdoors. The primary care system, which is part of the public health system, was largely intact following the earthquake and helped to provide ambulatory care at local outpatient clinics. Local health officials and responders describe a large surge of injured patients, but agree that most could be handled locally and that the majority of the cases were considered minor trauma.

According to PAHO, after the first few days of the emergency, the number of individuals seeking outpatient care actually decreased and was less than normal for the time of year. This was attributed to the population focusing on other priorities, such as cleaning up earthquake debris and confirming the well-being of family members in affected areas, as well as the desire on the part of some to stay close to their damaged homes for fear of losing property to looting.

5.5.6 Hospital and Health Care Continuity and Response

Hospital care was most impacted due to both structural and nonstructural damage that made the facilities, or portions of facilities, unusable (see fig. 15). The Ministry of Health indicated that the emergency medical system and primary care system remained intact throughout the disaster. Only twelve primary care centers, also run by the Ministry of Health, were significantly damaged. During the first week, the emphasis of the central Ministry of Health was on in-patient care, but by the second week the need was more for outpatient care. Field hospitals saw primarily new patients, since many patients who were in the hospital when the earthquake occurred had been transferred or discharged by the time field hospitals were established. The local facilities saw a major surge of ambulatory injuries in the first few days following the disaster.

5.5.6.1 Medical Record Keeping

In some hospitals, medical records fell from open shelves to the floor, in disarray. Few hospitals in the impacted regions had electronic medical records



Figure 15. Damage at Felix Bulnes Hospital, outside of Santaigo. As of July 2010, the hospital was still partially closed due to unrepaired damages.

(EMR), although that is being gradually implemented. However, EMR also would have been problematic due to the initial lack of power and Internet access. In the early period after the earthquake, care was performed under austere conditions, and thorough documentation of medical records was not a priority. It is not yet known what clinical information was captured or whether medical records for those first hours are available.

5.5.6.2 Special Medical Needs

Chile has fewer nursing homes per capita than the United States. Presumably, the elderly and those with chronic health conditions remain in the family home. There are no data available from central sources of the impact to nursing homes or evacuation or transfer of nursing home patients due to earthquake damage. None of the interviewees noted this as an issue, even when specifically asked. The team was also unable to observe or obtain specific information regarding people with functional and access needs, such as those who are wheelchair bound or have other mobility issues.

The home ventilator program supports approximately 1,000 patients across Chile. Public health nurses, who are normally responsible to monitor the care and status of ventilator patients, were dispatched to each residence to ensure their safety or have them moved to hospitals with generator power when necessary. MINSAL was not aware of any mortality among the home ventilator patients, even with the reported widespread power outages.

The southern region around Concepción has less than 1,000 outpatient dialysis patients. Local health centers reviewed their status, and special efforts were made to supply power and water to the clinics. Some patients were transported to Santiago if their local centers could not accommodate them. It is not known whether there was any morbidity or mortality among the dialysis-dependent population or how many patients required transfer to Santiago.

5.5.6.3 Behavioral Health

One of the major health care surge needs was for mental health support and counseling. Medical staff, first responders, and volunteers were affected, as well as the general population. Initial demand was driven by anxiety and grief induced by the disaster, but the need is expected to persist for a long period of time. This need was and continues to be met through a combination of volunteers, especially from NGOs and coordinated by MINSAL and PAHO.

- The psychiatric hospital in Valparaíso was severely damaged by earthquake and most of the patients were released to the community for outpatient care, since there are few mental health inpatient facilities in Chile.
- The Ministry of Health helped identify patients receiving mental health services on an outpatient basis and contacted the individuals to make sure they had their necessary medications.
- In Talcahuano, due to the severity of earthquake and tsunami damage and the large number of fatalities, mental health issues were identified early as an issue. Group therapy sessions were started in shelter camps to counsel and support victims.
- The national Comité de Emergencia is supporting a program currently focused on 4,500 families residing in temporary houses in the “villages.” All the residents

lost their homes, but some also lost jobs and family members. The Comité has coordinated with representatives from NGOs to live within the communities and communicate to the residents information regarding how the government can help them, that is, finding jobs/education. The goal is to focus on resiliency and recovery so that the “community” won’t become a permanent client.

5.5.7 Communication and Media

After the earthquake, all communications in the affected southern regions were interrupted. Communication between the south and the central government in Santiago was also impacted, as was local communication briefly within Santiago itself. The only intact communication was via hand-held emergency radio at the local level. Communications were restored over days, but the timeframe was highly variable, depending on modality and location. In Concepción, text messaging became available within the first day, followed by cell phone communication and Internet. By the end of the first day, half of the hospitals in the Bio Bio region had been contacted through text messaging. Although the central Ministry of Health had radio communication capability, it functioned inconsistently. The Ministry offices were able to contact Concepción and Talcahuano two days after the event. As soon as possible, the Health Ministry in Santiago began videoconferences with affected zones. One particularly devastated community on the coast had only local radio communication for 4 days.

The media played a mixed role. Only a single radio station remained on the air in Concepción immediately following the earthquake, but it was very helpful since no one had situational awareness or means of receiving information. Several people commented that some of the media, especially television, exacerbated the chaotic situation by reporting only on the worst of the disaster, rather than helpful emergency messaging and risk communications.

5.5.8 Morbidity & Mortality

The official death toll at the time of the visit was 521. Approximately half died as a result of the tsunami and half from the earthquake. Earthquake deaths were nearly all from burial under collapsed adobe structures. Health care statistics and epidemiology of injuries are not yet available. Health officials consistently made several unanticipated assertions:

- There were very few serious traumatic injuries resulting from the earthquake inside or outside of damaged hospitals.
- Of the patients who were transferred to remote facilities, most had been hospitalized at the time of the earthquake.
- Surgeries immediately following the earthquake were due to the usual surgical problems, rather than from earthquake-related injuries.
- There were no major fires, so there was a lack of burn patients, contrary to anticipated results of an earthquake in California (see Section 3.4).
- No one died due to mass evacuations from hospitals, numerous patient transports over long distances, or loss of power and utilities within the communities. Even with careful questioning, there was no reported loss of life for patients with special medical needs, such as dialysis and ventilator patients.

- Post-disaster, there were few cases (and no major outbreaks) of intestinal or respiratory diseases.

The team did hear a few reports of earthquake related mortality including a head-injured patient from the earthquake who died during transport out of the area and four people who arrived at a damaged hospital with myocardial infarctions and all died. One person related that two or three patients died due to collapse of hospital ceilings or walls, but the Ministry of Health did not validate this.

It is remarkable that the Chilean health care system was able to maintain operations and care for existing and new patients, with little apparent morbidity from the disruption to hospital care and long transports.

5.6 Health Services Key Findings and Recommendations

The following represent conclusions drawn from the information presented from meetings and interviews that have implications for health services preparedness and response in California. Limitations of drawing conclusions are that these data are from unstructured interviews and represent a perspective influenced by the individual's job, jurisdictional level, and experience following the disaster. One challenge in extrapolating these Chilean experiences to planning and response for a large California earthquake is the inability to determine the relative roles and impact of infrastructure, organizational development, and cultural differences on our conclusions.

1. **Evacuation.** Hospitals should plan for evacuation and develop a process and criteria for evacuating. No recommendation can be made on the advisability of encouraging spontaneous evacuation, as occurred in Chile. That question requires input from seismic and structural experts. It is unlikely that rapid spontaneous evacuation would be initiated in California; more likely, staff would wait for an order to evacuate and patients would wait to be assisted. After a significant California earthquake, it must be assumed that even hospitals that are structurally sound will have significant non-structural damage such as supplies and some equipment on the floor, fallen ceiling tiles, and other superficial damage, but this should not be the sole reason to evacuate. In a catastrophic event with widespread damage, health care facilities may initially evacuate, but should abandon the facility only when absolutely unable to provide care or when engineers deem the structure unsafe to occupy.
2. **Crisis Care.** After the Chilean earthquake, care was provided under austere conditions in many health care facilities and within the community. Hospitals in Chile initially operated in parking lots, and then made early decisions to use safe, functional areas of hospitals and clinics, which allowed them to continue improvised care despite difficult conditions. This could be the situation after a catastrophic earthquake in any country. Even hospitals that are structurally sound will be operating under austere conditions due to damage to equipment, lack of power and water, and no communications or Internet. Care will be provided outdoors or in improvised locations due to evacuations and influx of new cases without the capacity to accommodate them in emergency department or usual care locations. Certain resources and materials will rapidly be depleted or unavailable. Few physicians in the U.S. have experience under austere conditions; some will quickly adapt while others will require strong leadership to be effective. Although not needed in Chile, guidelines and plans to support these crisis conditions of care should

be available in California, as recommended by the Institute of Medicine (IOM), the Agency for Healthcare Research and Quality (AHRQ) and several professional organizations. In Chile, cultural factors and the flexibility of health care professionals and of the population likely contributed significantly to the resiliency of the health care system.

3. **Field Hospitals.** Field hospitals were used to add health care bed capacity to the damaged Chilean hospital system. Their experience demonstrates the advantage of placing these field hospitals on the site of existing health care facilities to extend capacity at sites where the public normally seeks health care and allowing patients to remain in their community. This arrangement also augments structurally safe facilities or usable portions of facilities and allows access to undamaged equipment and supplies. Chile is replacing tent hospitals with temporary modular hospitals that can be used until permanent facilities are rebuilt.
4. **Utilities.** Hospitals must be prepared to be completely self-sufficient, including sources for power and water, for up three days minimum, five days preferably, and one week optimally. Joint Commission standards currently recommend hospital self-sufficiency for 72 hours, and this is also consistent with current and new guidelines from AHRQ. Hospitals should have more than one generator and have technical specifications ready to order replacements. Public emergency services should plan for the capacity to provide required power, water, and food after that time. Emergency deployment of hospital generators in Chile was a problem, because authorities had not anticipated the special hook-ups and secured pads for mounting that were required but not available at various facilities. This resulted in some generators not being utilized and a delay in the use of others.
5. **Epidemiology.** Assumptions regarding morbidity following a catastrophic earthquake in California are very different from the Chilean experience and suggest the need for further assessment. Lack of fires and resulting serious burn injuries may be attributed to infrastructure differences, but it is more difficult to explain the few numbers of seriously injured in Chile. Conclusions are premature until epidemiologic analysis of injuries and illness is available.
6. **Health Care Worker Staffing.** The reports of staff shortages were not quantified, but appeared far less than some planning scenario estimates in the United States. Earthquakes do not create the same fear factor for personal safety in health care settings as does an infectious disease event; however, key issues are the ability of staff to travel to work and the need to ensure safety of their families. Chileans have strong local family and community support which allowed healthcare personnel to be comfortable in leaving their homes and reporting to work.
There will be many committed health care workers in the United States, but they will need major support from outside responders. Emergency plans should include a process to accommodate mutual aid consisting of medical teams and facilities from outside the impacted area. Medical personnel need the ability to move and practice freely between hospitals within the disaster region or the state during an emergency. This emphasizes the importance of California Disaster Healthcare Volunteer systems and other volunteer agencies, but this ability also needs to be extended through interstate emergency assistance such as that coordinated by the Emergency Management Assistance Compact (EMAC) and the Medical Reserve Corps (MRC).

7. **Health Care Surge.** Field hospitals are rationally situated at existing hospital sites to provide medical treatment at locations where the public is accustomed to seeking care. Since field hospitals and experienced disaster health care workers are available in limited quantities, serious consideration should be given to accepting international aid after a catastrophic earthquake in California. Coordination of this aid is the responsibility of the United States Department of Health and Human Services, but is likely to be mired in political and bureaucratic barriers.
Bed control and patient tracking systems are critical, especially when widespread evacuations and patient transfers are necessary. Chile has such a system that was utilized as soon as Internet access and local administrative organization was re-established. California is still developing a statewide bed control systems and does not currently have uniform patient tracking.
8. **Volunteers.** While volunteers are critical, their skills need to be matched with needs, whether basic volunteers or skilled medical teams. It is important and necessary to pre-validate and determine the skills of international teams, as well as domestic and in-state teams.
9. **Security.** Looting caused increased security concerns for personal property, impacting availability of health care staff; this emphasizes the need for immediate security measures in the community and at health care facilities.
10. **Behavioral Health.** Behavioral health needs occur early and are persistent through recovery. Disaster mental health planning and surge capacity is critical.
11. **Communication.** Although most communications were re-established rapidly in Chile, initially it was very frustrating and difficult to have no communications. Health and other critical agencies and institutions need redundant communication systems to communicate situation status and resource requests within and between jurisdictional levels. Initial situation status may be impossible to determine without functional communications, which in turn makes resource allocation decisions very difficult. Emergency hand-held radios proved particularly useful for local primary responders, allowing them to coordinate initial activities.
12. **Media.** The sensationalism of media can be detrimental to initial response efforts and to public stress. Proactive and competent risk communication is critical in order to have any control over the public message.

5.7 Questions for the American Red Cross that Arise from the Chilean Earthquake and Response

Many of the issues noted in this section could have significant consequence for the Red Cross in its preparation and response to a California catastrophe. Based on the Chilean experience, these are some of the healthcare-related questions the Red Cross should consider in its catastrophic disaster planning and development of partner relationships.

1. Is the Red Cross prepared to deliver post-disaster services in settings where there is no water, communication, sewage, or electricity?
2. Does the Red Cross have the capacity to deal with ongoing post-disaster mental health needs for clients and workers, especially if mass casualties occur?

3. Can the Red Cross address worker and volunteer issues, such as long and stressful work days and worker illness or injury attributable to fatigue, stress, or worry about family and loved ones?
4. How can the Red Cross better prepare to support clients who are unwilling to leave their damaged residences or who prefer non-traditional shelter settings such as tents and cars?
5. Does the Red Cross have adequate equipment, healthcare supplies, and partnerships to support the hygiene, medical, and chronic healthcare issues, including functional and access needs, for clients in long-term mass care environments?
6. Can the Red Cross obtain timely, accurate information and communicate to clients and the general community the availability of local health and medical resources, the status of healthcare facilities, and locations for obtaining triage or primary care services?
7. Basic community first aid provided at local service delivery sites, emergency aid stations, or through outreach teams in impacted neighborhoods may become an important post-disaster Red Cross function, especially if hospitals sustain widespread damage or experience patient surge due to disaster-related major injuries. Is the Red Cross able to provide personnel and first aid supplies to accommodate and deliver first aid services at the level that may be requested?

6.0 Volunteer Management

6.1 Introduction

The Red Cross Volunteer Management Team found that the Chilean Red Cross (CRC) faced numerous varied challenges during their response, including limited disaster response experience and preparedness, lack of volunteer management coordination and a national central volunteer database, as well as inadequate and ineffective communication. Moreover, the earthquake and tsunami severely impacted many of the buildings that housed the Red Cross, other volunteer organizations, and emergency response agencies. Despite these obstacles, the Red Cross and emergency responders provided an overall successful response within each community, thanks to a pervasive culture of volunteerism and commitment to their local communities.

Sheltering in Chile is conducted by ONEMI. The Chilean Red Cross and various religious non-profit organizations play a supporting role in providing shelter and basic needs to disaster victims. In this instance there was only a minimal amount of traditional sheltering provided in Chile, as most of the population stayed on their own property to protect their belongings and assist their neighbors. Building *Mediasaguas* (single family cabin-like structures), also helped to support the housing needs of many individuals and families.

6.2 Methodology

The team met with volunteers from a large number of the affected regions. We were taken on a tour of some of the hardest hit areas, which allowed us to talk first hand with Chilean Red Cross volunteers who were affected by the disaster. The CRC has a very limited role within the government structure at this time. In the past, the non-profit organization's role has been limited to health and safety education and did not include disaster response. It is the hope and intention of the organization to build stronger

relationships with government entities in advance of future disasters. ONEMI Director, Vicente Nuñez, recognizes that the CRC has an important part to play in disaster planning. He advised the investigative team that the agency is in the process of reorganizing, and that the CRC will be more involved in future disaster-planning discussions (oral communication, Vicente Nuñez, ONEMI Director, 2010).

6.3 General Chilean Red Cross Volunteer Background

The Chilean Red Cross has approximately 2,500 volunteers nationally and received 30,000 spontaneous volunteer inquiries after the earthquake and subsequent tsunami. While in the past young adults were not well accepted, leading to a predominantly older and 97-percent female volunteer base, attitudes are changing. The Chilean Red Cross now has a youth program intended to better integrate the youth into the volunteer system. Currently younger volunteers work in more than 200 schools across the country acting as school ambassadors who provide first aid training and sex/HIV education. Volunteers younger than 18 are not allowed to respond to disasters due to liability; however, when the organization's volunteers turn 18, they can train new incoming underage volunteers.

The Chilean Red Cross currently executes four major programs:

1. Youth
2. Health
3. Risk Management (disaster services)
4. Social Activities & Wellbeing (elderly, poor, immigrants, etc.)

Though Chile had previously gone through one of the largest earthquakes in recorded history, it did not plan for a disaster of this magnitude. Fortunately, the Maule 8.8 quake was not centered near any major cities, occurring in a sparsely populated part of the country. Nevertheless, many Chileans felt that they were prepared to deal with any large earthquake.

6.4 Timeline of Chilean Red Cross Response

National Chilean Red Cross members and other response agencies met with ONEMI responders within the first few hours after the disaster and participated in the agency's meetings for three days after the earthquake. Realizing that this disaster surpassed their response capacity, the CRC decided to redirect their efforts away from a national response to focus on local community responses (oral communication, Nelson Hernandez, CRC Director of Risk Management, 2010). Thus, Red Cross chapters handled the initial response with local volunteers. This continued for five days before they received mutual aid volunteers sent by the organization's headquarters (oral communication, Manuel Quezada, CRC Executive Director, Bio-Bio Region 2010).

6.5 Chilean Red Cross Volunteer Commitment

The Chilean Red Cross has few employees. Paid staff mainly consists of executive directors (National and Regional Directors), secretaries, and janitorial staff. All other personnel are volunteers who are expected to work a minimum of 20+ hours per week after required training is complete.

6.6 Chilean Red Cross Volunteer Activation

Volunteers are instructed to report to their Chapter within 3 hours for large disasters and 12 hours for small disasters (oral communication, Cristian Winkler Santander, Regional Director of Talca Region CRC, 2010). The Chilean Red Cross and other volunteer

agencies advised the investigative team that while it is understood that volunteers should report to their local office following a disaster, many volunteers were unable to report because the Red Cross building was either inaccessible or damaged. In most instances an alternative location was not designated before the event. Such was the case in Concepción. All government EMS workers in Concepción had been trained to report to one pre-designated meeting place in the center of the city. However, the meeting location suffered significant destruction and was inaccessible. The local Fire Department is now painfully aware that the failure to include redundancies in the plans of action greatly impacted their response. As a result, they have created a new disaster plan that includes three alternative meeting locations. This also underscores the importance of selecting meeting sites that would likely remain accessible after a disaster.

6.7 Chilean Red Cross Volunteer Identification During a Disaster

The Chilean Red Cross does not provide identification badges to authorized volunteers. During a disaster Red Cross vests are used to identify its volunteers. This raises concerns regarding the efficient identification of a legitimate volunteer. The Chilean system also does not distinguish between trained Red Cross workers and untrained spontaneous volunteers. In response, the CRC recently implemented a new protocol for uniforms, which consist of a new vest, a shirt, and cargo pants. At this time, there does not appear to be a need to create ID badges or implement background checks for personnel. This is an additional indicator of the difference between the Chilean Red Cross and the American Red Cross response during a disaster. The American Red Cross has a clearly identified need for ID badges, as do most other entities that respond and work together during disasters in the United States.

6.8 Chilean Red Cross Volunteer Database

Each region keeps its own volunteer database. When speaking with Chilean Red Cross personnel, many concerns were raised regarding a non-centralized database. If an area is adversely affected during a disaster, there could be a loss of data regarding names of volunteers, training records, and other personal information. There is no standard to decide what information is retained regarding volunteers. There are numerous databases with multiple formats, and each region collects and stores its volunteer information differently. This may cause problems identifying what skills are available in each region, as well as determining the quantities and types of resources available for deployment. On the other hand, having decentralized databases has the advantage of aligning with the Chilean focus on local community empowerment, rather than solely relying on national leadership. Another advantage is that local CRC chapters are able to keep customized records according to their specific needs. Additionally, smaller databases are easier to manage, an essential quality for an organization run mostly by volunteers.

6.9 Chilean Red Cross Retention

The Chilean Red Cross is challenged with retaining youth volunteers after they leave school as a result of the 20-hour-a-week requirement. After high school graduation, students join the workforce or enroll in a university and do not have more than a few hours to donate. This is an unfortunate downside of the 20 hour obligation which otherwise helps to maintain an active core group of volunteers. Youth should be considered the future of the Chilean Red Cross adult volunteer base, and yet there are few programs in place designed to boost youth retention.

6.10 Communication

Communications systems throughout all affected regions were impacted, if not destroyed, during the earthquake and tsunami. Many fire stations were heavily damaged, and communications between response organizations were not working in several areas. The media attempted to mitigate the problem by delivering response messages, but this too resulted in lapses in emergency service. Reports from Concepción focused on the Alto Rio building (fig. 4) and did not focus on other damages. As a result many emergency responders rushed to the building, and many other affected areas did not receive the immediate support they needed. These communications breakdowns demonstrate the importance of backup communications systems in all emergency plans. Specific disaster protocols, such as sending all damage reports to a few central locations, are essential so that emergency services do not have to rely on media to know where to go.

6.11 Fire Department Volunteer Management

The Chilean Fire Department consists of 311 fire stations. It is the oldest volunteer organization in Chile, and even the national *Bomberos* President, Miguel Reyes Nuñez, is a volunteer. The Chilean Fire Department has 38,000 *Bomberos*, 4,000 of whom are women (see fig. 16). Mutual aid is prevalent within the fire department and it is requested by proximity—the first request is within their district; as the disaster escalates, farther districts are contacted. This is very similar to the mutual aid and deployment process the ARC uses. Volunteer *Bomberos* receive subsidies, medical insurance, and life insurance if harmed in the line of duty. Dispatchers and drivers are the only paid staff and are on duty at a dispatch center or the fire station. Volunteers are not always in the stations (due to personal commitments, jobs, and so forth), and often respond directly from home to meet the fire truck at the incident. Firemen are primarily alerted by siren and mobile phones. There is no minimum time commitment; however Miguel Reyes Nuñez did not feel that they were often ‘short-staffed.’ This highlights the sense of commitment, accountability, and responsibility amongst the volunteers. Moreover, *Bomberos* pay a monthly fee to be a part of the volunteer department. (This sparks an interesting debate regarding the increased sense of value if members pay to be part of a group—an idea worth deliberation on the basis of greater participation seen among paying group members over those with free membership.)

The Chilean Fire Department has a youth program for ages 12-17, which encourages those older than 18 to become *Bomberos*. The success of this initiative demonstrates the importance of working with youth to positively influence communities. It has led to close bonds within the community and propagated a vibrant culture of volunteerism.



Figure 16 American Red Cross Delegates meet with National Bomberos President, Miguel Reyes Nuñez.

Their system should be considered a model for changing the culture of communities in the future through similar youth programs.

6.12 Volunteer Management Findings and Recommendations

Volunteers in Chile tend to be very resilient, resourceful and adaptable. They are able to work effectively with little or no direction from National Headquarters. This partly explains how they were able to respond immediately to such a devastating event.

The following are recommendations for improvement in California, based upon our observations in Chile:

1. There must be redundant ways of communicating with personnel.

- Ensure that radio communication equipment is in place and that personnel are trained to use radio equipment. Write a policy and procedures manual for radio communications during disaster responses.
- Employ automated call-out systems using an out-of-state server to ensure that the server is not damaged. The automated system should allow activation of calls by telephone or online. It should send messages by phone and text to ensure that the message is sent as soon as possible.
- Utilize social media to communicate with personnel and encourage subscription. Although this was not prevalent in Chile, news reports from Haiti noted that social media messages were active before mobile phone and landline messages were working.
- Have a backup plan in place so that personnel know what to do when all communication is down. For example, Red Cross Volunteers could be advised to report to their local office (or secondarily to another locally assigned area, for example a school or park) for instructions, and designated personnel would be trained to open offices, coordinate volunteers, and use radio equipment.

2. Emergency plans need to be flexible and include alternative options in case primary plans are unable to be executed.

- It is imperative to have at least one backup alternative plan and to communicate disaster plans with personnel. For example, there should always be more than one meeting place and more than one designated person fully trained in each position in case the primary person is not available.
- Plan for technology failure; ensure staff has access to manual volunteer databases and the paperwork needed to handle staffing.

3. All volunteer leadership, at all levels, need to know emergency plans.

- All responders at all levels should be aware of the disaster plan.
- Leadership should be fully trained in their role and clearly aware of the roles and responsibilities of complimentary team leaders and members.

4. Exercises need to be performed on a regular basis with volunteers rotating in their normal roles.

- Preparedness exercises improve response time and effectiveness as well as increasing public education and trust.

- If only a select number of volunteers know the plan and they are unavailable after a disaster, no one will know what procedures to follow.

5. Involve local officials in regional planning.

- Plans should be developed in coordination with government entities.
- Partnerships should be formalized when possible via development of written agreements such as Memoranda of Understanding (MOUs) and should be developed in advance with government and non-government organizations.
- Inter-agency training is strongly recommended for entities that would work together during a disaster.

6. Perform a realistic assessment of life-essential systems, such as potable water sources and emergency medicine supplies.

- Community preparedness is a key element in working with these issues.
- Personnel should be trained for the probability that core services may not be available, and know how to respond and support the community in such conditions.

In summary, both the Red Cross in Chile and in the United States seem approachable to local residents, and have strong community relationships. The success of the organization will depend on strong community relationships and a positive public impression to ensure that communities continue to feel they can approach them for aid. It is crucial that the American Red Cross increasingly maintain and develop strong relationships with government and non-government entities to ensure a unified and effective response.

7.0 Executive Management

7.1 Introduction

How a government responds after a disaster usually captures the headlines. But most often, it is the role that government plays in preparing for these types of events that can be the single biggest factor in minimizing not only the event's initial toll, but also the recovery time necessary to bring a community back to a healthy, functional state. In this regard, an examination of how the government in Chile responded during the immediate aftermath of the earthquake and related tsunamis is appropriate. The relationship between the government and the local Red Cross is also important to understand the social dynamics of the recovery process. In addition, some observations about the plans and programs the government is now instituting for the recovery phase may offer insight into where things may evolve in terms of capabilities, culture, and priorities.

Information compiled for this report includes direct observation, interviews with various government, non-government, and community officials, data received directly from each of these groups, and external data that are referenced to provide context and foundation. In each case, attribution is cited and footnoted.

7.2 Analysis of Social Interactions

7.2.1 Social Priorities

It is very clear that in the United States, a high priority and expectation is placed on government and recognized organizations such as the Red Cross to keep people safe and provide for their basic human needs during times of emergencies and disasters. This expectation was reinforced by the many reports that emerged after Hurricane Katrina. Criticism of the U.S. Government's response ranged from Nancy Pelosi's report (California Policy Desk, 2006) entitled "Katrina Response: a Scandal of Incompetence and Cronyism" to the Select Bipartisan Committee Report to Congress entitled "A Failure of Initiative" (House of Representatives, 2006). Despite the fact that this was the single largest disaster to ever strike the United States in terms of total losses, total costs, and total resources required, it is clear that the expectation remains among some in this country that response to such events, however cataclysmic, will be timely, effective, and efficient.

In Chile, it appeared that central government believed that the expectations of the Chilean public were much lower than those of the American public. In our meeting with the head of the Emergency Committee that had been commissioned by the President to oversee the response and long term recovery efforts, there was an admission that because the country had not suffered a large disaster in many years, this had led to a gradual reduction of planning, exercising, and investment in preparedness infrastructure, thus contributing to the deterioration (and ultimate failure) of their systems and other emergency response and recovery capabilities (Oral communication, Cristóbal Ibáñez, Director, President's Emergency Committee. July 20, 2010). Both Chilean Government and Red Cross officials told the delegation that there had been surprise at the level of public criticism to the government's response. Both agreed that the positive public perception of the Red Cross had contributed to the government's early efforts to engage the Red Cross in more meaningful and proactive ways, including participation on the President's Emergency Committee.

Chile has an ongoing, albeit innate public-private relationship in that most of the 100% volunteer fire fighters come from the private sector. The new president, who comes from the private sector, called immediately upon the private sector to reinvent the country's emergency management organization.

7.2.2 Relationships between Agencies

From our discussions with officials at the national level down to local government and individual responder agencies, there was little to suggest that the various organizations had worked closely with each other during planning and preparedness activities within recent times (Oral communication, ONEMI, Chilean Red Cross, Regional and Local Government Officials, July 2010). In 2006, the Board of Governors of the Chilean Red Cross strengthened the disaster charge of the national society, but progress has since been slow in co-opting national and regional government to reconsider this broader role (Oral communication, Chilean Red Cross officials, July 2010). A pattern that emerged from our various meetings was that each organization with whom we met seemed quite clear about their own role and responsibilities for preparedness, response and recovery activities, while their understanding and expectations of different levels of government or outside organizations starkly differed.

While everyone with whom we spoke saw the Red Cross in a positive light, there were in many cases very low expectations about the ability of the Red Cross to play a significant role in disaster services. In certain settings, that reduced expectation may have accurately reflected the presence and capabilities of the local Red Cross Chapter. However, in at least one case, there appeared to be more local Red Cross capability than that which local government was initially aware of or perhaps preferred to acknowledge. In this particular region, the Red Cross was poised to begin providing financial relief (approximately \$300 per family) and requested records from the Mayor's office regarding the affected families in order to establish and confirm the need for assistance. The mayor requested that his office be given the funding so they could distribute the assistance. When told that was not possible and that the Red Cross would need to work directly with the clients, a decision was reached to not provide the Red Cross with the requested records. Red Cross officials told us the rationale they were given by the Mayor's Office was that it would have been harmful to the public's perception of the government's response if people saw that they were receiving assistance more from the Red Cross than they were from their government.

During a visit to one of the tsunami-affected areas in this region, we were pleased to see brand new mattresses being distributed to the housing units in the relief camp there. The local Mayor met with us inside the camp and provided us with his talking points and priorities for what he felt his area needed from their national government. It was only later that we learned from the local Red Cross officials that the mattresses we saw being distributed had been sitting for weeks in a local warehouse, and that it was very likely the presence of the Study Team that finally prompted their distribution during our time in the relief camp (see fig. 17).

As for its relationship with the general public, Red Cross has a strong reputation across Chile. It is volunteer led, has a local presence all over Chile, and is seen as part of the overall global Red Cross movement. Many Chileans are vague on what exactly the Red Cross provides in Chile, but they almost all have a very good overall impression.



Figure 17. Mattress delivery to *Mediasaguas* 'village' outside of Tumbes.

7.2.3 Responsibilities for Documentation

A key finding for most of the team members was the paucity of data relating to the earthquake response. Even four months after the event, many areas of statistical information had yet to be developed or completed. When we met with the National Fire Chief in Santiago and inquired as to certain fire-related reports, he told the study team that even basic fire incident reports in Santiago for the days immediately following the earthquake had yet to be completed and compiled (Oral communication, Miguel Reyes Nuñez, National Chief of Bomberos. July 27, 2010). The inconsistency with which data were being mined and

developed was reflected by all disciplines, even hospitals. By contrast, medical records, systems, and documentation are traditionally held to a high standard of precision compared to many other industries (American National Standards Institute, 2010).

The general lack of emphasis on data collection and information development led to national statistics that were inconsistent and inconclusive. While there is general agreement about the key areas of failure surrounding the country's response to the earthquake, it was never evident that these were developed as a result of any process of statistical collection and analysis, but rather through a combination of anecdotal feedback and written or verbal comparisons of common problems encountered. Without the development of additional means to identify or confirm specific incident response data, both analysis of past events and planning for future ones will remain challenging. It may be somewhat telling that while there was a general acknowledgement that better systems for collecting and analyzing data were necessary, this was never cited as one of the leading problems or areas of future concern by any of the organizations with whom the Executive Team met.

7.2.4 Culture

Our team noted an amazing resiliency on the part of the Chilean people. Many of the affected population, even in the wake of this enormous disaster, chose to remain completely self-reliant. If people lived near the coast, they knew to evacuate for higher grounds after any earthquake where they had fallen down or could not walk due to the shaking. In almost all cases, these were not lessons learned from national or local government officials, nor even from the Red Cross. Most natives have learned what to expect and what they should do from their parents, grandparents, and others who have passed the information down through generations of people, many who experienced similar events during their lifetimes. We learned about many people who had returned to their properties as soon as the tsunami threat had passed, only to find their homes either nearly destroyed or, in many cases, missing completely. Despite this, many opted to remain at their land and manage their own recovery, rather than seek the assistance that was being organized and available at various relief camps.

At the national level, a history and culture of self-reliance also continues to be strongly evident. During the initial hours following the earthquake, then-President Michelle Bachelet refused early offers of international aid, including both formal and informal offers from the United Nations (oral communication, Enrique Ganuza, United Nations Resident Coordinator. July 26, 2010). Critics have claimed this as a contributing factor to the delays seen in meeting the basic needs of victims in the first days following the disaster.

Coming on the heels of the Haiti earthquake, the timing of the Chilean earthquake coincided with when many aid agencies began struggling to raise money for relief efforts, amid fears that the world community was becoming "disaster weary." Within weeks, the world had new disasters to which their attention had been diverted, including the Gulf oil spill. The long-term financial implications for Chile are daunting, with a total recovery cost that has been projected at \$30 billion.

7.3 Implications for California and the American Red Cross

7.3.1 Relationships

Our findings reinforced the importance of our “pre-disaster” relationships with all of our governmental, non-governmental and community partners. Properly done, these relationships require an organizational commitment, as well as a significant investment of time and personnel. The number and complexity of these relationships will vary based on local nuances, but as a general rule it is vital to ensure Red Cross representation and active participation in disaster policy, planning, response, and recovery activities at all levels appropriate to the specific setting. It was no surprise to learn that the areas in Chile that made the most effective use of the Red Cross and its resources were the very areas where some level of interaction had been ongoing before the earthquake struck.

In the United States, our government’s approach to disaster response is well defined and emphasizes a “bottom up” approach, where local government is considered as having primary responsibility for emergency management. The National Response Framework (Department of Homeland Security, 2008) describes the tiered approach and flow in this manner:

“Even when a community is overwhelmed by an incident, there is still a core, sovereign responsibility to be exercised at this local level, with unique response obligations to coordinate with State, Federal, and private-sector support teams. Each organization or level of government therefore has an imperative to fund and execute its own core emergency management responsibilities.”

In any particular setting, therefore, the appropriate connections must be made at all relevant levels. Paul Schulz, the CEO for the Los Angeles Region, met with the ARC Delegation as well as with Chilean national government and Red Cross officials during the final three days of our visit. The summary of his observations included the following:

“When there is a major disaster in Los Angeles, the natural political leader will be the Mayor of Los Angeles, just as it was the President in Chile. It is critical that the Red Cross, and the regional CEO in particular, have a personal relationship with the Mayor in order to be a key part of the ad hoc kitchen cabinet that will inevitably be formed. Mayor Riordan formed this ad hoc group during the Northridge earthquake, and most likely this would happen again. As the Mayor will reach out to those he or she trusts during this crisis, having a personal working relationship is a prerequisite for being on this senior team.”

7.3.2 Social Priorities

There is little to suggest that Americans are willing to accept less readiness in this country, despite the significant costs associated with maintaining such a state of preparedness. While the American Red Cross plays a vital role in the nation’s readiness infrastructure, it is ultimately the responsibility of local government and local communities to ensure that mass care equipment, supplies, and facilities have been made available to provide for the needs of the community during the immediate post-event phase of a response. As we saw in Chile and on many occasions in the United States, the early days after a large-scale disaster will best reflect and will ultimately serve as a barometer for local community readiness.

American Red Cross representatives should rightfully consider themselves as advocates and spokespersons for ensuring that mass care needs within their community are properly represented. This can assist local emergency management officials in developing an all-inclusive approach to emergency management in their respective jurisdictions that considers all of the Emergency Support Functions listed in the National Response Framework.

Michael Kleiner, Director of Emergency and Disaster Response for the Los Angeles Region of the American Red Cross, believes that many communities have yet to achieve balance with respect to their planning and approach to community preparedness:

“A comprehensive emergency management program must consider all of the Emergency Support Functions outlined in the National Response Framework. Like any chain of related activities, we will only be as good as our weakest link when actual events stress and test our systems. If, for example, we haven’t properly planned and resourced a community’s mass care needs, we are doomed to keep repeating similar mistakes as we have seen in the past during large disasters, where people begin sensing early that they may need to fend for themselves. This gives rise to unrest and activities such as looting, which immediately requires the diversion of precious and scarce emergency resources away from the initial disaster. In our community, Mass Care was recently rated by the various jurisdictions in our county as our largest collective capability gap, yet only a small and disproportionate fraction of the funding from numerous emergency preparedness grants was earmarked to address this shortfall. We need to do better at balancing the actual needs with our planning and preparedness priorities.”

7.3.3 Responsibilities for Documentation

Most members of the study team found the lack of data to be initially somewhat disorienting, particularly for the scientists and clinicians on the team who find themselves immersed daily in information relating to their professional roles. Despite the lack of data, there was agreement among the study team that many of the best lessons learned were about things that are inherently difficult to “measure,” such as the cultural distinctions noted in this report.

Dr. Richard Hinrichs, Chief Officer of Disaster Services for the San Diego Red Cross and former Federal Coordinating Officer in FEMA Region IX, helped put things in perspective regarding the lack of hard data:

“We have often in the past realized only after a disaster certain things we should be tracking better. Nearly every after-action plan you will ever see will discuss the need for better communication and recommendations on ways to better gather and use real-time information. Despite our best efforts, we all know from experience that many of our most significant learning moments come from intuition and observation, rather than from a data set. Albert Einstein once said, “Not everything that can be counted counts, and not everything that counts can be counted.” This statement exemplifies many of the most significant lessons we learned during our time in Chile, such as our observations about the ability of Chileans to react to the needs in front of them, taking action without waiting for some central authority to tell them what to do.”

7.3.4 Culture

Unfortunately, the individual mindset in the United States has not yet evolved to include a culture of personal preparedness. Many people in this country look to government and organizations such as the American Red Cross to be prepared to address the needs of communities and disaster victims, regardless of past attempts to shift some of that responsibility back to individuals and families.

The American Red Cross has long advocated personal responsibility. The Red Cross provides Community Disaster Education classes, sells disaster preparedness kits and supplies, and works in many settings with local government to continue efforts to shift our culture towards a greater sense of personal responsibility. A key for this may well be the consistency in messaging. As the public continues to be barraged with advice on what exactly constitutes adequate personal preparedness, subtle differences in this messaging may be hurting our collective efforts.

Craig Fugate, Director of FEMA, has cited improved personal preparedness as having the largest potential for improving our nation's level of readiness. Over the past several decades, this theme of personal responsibility for disaster readiness has been widely espoused, and during that time our culture has continued to reject this responsibility, not so much by words as through a collective failure to act. Fundamentally, something must change or we will likely continue to expend significant amounts of time and money promoting a concept that has not succeeded in making itself a part of our national culture. One fundamental change could be to strictly limit the ambiguity of our messaging by jointly working to develop one common script. Accomplishing this on a national level would require a national forum, and should be encouraged, but if even local communities that share a media market can agree on a singular message, the promotion of that singular message by many organizations would almost certainly be more conducive to achieving the desired changes in social behavior than would result from multiple and often contradictory messages being delivered by multiple organizations.

Ellis Stanley, former President of the International Association of Emergency Managers, previously worked as the Emergency Manager for two large metropolitan areas of the country (Atlanta-Fulton County and the City of Los Angeles). He currently serves on the Homeland Security Advisory Council's Emergency Response Senior Advisory Committee. Ellis has long advocated the notion of a simple, singular, standardized message for the public:

"People have often told us they end up confused as a result of the different preparedness messages they hear from various sources within their communities. For whatever reason, many organizations feel the need to "brand" the message by developing their own unique catch phrases or marketing strategy. Then, when people hear inconsistent and contradictory messages about how they should prepare, how much food and water is adequate, and how long they can expect to wait for help, it becomes that much harder to convince them to take action. If we can develop a National Response Framework, why can't we agree on a National Preparedness Framework that could provide the same level of standardization regarding the necessary elements of readiness, including a common message for the public that has been vetted and agreed upon by the emergency management community?"

From a financial and fundraising perspective, past experience both here and internationally has shown that the window of time available to effectively fundraise for disasters is unreliable at best. Uncontrollable variables such as other disaster events occurring simultaneously or shortly afterwards can greatly limit the time frames for generating adequate financial support for our events. This reinforces the importance of fundraising as one of the basic things we must all focus on early during disaster relief operations.

8.0 Recommendations for California

Throughout each section, we have presented findings and recommendations that will be useful for professionals in specific areas. In this section, we highlight overarching themes in Chile's response that resonated through multiple disciplines and areas of response. These represent the main strengths and weaknesses that surfaced during the event and could be put to use in preparing California for potentially catastrophic events.

1. **Conducting comprehensive exercises (including joint Government, private sector, NGO, emergency responder, and community exercises) before the event is paramount to surviving and thriving after a natural disaster.**

Justification. When we visited the coastal towns hardest hit by the tsunami, we were told that communities often drill at least twice a year, practicing full evacuations to higher ground. Emergency drills need to be done on a regular bases with key players actively exercising in their specific roles. It is important to exercise within one's own organization; however, it is strongly advisable for entities to work together when drilling.

2. **Individual resiliency and effective networking with local partners are vital to the continued success of a community after a disaster. It is critical to empower people to be prepared.**

Justification. Most of the hardest hit areas in Chile were cut off from aid and communication with the capitol for several days following the earthquake. All of the responders in these areas cited their personal resourcefulness and local partnerships (for example, between the firefighters, police, emergency management, and the Red Cross) as critical in their ability to help their communities in the difficult first few days. The already strong ARC partnership with state and local governments should be maintained and enhanced when possible.

3. **Education about what will happen during the event is an important part of preparing for a disaster; this information can save lives during a disaster.**

Justification. Most sources in Chile cited their "culture of resiliency" as a central factor in their ability to respond. It is clear that earthquake drills are more common than in California and that earthquakes are a more visible part of their society. At the same time, lack of information about the true nature of great earthquakes and tsunamis appears to have contributed to injuries and fatalities. For example, many people were taught to head for high ground if shaking was so strong they could not stand; this appears to have saved

many lives in the tsunami. At the same time, it is not clear that the occurrence of multiple waves over many hours in tsunamis was anticipated.

4. **Emergency and earthquake professionals should work with representatives of the print and broadcast media before the disaster to determine how to best serve the community.**

Justification. The media played a mixed role. Only a single radio station remained on the air in Concepción immediately following the earthquake, but that was very helpful since no one else had situational awareness or means of receiving information. At the same time, several people commented that some of the media, especially television, exacerbated the chaotic situation by reporting only on the worst of the disaster, as well as emphasizing the dangers from looters and the potential shortages of supplies.

5. **Emergency plans need to be redundant, flexible, and detailed to handle the unexpected in very large disasters.**

Justification. Emergency plans in Chile were in place for the Chilean organizations we met with, but in all cases they were described as inadequate for the situation they faced. Deficits were especially seen in flexibility and alternate plans. For example, plans had only one meeting place that could not be accessed, or one designated person in each position who was injured or out of town.

6. **Recognize the competing personal and professional demands that will be made on an organization's staff after a disaster and include this in emergency plans.**

Justification. Immediately after the Chilean earthquake and tsunami, many critical staff members stayed with their property or left work to see if their families were safe. Other staff simply could not get to work. Staffing shortages have the potential to hamper response efforts in the hours, days, and weeks following a major disaster.

7. **Organizations need to plan for nonstructural damage and the potential need to evacuate even without structural damage.**

Justification. After a significant California earthquake, it must be assumed that even buildings that are structurally sound will have significant non-structural damage with supplies and some equipment on the floor, fallen ceiling tiles, and other superficial damage, but this should not be the sole reason to evacuate.

8. **California must recognize vulnerabilities in our communications systems and make comprehensive backup plans to avoid complete communication collapse. It is important to do this as individual organizations, but also to team up with other organizations.**

Justification. Although most communications were re-established rapidly in Chile, initially it was very frustrating and difficult to have no communications. Health and other critical agencies and institutions need redundant communication systems to communicate situation status and resource requests within and between jurisdictional levels. Initial situation status may be impossible to determine without functional communications,

which in turn makes resource allocation decisions very difficult. Emergency hand-held radios proved particularly useful for local primary responders, allowing them to coordinate initial activities.

9. Explore mechanisms to encourage building owners to adhere rigorously to existing building codes.

Justification. In Chile, buildings performed extremely well, due to strong, well-enforced building codes. By law, if there is building damage or injuries within a building, the building owner may be liable. Both building professionals and lay people in Chile reported that this law serves as extra incentive for building owners to adhere to the building code during construction.

10. Collect all possible data about each disaster when it happens.

Justification. Many of the consequences of the Chilean earthquake and tsunami have not yet been quantified, such as the numbers of fires or injuries caused by the events. Each disaster is a unique opportunity to learn how society is affected by the events and this information if captured can support researchers who are trying to minimize future losses.

9.0 Recommendations for the American Red Cross

1. The ARC (American Red Cross) should actively seek to create, develop and maintain close working relationships at all levels of local and state government that play roles in disaster preparedness, disaster education, disaster response, and recovery from disasters.

Justification. The health of our pre-disaster relationships will be key in whether the Red Cross will play a comprehensive role in decision-making at the highest operational levels of an event. Our ability to do so will not only enhance our services to clients, but can provide a mechanism for the consideration of certain cost-containment strategies that may help influence efficiencies.

2. The ARC should promote the standardization of preparedness messages provided to the public.

Justification. As the preeminent national organization and one widely recognized as a leader in the area of disaster preparedness, the ARC should attempt to play a larger and more central role in the process of standardizing the many preparedness messages that routinely bombard the general public currently. As a national organization, ARC is uniquely suited both geographically and by area of expertise to take a greater leadership position in the pursuit of this goal.

3. As a participating response agency, the ARC should play a greater role in the development of research in order to contribute to the knowledge gained by such endeavors.

Justification. The absence of data for the Chilean events was profound by our standards in the United States. This further highlighted the importance of not only data collection, but also the need to establish methods to process and analyze such data in order to

provide meaningful information for purposes of better informed planning and mitigation. The ARC and all other response organizations with significant disaster roles should contribute to this effort beyond the simple provision of data.

4. **The ARC should anticipate the significant gap in Disaster Health Services and Disaster Mental Health personnel available for a catastrophic event and seek to address this by the pre-arrangement of ancillary licensed personnel.**

Justification. The medical capabilities of any community will easily become overwhelmed in the wake of a major earthquake. The Red Cross has licensed personnel who provide Disaster Health Services and Disaster Mental Health. Without pursuing additional strategies, we will not have adequate human resources in these areas. The pre-arrangement by MOU of Public Health and other medical personnel by Emergency Support Function (ESF) could provide for appropriate percentages of community resources to be dedicated to each of the necessary response functions.

5. **The ARC should develop as a portion of their Disaster Plans a “pre-scripting” of basic initial activities in order to ensure that early actions are organized even in the absence of emergency communications. These scripted activities should be realistic and scalable to accommodate larger scale events.**

Justification. In virtually every after-action plan, communications is cited as a key factor contributing to problems during the response phase. Pre-scripting provides a standardized approach to initial organization of response efforts, while scalability should include a strategy for the controlled degradation of staffing ratios and systems. For example, pre-defined criteria for reduction to more austere levels of staffing and care should be considered in advance of an event, so as to avoid being forced to make such decisions during actual operations.

10.0 Sources and Acknowledgments

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11.0 Appendices

11.1 Appendix A

American Red Cross Multidisciplinary Delegation to Chile—Participant List

First Name	Last name	Title	Agency	ARC Delegation Team
Jim	Goltz	Earthquake and Tsunami Program Manager	California Emergency Management Agency	Emergency Management
Richard	Hinrichs, PhD, CEM	Chief Officer, Disaster Services	American Red Cross, San Diego/Imperial Counties Chapter	Emergency Management
Randy	Linthicum	Chief, Disaster & Client Services Bureau (CA DSS Sheltering)	Department of Social Services	Emergency Management
Gregory	Smith	Emergency and Disaster Response Director	American Red Cross, Bay Area Chapter	Emergency Management

Scott	Underwood	Emergency and Disaster Response Assistant Director, Los Angeles Region	American Red Cross, Los Angeles Region	Emergency Management
Michael	Whitehead	State Mass Care Coordinator, State of Florida	Florida Department of Business & Professional Regulation	Emergency Management
Michael	Kleiner, CEM	Emergency and Disaster Response Director	American Red Cross, Los Angeles Region	Executive/Policy
Paul	Schulz, MBA	Chief Executive Officer	American Red Cross, Los Angeles Region	Executive/Policy
Ellis	Stanley, CEM	Vice President of Dewberry, Western Emergency Services, Emergency Management and Homeland Security Branch / Board Member, ARCLA	Dewberry	Executive/Policy
Howard	Backer, MD, MPH	Associate Secretary for Emergency Preparedness	California Health and Human Services Agency	Health Services
Mary	Chasin, RN	Health Services Supervisor	American Red Cross, Los Angeles Region	Health Services
Jeff	Upperman, MD	Director of the Trauma Program at Childrens Hospital Los Angeles, and an Associate Professor of surgery at the Keck School of Medicine of the University of Southern California.	Childrens Hospital Los Angeles	Health Services
Lucy	Jones, PhD	USGS Seismologist	U.S. Geological Survey	Science/Engineering
Keith	Porter, PhD	Associate Research Professor - Civil, Environmental, and Architectural Engineering	University of Colorado	Science/Engineering
Deborah	Weiser	Geologist, contributor and recorder	U.S. Geological Survey	Science/Engineering
Pat	Mac Neil	Emergency and Disaster Response Volunteer Chair, Los Angeles Region	American Red Cross, Los Angeles Region	Volunteer Management

Kelly	Mulock	Emergency and Disaster Response Personnel Manager	American Red Cross, Los Angeles Region	Volunteer Management
Nancy	Carrillo-Rodriguez, MSPA	Disaster Response Liaison, Grants & Special Projects	American Red Cross, Los Angeles Region	General Logistics Manager/Translator/ Consulate Liaison
Monica	Leon Uribe, MA	Development Associate	American Red Cross, Los Angeles Region	General Logistics/Translator/ Consulate Liaison
Charlie	Sardou, MBA	Communications, Community Disaster Education and Marketing Director	American Red Cross, Los Angeles Region	Communications

11.2 Appendix B

The table below summarizes each of the meetings we had with Chilean officials and key players. Each meeting has a description of what was discussed, as well as the individuals we met with and which teams met with them.

Abbreviations: SE=Science and Engineering Team; V=Volunteer Team; HS=Health and Medical Services Team; EM=Emergency Management Team; E=Executive Team.

Date	Meeting, Location, and Key Officials	Topics Discussed
July 19	ONEMI, Central Alert System (CAT), Santiago [All] -Johaziel Jamett, CAT Manager -Andres Salgado Saint-Anne, Cabinet Chief -Cristian Torres F., Institutional Development Coordinator	-Need for better interagency coordination -Impacts of earthquake (damage #s, etc) -Importance of practicing operational plans -Communications systems restored quickly, overall
July 20	Chilean Red Cross (Chilean Red Cross) National Leadership, Santiago [EM, E, SE] -Lorenza Donoso, Chilean Red Cross National Director -Yolanda Munoz, Executive Director -Francisca Ringer and Patricio Acosta, Vice Presidents -Nelson Hernandez, Director of Disaster Risk Management -Jorge Romo and Maricella Huentemilla, Logistics Coordinators -Robinson Talavera, Director of Health -Cristian Ramirez, Water and Sanitation Coordinator -Osvaldo Rodriguez (Not Chilean)	-Chilean Government (GOC) has increased the Chilean Red Cross's post-disaster responsibilities -Country's view of Chilean Red Cross is shifting to see them as disaster responders, instead of only being seen as first aid support and disaster educators -Chilean Red Cross shelters were widely unused. It is culturally traditional to stay in ones' own home. -30,000 spontaneous volunteers came forward to help in aftermath-Chilean Red Cross not equipped to receive this high of a volume of volunteers.

	Red Cross), Real Estate Consultant	
July 20	Chilean Red Cross Volunteer Management, Santiago [V] -Francisco Cruzat, Director of Youth Services -Andres Recabarren, Director of Corporate Social Responsibility -Sylvia Santander, Communications Director	-Currently no specific process for new volunteer intake, nor any specific set training; content is decided by instructors. -Each Chapter handles volunteer management independently. -No national volunteer database -Older volunteers manage the Chapters; younger volunteers often not well accepted. 97% of volunteers are women. Primary “peace time” roles for Chilean Red Cross include: -Youth -Risk Management -Health -Social Activities/Wellbeing (elderly, poor, immigrants)
July 20	Health Services Meeting, Santiago [HS] -Dr. Celso Bambaren, Pan-American Health Organization/WHO	-Overview of the earthquake impact to health and medical services -Loss of approximately 4,000 hospital beds -Use and role of temporary and field hospitals -Relationship and agreements between PAHO and the Chilean central government and regions regarding emergency response -Immediate emergency financial assistance (equivalent to \$12 million US) from the UN, PAHO—60% of emergency funds used for recovery of healthcare facilities -Government identified healthcare priorities post quake: 1.) Need for field hospitals (17 were erected post quake); 2.) Need for electrical generators (PAHO purchased 13 for hospital use); 3.) Technical support for hospitals -No official national/government report available on damage to healthcare facilities or infrastructure -Many decisions post quake were political and depended upon the expectations of the local, impacted communities
July 20	President’s Emergency Committee, Santiago [All] -Cristobal Lira Ibañez, Executive Secretary	-Official GOC damage numbers -Discussed GOC’s response to this event, including long-term recovery plans -General lack of preparedness for this magnitude of an event
July 21	Catholic University of Chile, Santiago [SE] -Rafael Riddell, Professor of Civil Engineering -Ernesto Cruz, Professor of Structural Engineering	-Single-family dwellings mostly built of confined masonry, some are built of adobe; very few are built of wood frame -Three or four collapses of engineered reinforced concrete buildings occurred during earthquake shaking -Professor Riddell attributed most of the damage to engineered buildings to structural irregularities
July 21	Health Services Meeting, Santiago [HS] -Dr. Vladimir Pizarro, Director of Recovery for Ministry of Health, former Director, Hospital Felix Bulnes, Santiago	-Overview of evacuation of Felix Bulnes Hospital, Santiago (only hospital in the Santiago area to evacuate entirely) -Entire hospital (275 adult/children patients on floors 2-7) evacuated in 17 minutes -All but #20 ventilator-dependent patients evacuated to parking lot -All evacuees were transferred to other hospitals or discharged within 24-48 hours -Ministry of Health has a centralized system to coordinate hospital bed occupancy

		<ul style="list-style-type: none"> -Felix Bulnes had an emergency plan but no centralized plan for evacuation -Ministry of Health reviews hospital plans but has little ability to enforce -Overall, approx 3,100 patients throughout Chile had to be transferred to other hospitals due to earthquake damage -Field hospitals were used primarily for new patients (the timing was such that most were not set up in time to accept transfers) -No reports of death/injury associated with hospital evacuation/transfers
July 22	Maule Region Chilean Red Cross and other key regional players [All] <ul style="list-style-type: none"> -Cristian Winkler, Chilean Red Cross Regional Exec. Dir. -Marcella Winkler, Chilean Red Cross -Francisco Sans, Civil Engineer (regional government) -Maria Soledad Acuna, Social Assistant (regional government) -Orlando Saavedra, Political Scientist, Government of Talca 	<ul style="list-style-type: none"> -Two options for government-supplied emergency housing: move to 'village' with others displaced by tsunami and earthquake; or have temporary housing on one's own property -Many affected people preferred to remain on their property to protect belongings instead of going to shelters -16 <i>Mediasaguas</i> Villages in Maule Region housing about 700 families -Towns in coastal parts of Maule Region have tsunami drills every two months -Many cities execute extensive emergency drills 1-2 times yearly, including evacuations to high ground -In the Maule Region, GOC distributed 40k boxes of food which fed 4 people for 4 days in first 2 months -In the Maule Region, Chilean Red Cross distributed 5071 boxes of food which fed 5 people for 15 days in first 2 months
July 22	Visited Mediasaguas Village outside of Constitución [All]	<ul style="list-style-type: none"> -Tour of village with Chilean Red Cross and informal discussions with village lead and residents -Village had toilet and shower facilities, which were divided up amongst families. -Each <i>Mediasagua</i> had electricity, but no heating or cooling systems. -Village had group meeting tent, which was originally built for residents to watch the World Cup -Trucks come from the city with goods, produce and meat for people to buy.
July 23	Cauquenes Government and local Chilean Red Cross [All] <ul style="list-style-type: none"> -Guillermo Garcia Gonzalez, Governor -Jorge Rojas Luna, Provincial ONEMI director -Hernan Larraín Fernandez, Senator -Ignacio Urrutia Fernandez, District Representative -Girardo Arellano Vallejas, Cauquenes District Emer. Mgr -Cristian Winkler, Chilean Red Cross Regional Exec. Dir. -Marcella Winkler, Chilean Red Cross 	<ul style="list-style-type: none"> -Historical part of Cauquenes, which was comprised mostly of adobe homes, was destroyed -There were approximately 4200 adobe homes in the District of Cauquenes; the 12 people who died in the district were all killed in adobe houses -Many people ran out of homes during earthquake -In Province of Cauquenes, 64 people died, and 3 are still considered missing

July 23	Cauquenes Hospital [HS] -Hospital Director -Public Affairs Manager	-Tour of hospital and discussions with Hospital Director and Public Affairs Manager -Tour of field hospital set up to replace portions of Cauquenes Hospital destroyed by the quake
July 23	Regional Bomberos, Cauquenes [All] -Carlos Peñalillio, Community of Chanco Fire Chief -Richard Castillo, 3 rd Company Fire Chief in Cauquenes	-Local inspections put houses in following categories: Completely destroyed, habitable, or inhabitable; completely destroyed, major damage, or minor damage -International help started arriving five days after initial quake -All Chilean <i>Bomberos</i> are volunteers, but most local employers kept paying <i>Bomberos</i> employees during rescue efforts
July 24	Meeting with local Bio Bio region Chilean Red Cross volunteers [All] -Manuel Quezada, Regional Emergency Director -Claudia Betancourt, Chilean Red Cross Paramedic -Gladys Rivero, Chilean Red Cross hazards manager for Bio Bio Region (from Concepción) -Angelica Lagos, Chilean Red Cross Paramedic -Ricardo Rios, Talcahuano Hazards Manager -Marcia Gutierrez, Temuco Chilean Red Cross	-10-12 days for most basic services to resume in Concepción -Military service is required for most Chileans. Those who do not join the military can be a part of the Civil Defense. Both teach first aid and general preparedness actions -Military presence in streets of Concepcion five days after quake, in effort to quash looting -In Tumbes, over 500 people live in Villages -99 families in Village in Talcahuano -Radio Bio-Bio (emergency broadcast station) was the only station transmitting-bandwidth covers most of Chile; initially, a lot of misinformation may have been disseminated
July 24	Regional Bomberos Coordination Center (Regional Emer. Operations Ctr.) [All] -Marcos Oyarzo Espinoza, Province of Talcahuano <i>Bomberos</i> Commander -Dino F. Olivieri Diaz, Regional President of Bio-Bio <i>Bomberos</i>	-VERY few fires caused by earthquake -People causing fires by using damaged heating units -Regionally, 36 fire stations were completely damaged. In Concepcion, four stations collapsed. In Talcahuano, three engines were destroyed -Some streets in tsunami-ravaged Talcahuano were clogged with 1-1.5 meters of debris -Lack of ability to communicate between emergency responder/service entities - <i>Bomberos</i> offered security to last supermarket in town that had not been looted in exchange for supplies for emergency services personnel
July 24	Tours of Cities of Concepción, Talcahuano, and Tumbes [All] -Local Chilean Red Cross Representatives -City and Regional Fire Personnel	-Survey/tour of damaged parts of Concepción, Talcahuano, and Tumbes with Chilean Red Cross and regional fire personnel -Visited Alto Rio and Torre O'Higgins buildings (two of most well-known quake-damaged buildings in the country) in Concepción; 8 dead, 71 rescued in Alto Rio -Saw heavily a damaged fire department building in Talcahuano (it is across street from the ocean and was hit hard by the tsunami)
July 24	Visited Mediasaguas Village outside of Tumbes [All]	-Tour of village with Chilean Red Cross and informal discussions with village lead and residents, and Mayor of Tumbes -Village had five portable toilets

		<p>-78 <i>Mediasaguas</i></p> <p>-Each <i>Mediasagua</i> had electricity, but no heating or cooling systems.</p> <p>-Village had group meeting tent, which was originally built for residents to watch the World Cup</p> <p>-Trucks come from the city with goods, produce and meat for people to buy.</p>
July 24	<p>Former Regional Secretary of Health, Concepción [HS]</p> <p>-Dr. Mara Werner, former Regional Secretary of Health, Concepción</p>	<p>-No ability to communicate internally or externally immediately post quake</p> <p>-By 0600 able to text message other Directors</p> <p>-All clinics/hospitals “did the best they could to respond to the moment.”</p> <p>-Loss of 1/3 of the hospital beds and 36% of operating rooms in the Concepción region</p> <p>-First priority was to assess structural damage in the provinces – but little communication with outlying areas</p> <p>-Outpatient dialysis was a “big problem”</p> <p>-No data regarding hospitalizations or injuries post quake, few records were kept (Dr. Werner is attempting to reconstruct some data)</p> <p>-Mental health issues noted almost immediately, started group therapy sessions in the shelters and communities</p> <p>-No known water/food rationing but had to be “very careful” – some workers brought food to hospitals, looting also contributed to food availability in Concepcion area</p> <p>-“Seismic Culture” (supposedly) but few are personally prepared w/food, flashlights</p> <p>-Locals were really affected by the disaster, workers got sick and tired – it was difficult to receive external help since they required a great deal of direction from local medical authorities</p>
July 26	<p>University of Chile, Santiago [SE]</p> <p>-Professor Sergio Barrientos, Ph.D.</p>	<p>-450-500-km-long section of fault ruptured</p> <p>-Approximately one magnitude 7.75 earthquake or greater every 10 years in Chile (over a 450 year average)</p> <p>-Tsunami hit as tide cycles were approaching neap tide (the lowest low tide), so the largest tides came when high tide was approaching (3-8 hours later in some places)</p> <p>-Received isoseismal map, which shows earthquake intensity for the affected regions</p>
July 26	<p>Ministry of Housing and Urban Development, Santiago [EM, E]</p> <p>-Vicente Nunez, ONEMI director</p> <p>-Enrique Ganuza (UN)</p> <p>-Francscio Irarrazabal (Housing Ministry)</p>	<p>-Design plans were presented for the reconstruction of the cities of Constitución (including its island) and Concepción.</p> <p>-Presentation of the Tsunami action plan was presented. Plans include moving the existing port in Constitución to another location for example</p>
July 26	<p>Red Cross National Headquarters, Santiago [EM, E]</p> <p>-National Director and Staff</p>	<p>-A tour was provided to the ARC delegation</p> <p>-Chilean Red Cross hosted a roundtable to present their lessons learned. ‘Be prepared for everything and anything. Be prepared to have absolutely nothing to support the recovery efforts—water, technology, electricity, and supplies. Everything you believe can go wrong (and more), will go wrong.’</p> <p>-Suggestion to conduct an exercise of emergency and disaster response with absolutely No technological resources at play.</p>

July 27	Ministry of Health, Santiago [HS] -Gisela Acosta, RN, Chief, Emergency Preparedness and Response, Ministry of Health	-Weak in preparation, good at response -Discovered many strengths, weaknesses -Communication biggest problem -Many places didn't have radio communication, others had systems but weren't maintained (example: no batteries) -Took 2 days for central gov't to have contact w/ Concepción and Talcahuano -Main request post-quake was for structural evaluation of hospitals -Donations began to arrive immediately but weren't always what was needed or requested -Public hospital system was very stressed—few private hospitals in the southern region to accommodate surge/transfers -Not as many injured in quake as expected, few major injuries, mostly minor and treated locally -Finding available ICU beds for those in ICU pre-disaster was an issue -ONEMI had a good plan but there was failure to execute -Assistance from police/fire/power workers to get electricity to impacted hospitals -Current priority: New emergency disaster plan with reinforcement of regional and central plans, emphasis on the importance of communication and safe hospitals
July 27	National Bomberos Headquarters, Santiago [EM, E, V, SE] -Miguel Reyes Nuñez, National Bomberos Chief	-In Concepcion, <i>Bomberos</i> had to fight fires set by looters instead of being able to fully focus on search and rescue efforts -15,000 <i>Bomberos</i> helped during earthquake aftermath -The only paid staff are engine drivers and communication staff (dispatchers) -Country profile of <i>Bomberos</i> : 38,000 <i>Bomberos</i> 4000 Female <i>Bomberos</i> 311 Fire Stations -There are 345 districts throughout Chile, so some stations service more than one district, and some districts have many fire stations
July 27	Ministry of Health, Santiago [HS] -Dr. Jorge Lastra, Director of Medical Response for Ministry of Health in Bio-Bio Region	Dr. Lastra was unable to meet with us. Upon return, there has been e-mail contact and follow-up. The HS Team submitted written questions to Dr. Lastra (translated by Nancy Carrillo into Spanish) and is awaiting a response from him.

12.0 Glossary of Terms including Acronyms

AHRQ: Agency for Healthcare Research and Quality

Aldeas: Temporary housing villages.

ARC: American Red Cross

ARCLA: American Red Cross, Los Angeles

ATC-20: Applied Technology Council-20 (Procedures for Post-earthquake Safety Evaluation of Buildings)

Bomberos: Chilean firefighters.

CA DSS: California Department of Social Services

Comité de Emergencia de la Presidencia: President's Emergency Committee

FONASA: Fondo Nacional de Salud (National Health Fund; public sector healthcare)

GEER: Geo-engineering Extreme Events Reconnaissance

IFRC: International Federation of Red Cross and Crescent Societies

IOM: Institute of Medicine

ISASPRE: Instituciones de Salud Previsional (Health Insurance Institutions; private sector healthcare insurance)

ONEMI: Oficina Nacional de Emergencias, Ministerio de Interior

Mediasaguas: Temporary housing shelters built by the Chilean Government, in order to house those displaced by the earthquake and/or tsunami.

MINSAL: Ministerio de Salud de Chile (The Ministry of Health of Chile)

MRC: Medical Reserve Corps

NOAA: National Oceanic and Atmospheric Administration

PAHO: Pan-American Health Organization

WHO: World Health Organization