THE 1908 MESSINA EARTHQUAKE: 100-YEAR RETROSPECTIVE

RMS Special Report

INTRODUCTION

On December 28, 1908 at 5:20 a.m. local time, a devastating earthquake occurred along the Straits of Messina between the island of Sicily and mainland Italy (Figure 1). Measuring between M6.7 and M7.2 on the moment magnitude scale, the Messina Earthquake, also known as the Messina-Reggio Earthquake, caused severe ground shaking throughout the region and triggered a local tsunami, which struck within minutes of the earthquake. By all accounts, the cities of Messina along Sicily's coast and Reggio di Calabria on Italy's mainland were completely destroyed, as many unreinforced masonry buildings collapsed. One hundred years following the 1908 earthquake, it remains the deadliest event in Europe with an estimated 60,000 to 120,000 fatalities.

One hundred years later, Risk Management Solutions (RMS) revisits this historic earthquake, summarizing the ground shaking damage and tsunami's impact. In addition, a recurrence of the event is considered in 2008, highlighting the susceptibility of the current building stock and its population from future damage and injury, as well as the ability of earthquake insurance to assist in the recovery efforts.

Figure 1: Map of region with inset of southern Italy and eastern Sicily

THE 1908 MESSINA EARTHQUAKE

The Messina Earthquake of December 28, 1908 occurred before the advent of a global seismic network for monitoring earthquakes. However, at the beginning of the 20th century, early quantitative seismic stations had been installed at locations around the world. Similar to the 1906 San Francisco Earthquake, the ground motion from the 1908 Messina Earthquake was measured by seismographs at these seismic stations; in the case of the 1908 earthquake, seismograms were gathered from at least 110 seismic stations. Levels of precision obtained using seismograms from these early stations are less than would be obtained through modern instruments and global seismic networks, yet they provide a valuable data set to help understand the origins of the earthquake. Descriptions of the damage due to ground shaking, including macroseismic intensity reconstructions (Figure 2), and the impacts of the tsunami also help constrain the most likely source of the earthquake.

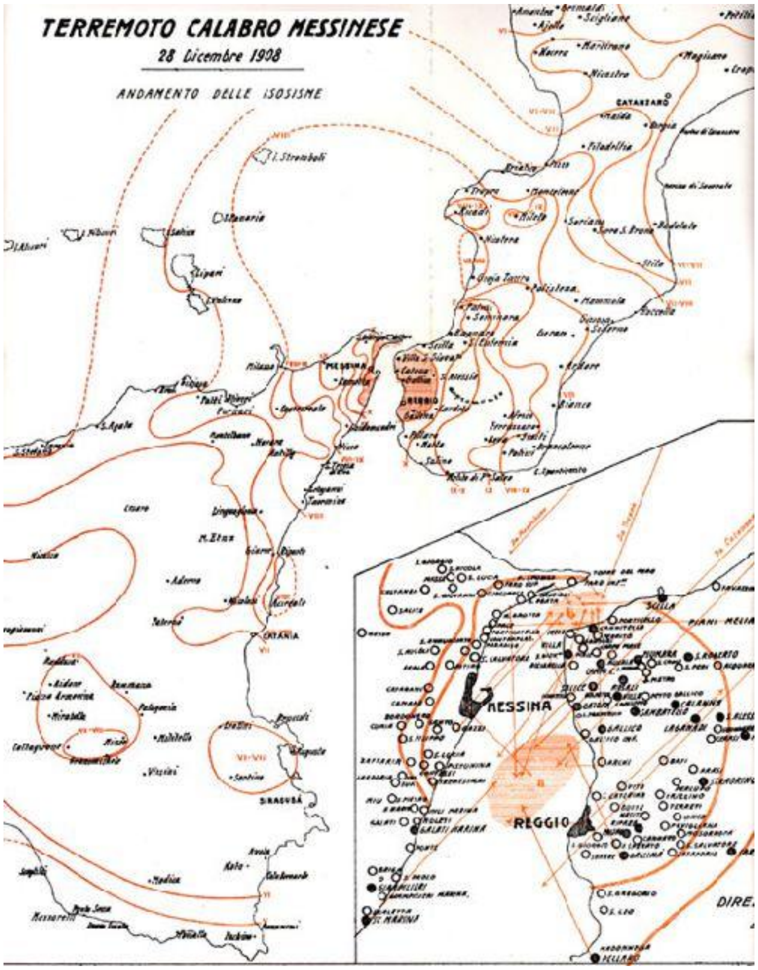

Figure 2: Isoseismal map of the 1908 Messina Earthquake

Seismic Activity Prior to December 28, 1908

A catalog of recorded seismicity in the area around the Straits of Messina suggests that seismicity appeared to increase in the region in the months prior to the December 28 earthquake. Unusually high seismic activity was recorded from November 1, 1908 through December 27, 1908. Most notably, on December 10, an earthquake with a magnitude of “above 4” damaged some buildings in Novara di Sicilia and Montalbano Elicona in the province of Messina. This particular event, as well as the general increase in seismicity, has been interpreted as foreshocks to the Messina Earthquake (Mulargia and Boschi, 1983).

In addition, the data presented in Mulargia and Boschi (1983) suggest spatial migration of the seismic activity for some months before the December 1908 earthquake. In April, the events were clustered around the Montalbano Elicona area, approximately 40 mi (64 km) southwest of Messina. By the beginning of July, seismicity began to migrate toward the Straits of Messina and by the end of November 1908, seismic activity was clustered in the southern part of the Straits near the eastern coast of Sicily. However, as the instruments operating at the time were rudimentary, the magnitude and location of many smaller earthquakes (< M3.0) may not have been detected. Given the uncertainty, the significance of these earthquake swarms is still debated among scientists.

Tectonic Setting

Italy has a lengthy history of catastrophic earthquakes and is one of the most earthquake-prone areas in Europe. During that last 2,000 years, more than 400 destructive earthquakes have been documented in Italy and seismic activity varies considerably across the country due to the complex tectonics of the region.

The Mediterranean-Alpine region forms part of a complex boundary zone between the Eurasian, African, and Arabian plates (Figure 3). The convergence of the Eurasian and African plates across the region has resulted in a wide zone of collisional tectonics. The boundary zone has undergone multiple episodes of deformation over time, producing a number of microplates within this broader zone of collision. The tectonic setting of Italy is defined by the relative motion along the boundaries of these microplates, tied to three tectonic movements in particular: the subduction of the African Plate along the Calabrian Arc; the formation and deformation of the Apennine Mountains as they push up and over the Adriatic Microplate; and the formation of the Alps. As a result, the regions of highest seismic activity are focused in and around the Apennine Mountains that bisect the Italian peninsula, the Alps in northeastern Italy, and the Calabria-Sicily region of southern Italy.

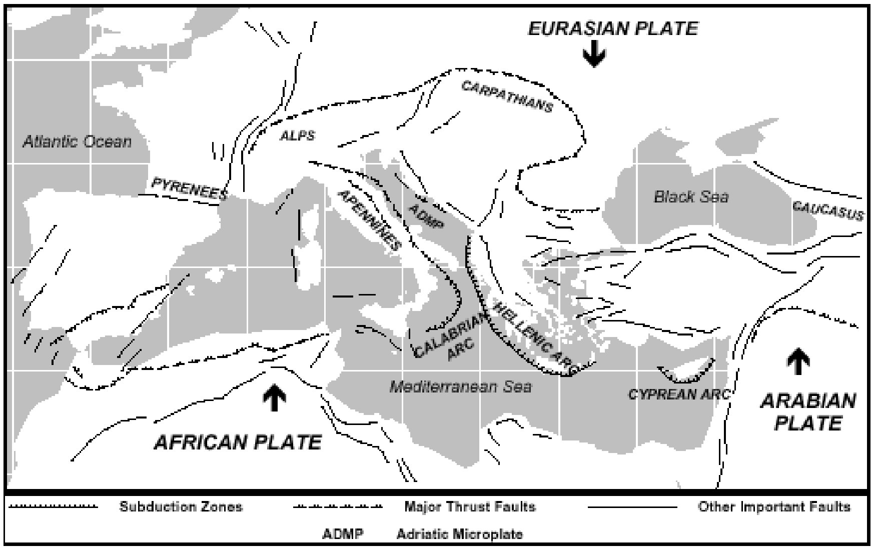

Figure 3: Tectonic setting of Europe

Ground Shaking Damage

The Messina Earthquake was the result of normal faulting in the Straits of Messina. Occurring in the early morning on December 28 and lasting for approximately 30 seconds, the earthquake was strongly felt throughout Sicily and the Calabria region of southern Italy. Ground shaking was additionally felt to the north, in Naples and Campobasso on the Italian mainland, as well as on the island of Malta (south of Sicily). Historic records indicate that ground motion was felt as far away as Montenegro, Albania and the Ionian Islands off the west coast of Greece.

A total of 293 aftershocks were reported between December 28, 1908 and March 31, 1909, but none caused significant damage. The larger aftershocks were concentrated near the cities of Messina and Reggio di Calabria, while a vast number of moderate shocks were clustered around Mileto and Capo Vaticano, both in Calabria. A cluster of aftershocks also occurred near Mount Etna on Sicily, but it is unclear whether these events were related to the 1908 earthquake or were of volcanic origin.

While ground shaking was experienced over a wide area—extending hundreds of kilometers from the epicenter—the area of violent shaking causing building collapse was much smaller. Damage extended over an area of about 1,660 mi^2 (4,300 km^2) (Mulargia and Boschi, 1983), with the geographic extent of the devastated areas more widespread in Calabria than in Sicily. On Sicily, damage was most severe from the northeastern tip of the island to south of Messina. Catania, the other major city along the eastern shores of Sicily located around 53 mi (85 km) from the epicenter, did not suffer any significant damage from the ground shaking (Omori, 1909). In Calabria, the most intense ground shaking was felt from southwest of Scilla to south of Reggio di Calabria.

The worst hit areas were Messina, on the northeast Sicilian coast, and Reggio di Calabria, in the province of Calabria on the Italian mainland. From all accounts, both cities were completely destroyed and reduced to rubble. Ground shaking was so intense in the port area of Messina that the stone paving was permanently displaced in a wave-like pattern (Mulargia and Boschi, 1983). Describing the damage in the city of Messina, Omori (1909) wrote: "The enormity of the destruction of Messina is really beyond one's imagination. All the buildings in the city were, with a very few exceptions, considerably cracked or absolutely reduced to masses of ruin...."

Around ninety percent of buildings in Messina were destroyed (Barbano et al., 2005), with the worst damage in the central and northern parts of the city, which were built on soft soils. The main streets of Via Cavour and Via Garibaldi were inaccessible (Figure 4), as they were covered by rubble and debris up to 16 ft (5 m) thick (Omori, 1909), while streets near the Matagrifone Castle in the center of the city sustained less intense damage. Damage was also reported as less severe in the western part of the city, particularly for structures built on more compact terrain. For example, damage was described as only minor or slight in the areas around the Gonzago Castle.

Figure 4: Rubble along the main street of Via Cavour in Messina, Sicily as a result of the 1908 Messina Earthquake (Source: http://www.grifasi-sicilia.com/messina_terremoto_1908_gbr.html)

Portions of the coast were also lost, especially on the Calabrian side of the Straits of Messina. A submarine telephone cable between the towns of Gallico in the region of Calabria and Gazzi on Sicily was severed in two places and only one segment could be recovered. It has been suggested that the unrecovered segment was likely buried by a submarine landslide (Comerci et al., 2008).

The permanent ground deformation caused by the earthquake was recorded by a geodetic survey. A survey had been completed just a few months before the earthquake and the measurements were repeated immediately after the event to capture the vertical displacement produced by the earthquake (Mulargia and Boschi, 1983). In Messina, subsidence of the ground was measured up to 28 in (70 cm). Fires were also observed in some parts of Messina following the earthquake, which added to the devastation. Unfortunately, the impact of fire loss—separate from ground shaking loss—was not well-documented immediately following the event.

Tsunami Impacts

The devastation caused by the earthquake was amplified by a tsunami that shortly followed. Less than ten minutes after the initial shock, a tsunami impacted the coastlines on either side of the Straits of Messina, striking with waves exceeding 20 ft (6 m) in some locations. The tsunami was a local tsunami, originating in the Straits of Messina and consisting of at least three major waves. From historical records, it was observed that in most locations, the second and third waves were higher than the first.

The tsunami severely impacted a 62-mi (100-km) stretch of coastline in eastern Sicily from Messina to Catania and a 24-mi (38-km) stretch of the Calabrian coastline from north of Villa San Giovanni to Saline Ioniche (Omori, 1909), with the highest run-up or inundation heights along the Straits of Messina (Figure 5). Damage from the tsunami waves was most severe on the Calabrian coast near the villages of Lazzaro and Pellaro, where three powerful waves caused extensive destruction. Between Lazzaro and Pellaro, the force of the water washed away houses and destroyed a railway bridge, removing a 138-ft (42-m) girder (Omori, 1909). The waves also destroyed houses on Sicily's coastline, in Messina near the mouth of the Torrente Portalegni, a small river located south of the harbor, as well as farther south in the village of Schiso and town of Riposto (Omori, 1909). In Messina, the tsunami run-up heights were observed to be approximately 10 ft (3 m) along Vittorio Emanuele Street and near the St. Salvatore fortress in the harbor area. Farther south, near the mouth of the Torrente Portalegni, the run-up heights were observed at over 20 ft (6 m).

Reported damage from the tsunami did not always correlate with the maximum inundation heights and was more closely related to the density of the building stock along the coastline. Heavy damage was incurred north of Messina, where the waves reached a run-up height of 15.4 ft (4.7 m) and the building density was high. Less than 22 mi (35 km) to the south, only moderate damage occurred in Sant'Alessio Siculo, despite the waves reaching a run-up height of up to 38.4 ft (11.7 m). Other tsunami inundation heights were recorded at Giampilieri Marina on the Sicilian coastline, where the waves were reported as high as 23.6 ft (7.2 m), and at Reggio di Calabria on the Calabrian coastline, where tsunami heights reached up to 31.8 ft (9.7 m).

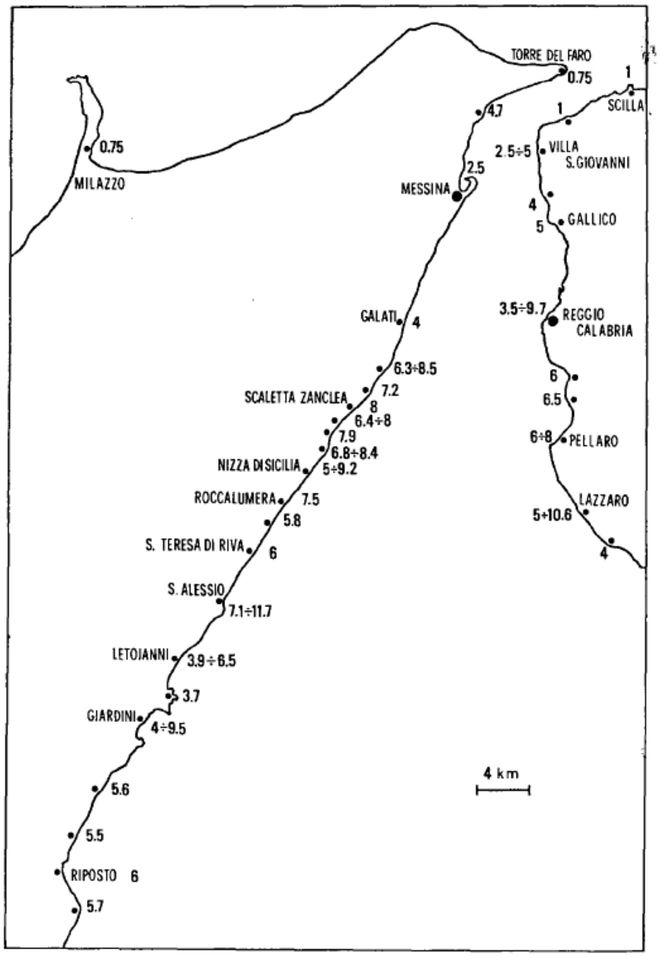

Figure 5: Maximum run-up heights in meters along the Straits of Messina from the tsunami following the 1908 Messina Earthquake (Source: Tinti and Guiliani, 1983)

One hundred years following the 1908 event, the origins of the tsunami are still debated in the scientific community. Uncertainty in the location of both the earthquake and the tsunami has led to competing hypotheses on the tsunami's source. For nearly a century, it was believed that the tsunami was earthquake-induced, resulting from the displacement of the seafloor along the ruptured fault. More recent research has suggested that the tsunami was generated by a seismically triggered submarine landslide (Billi et al., 2008). Billi and others (2008) utilized tsunami travel-time data to infer the origin of the tsunami, proposing that the assumed source location for the tsunami was different from the earthquake's source location. As a result, they postulated that the cause of the tsunami was a submarine landslide on the shelf off Sicily's Ionian Sea coastline, approximately 50 to 62 mi (80 to 100 km) east of Giardini Naxos. However, other research has questioned this hypothesis (e.g., Gerardi and Barbano, 2008), asserting that the tsunami was due to underwater fault movement. The source of the tsunami—from an earthquake, a seismically triggered underwater landslide, or a combination of the two—continues to be debated.

Casualties

Although the precise number of casualties resulting from the Messina Earthquake remains uncertain, historical accounts place the number of fatalities between 60,000 (Baratta, 1910) and over 120,000 (Mercalli, 1909). Across Europe, only the 1755 Lisbon Earthquake is considered to have caused similar levels of fatalities, with estimates ranging from 65,000 to 100,000. Many original documents were lost in the confusion following the 1908 earthquake, making it difficult to assess the accuracy of various estimates. From Omori (1909) and Restifo (1995), it is noted that the populations of the cities of Messina and Reggio di Calabria were 150,000 and 40,000, respectively, at the time of the event. The loss of life in these cities, which sustained the highest casualty levels, was approximately 75,000 in Messina "and the suburbs," and 25,000 in Reggio di Calabria "and other places in Calabria." These estimates indicate that nearly half of Messina's population was killed. From the written and pictorial record, it is clear that the majority of the casualties resulted from the collapse of unreinforced masonry buildings. The tsunami has been estimated to have caused only 2,000 deaths in coastal areas along the eastern shores of Sicily and the Calabria coast (Comerci et al., 2008).

With thousands of bodies trapped in the ruins, Messina became known as "Cittá di Morte" or "City of the Dead." The large number of damaged buildings highlighted the vulnerable nature of the building stock in Messina at the time. The use of poor quality construction materials, often rubble stones, and the widely adopted construction technique known as "a sacco," which used bare stones, poor quality mortar, and delicate stone facades, was blamed for the widespread collapse of many buildings. Buildings constructed with better quality materials or practices were less prone to collapse during the earthquake. For example, two buildings built just before the 1908 earthquake of good quality materials with reinforcing ties were relatively undamaged (Barbano et al., 2005, citing Luiggi, 1909).

THE MESSINA EARTHQUAKE IN 2008

For the 100th anniversary of the 1908 Messina Earthquake, RMS investigated the potential impacts of an earthquake of a similar magnitude striking the Messina Straits region in 2008, examining the tectonic setting, source characteristics, and ground motion of the historic event.

The Straits of Messina

The Straits of Messina lie between the Calabrian region of southern Italy and Sicily, forming a part of the Calabrian Arc, where the African Plate is thrust beneath Calabria, Sicily, and the Tyrrhenian Sea. Oriented approximately north-south with an east-west bend at the northern end, the Straits are bound on either side by a series of normal faults that approximately follow the north-south and northeast-southwest trending Sicilian and Calabrian coastlines. Normal faulting, in which one side of the fault is displaced downward relative to the other, is the dominant type of faulting in the region around the Straits, with many of the large historical earthquakes associated with a normal faulting mechanism.

The region around the Straits of Messina has experienced some of Italy's most destructive earthquakes. The January 9 and 11, 1693 earthquakes were centered in southeastern Sicily, devastating Catania, Noto, Ragusa, Siracusa, and other towns and resulting in at least 60,000 fatalities. The February 5–March 28, 1783 earthquake sequence in Calabria, with up to 50,000 fatalities, was an event that caused severe damage to both Messina and Reggio di Calabria. These earthquakes, measuring between M5.7 and M7.0, have been blamed for the poor performance of many older buildings in the worst-affected northern part of Messina during the 1908 earthquake due to inadequate and hasty repairs (Barbano et al., 2005, citing Baratta, 1910).

Since 1908, Messina and Reggio di Calabria have been affected by smaller earthquakes in the Straits of Messina, with two events in 1909, and one event each in 1910 and 1975. The most significant of these earthquakes was the January 16, 1975 event, measuring M5.4 and causing heavy damage to just three buildings in Messina.

Modeling the Messina Earthquake

As the Messina Earthquake occurred in the early days of modern seismology, there is uncertainty in the magnitude of the event, with estimates varying between M6.7 to M7.2 based on the recorded seismograms. The scientific community agrees, however, that the event occurred at a relatively shallow depth (< 6 mi or 10 km), with reconstructions placing the epicenter within the Straits of Messina.

Although it is certain that the 1908 earthquake occurred along a normal fault, there is scientific debate as to the exact fault source and the seismotectonic model. One study on the seismic moment, fault length, and slip distribution suggests that the blind fault underlying the Straits of Messina ruptured its entire length up to the Ganzirri Peninsula, which is the Sicilian northern end of the Straits (Pino et al., 2000). The study by Pino and others (2000) further concludes that the maximum fault length is at most approximately 28 mi (45 km), and the fault's rupture unilaterally propagated in a northward direction.

Due to the uncertainty in the 1908 earthquake's source and propagation, historic intensity maps can be used to supplement the understanding of the earthquake's ground motion. In particular, the severity of damage in Messina and Reggio di Calabria led researchers to infer a maximum epicentral intensity of XI on the Mercalli-Cancani-Sieberg (MCS) scale, a commonly used intensity scale in Italy in the early 20th century and a predecessor to the European Macroseismic Scale (EMS). Later studies found the overall effects of the earthquake consistent with intensity X–XI on the EMS (Barbano et al, 2005).

Reconstructions using the MCS scale place the highest intensities in Messina and Reggio di Calabria, on either side of the Straits of Messina, although this zone was more extensive on the Calabrian side (Figure 6). Soon after the earthquake, researchers (e.g., Baratta, 1910) produced isoseismal maps that infer the intensity felt in the surrounding areas. Interpolating from an isoseismal map, intensities are inferred across the impacted region. All of Sicily felt the ground motion, with most of eastern Sicily experiencing intensities greater than VI on the MCS scale, although intensities in the western part of Sicily were much lower. Palermo, located approximately 124 mi (200 km) from the epicenter, experienced intensities between IV and V. In Calabria, intensities were generally above VI over a region of around 93 mi (150 km); in Catanzaro and Cosenza, intensities ranged between V and VI on the MCS scale.

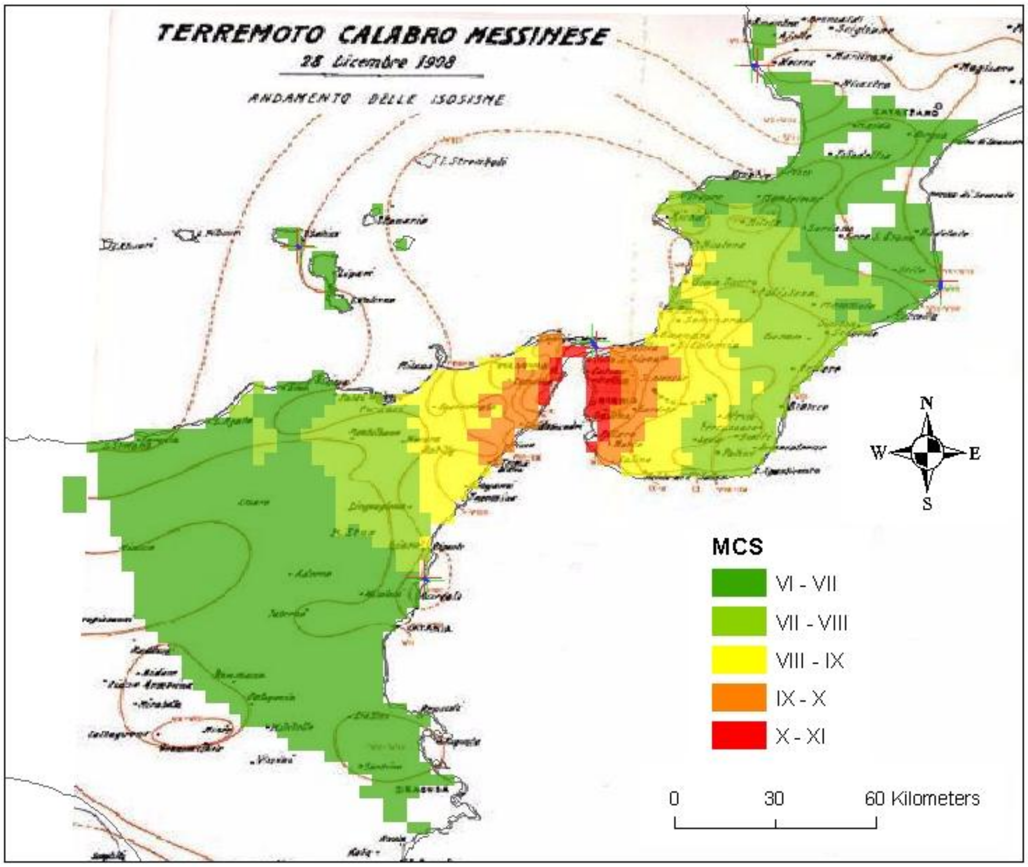

Figure 6: Modeled intensity map of the 1908 Messina Earthquake, based on the Mercalli-Cancani-Sieberg (MCS) and overlaid on the historic isoseismal map (shown in Figure 2)

Exposure at Risk

If the 1908 Messina Earthquake were to recur in 2008, the damage-inducing ground motion would be felt across Sicily and southern Italy—primarily in the Calabrian region. Across this area, RMS estimates the value of the building stock and its contents at over €242 billion (US$317 billion) for residential, commercial, and industrial properties. The residential exposure, which includes single-family and multi-family dwellings, comprises the majority of the exposure at risk, with an estimated value of approximately €151 billion (Table 1). These values are based on capital stock estimates derived from various sources, such as the Organization for Economic Cooperation and Development (OECD), as well as RMS proprietary data.

The 1908 earthquake spurred the adoption of the first seismic design regulations in Italy in 1909, which were issued by Royal Decree and included regulations for the entire Calabria region, as well as a small part of Messina Province in the northeastern extremities of Sicily. In the updates to the zonation map of the Italian building code since 1909, with the most recent occurring in 2003, the areas earmarked by the 1909 Royal Decree have always been in the zone with highest seismic coefficient, indicating the highest seismic risk area of the country. Therefore, the structures in the region—in particular those that were rebuilt following the collapse of numerous buildings in the 1908 earthquake—have been designed with some seismic resistance.

In addition, close to 2.8 million people live in this region, with the present-day populations of the cities of Messina and Reggio di Calabria at 245,000 and 185,000, respectively. One hundred years since 1908, the population of Messina is over 60% higher, with the population of Reggio di Calabria over 4.5 times higher than it was in 1908.

Table 1. Property and people at risk from a repeat of the 1908 Messina Earthquake

Region	**Residential Property (in € billions)**	**Commercial and Industrial Property (in € billions)**	**Population (in thousands)**
Sicily	€115.0	€67.0	1,900
Mainland Italy	€36.0	€24.5	880
Total	**€151.0**	**€91.5**	**2,780**

Property Losses

Based on an analysis utilizing the RMS® Europe Earthquake Model, RMS estimates that if the 1908 Messina Earthquake were to recur in 2008, it would be a major catastrophe for the region, triggering loss amplification and adding to the cost of reconstruction. Economic damage in 1908 was significant, as Messina was an important Mediterranean harbor. Losses have been estimated at €88 million (US$116 million) at the time (Geological Society of London, 2001).

In 2008, considering the exposure at risk to a repeat of the 1908 earthquake, as well as its vulnerability to earthquake ground shaking, property losses are estimated at over €45 billion (US$58.7 billion). These losses are based on a modeled scenario with a moment magnitude of 7.2 and include damage to buildings, their contents, and additional costs due to business interruption and temporary accommodations while homes are rebuilt. The impact of a tsunami, if generated, would contribute additional loss to properties along the coastline. The vulnerability of the building stock was based on the distribution of various types of structures within the region. For example, a building's vulnerability is a function of its construction material (e.g., unreinforced masonry, reinforced concrete frame, etc.), its height (low-rise, medium-rise, or high-rise), and its period of construction (e.g., pre-1919, 1919-1980, 1981-1996, or post-1996). Consideration was taken for the differences in building stock between the urban and rural areas, as there are more low-rise unreinforced masonry buildings in rural regions and more medium-rise reinforced concrete apartment buildings in the urban regions of Messina and Reggio di Calabria.

Casualty Losses

In 1908, the Messina Earthquake resulted in a large loss of life due to the collapse of unreinforced masonry buildings, as described by Barbano and others (2005). Considering the loss of life in historic earthquakes in Sicily and Calabria over the last 370 years—in 1638, 1693, 1783, and 1908—it is important to model the potential for fatalities and injuries in this region if the 1908 earthquake occurred today.

In this analysis, the event is assumed to occur at the same time as the 1908 earthquake, at 5:20 a.m. local time. At this time, the overwhelming majority of individuals would be asleep at home, with the remaining population outdoors, in other buildings, in their cars in traffic or outside the affected region. Earthquake intensities as illustrated in Figure 6, and data on the building stock were utilized to derive the distribution of the population within various types of structures, subject to various levels of ground shaking.

Probabilities of collapse, as a function of seismic intensity, were assigned for each class of structure. Historical damage information was used to validate the collapse probabilities, including damage surveys from the 1976 Friuli and the 1980 Irpinia earthquakes, two of the most lethal events in recent history, as well as the 1997 Umbria-Marche and the 2002 Molise earthquakes. Specifically, damage statistics on the number of collapsed buildings and the resulting human casualties were obtained from various publications (e.g., Ambraseys, 1976; CNEN-ENEL, 1976; Benedetti and Vitiello, 1979; Alexander, 1982; Braga et al., 1982). More recent research on the probability of collapse of Italian buildings in earthquakes was also considered in this assessment (e.g., Rota et al., 2008; Goretti et al., 2008).

Buildings in the Messina and Reggio di Calabria regions are expected to perform somewhat better than their counterparts in Friuli and Irpinia, primarily due to the building code provisions. In the impacted region, buildings are within the highest seismic zone of the Italian building code (and have been since 1909), while the buildings impacted by the the Friuli and Irpinia earthquakes were designed for gravity loads (i.e., non-seismic zone of the Italian building code) at the time the respective events took place. In addition, a large portion of Messina was destroyed during World War II and then reconstructed, resulting in Messina being called "the city without memory" due to its lack of old and historic buildings.

Given collapse probabilities, the probabilities of death, serious injury or minor injury in each structural type were derived from various sources (e.g., Coburn et al., 1992), as well as the detailed studies following the 1980 Irpinia Earthquake (de Bruycker et al., 1983; de Bruycker et al., 1985). As a result, RMS estimates that if the 1908 Messina Earthquake recurred in 2008, the loss of life would be around 17,000 people, with an additional 24,000 serious injuries and 22,000 minor injuries. Approximately 2.5% of Messina's present-day population and 3.1% of Reggio di Calabria's population may perish in such an event.

Casualty figures would also be impacted by the subsequent tsunami, if such an event was to occur. In order to ascertain the proportion of the population impacted by a tsunami of similar size to the one following the 1908 earthquake, tsunami run-up heights and the extent of inundation was reconstructed from various sources (primarily Tinti and Giuliani, 1983, citing Platania, 1909 and Omori, 1909). As illustrated in Figure 7, modeled run-up heights are consistent with those shown in Figure 5. RMS estimates that presently around 75,000 people live within the tsunami inundation zone, with less than 45% of these individuals directly affected by the tsunami wave (as many live on the higher floors of multi-story buildings). In the densely built-up urban areas (e.g., Messina and Reggio di Calabria), it is assumed that the tsunami's run-up height and impact energy would attenuate rapidly, resulting in up to 2,000 casualties, with another 3,000 individuals sustaining serious or minor injuries.

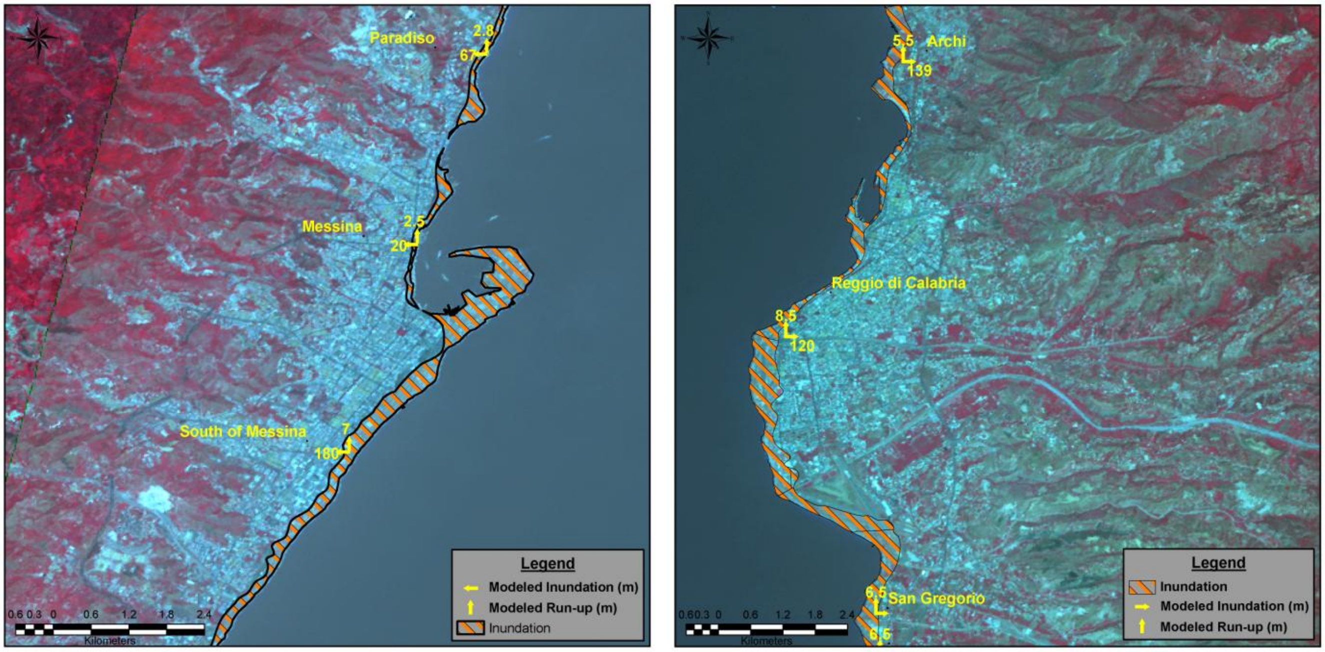

Figure 7: Reconstruction of tsunami run-up and inundation heights (in meters) for the coastlines around the cities of Messina (left) and Reggio di Calabria (right)

EARTHQUAKE RISK AND INSURANCE IN ITALY

With Italy's long record of damaging earthquakes stretching back over 2,000 years, earthquakes represent the most hazardous natural peril to which the country is exposed. Despite large levels of property and casualty loss due to earthquakes in recent history, such as in Friuli in 1976 and Irpinia in 1980, losses to the insurance market have been relatively small due to a lack of market penetration for earthquake coverage and property insurance in general. Insurance against natural catastrophe perils is not compulsory in Italy. With no obligation for insurers to cover earthquake risk in conjunction with little demand from the general population, earthquake insurance is not widely sold. Where it is available, the overwhelming majority of insured properties are commercial or industrial risks. As a consequence, very few homes in Italy would have adequate insurance to cover losses in the event of a major earthquake.

With many residents unable to pay for major repair work following an earthquake, they would be obliged to depend upon government assistance. The low insurance penetration among commercial and industrial risks (an estimated 30%) also means that local businesses could be exposed to direct financial losses, potentially becoming unable to function. Local jobs would be lost, prolonging the impact on the local economy and impairing the ability of a region to recover. The insurance industry can provide the loss-adjusting expertise and the liquidity needed to accelerate reconstruction and restore a community's livelihood. A strong earthquake insurance market can also provide the opportunity to share risk with the global reinsurance market, providing global support to help fund losses from a local catastrophe.

However, earthquake insurance as part of a comprehensive risk management strategy also requires the financial quantification of potential outcomes. How likely is it that a whole city or a series of towns and cities might experience destruction and losses in the same large earthquake? What would be the levels of damage and financial loss? To answer such questions, a fully probabilistic catastrophe loss model is required. Catastrophe models perform at their optimum when details on a building's physical and geographic characteristics are known. A procedure to capture and transfer this information is also an important part of any risk management strategy. Output from a model such as the RMS® Europe Earthquake Model can be used to quantify the probability of exceeding different levels of loss. It can also determine the technical price for risk, for either a single property or a portfolio of properties across multiple locations.

The Future: Natural Catastrophe Risk and Solvency II

Insurance firms that operate in the European Union (EU) will soon be subject to a new set of European insurance regulations, known as Solvency II. As of late 2008, it is anticipated that the new requirements will be fully implemented in 2013. However, many of the industry leaders are taking steps to understand how to best be prepared for the updated reporting requirements. Under Solvency II, companies will be required on annual basis to hold sufficient capital to ensure that their probability of technical insolvency remains less than 1-in-200. Though losses from earthquakes and other natural hazard events are not the only cause for insolvency, the industry is looking very closely at catastrophe risk, as losses from natural catastrophe events could drive technical insolvency rates at the 1-in-200 year return period.

Solvency II provides a standard model to evaluate capital requirements, but non-life insurance companies, which intend to use in-house models to best depict the unique structures and relationships of the company's business, will need to familiarize themselves with probabilistic catastrophe modeling. In addition, the benefits from embracing catastrophe model risk metrics will permeate in other business functions, and strengthen risk management at multiple levels. For example, in managing earthquake risk accumulations, seismic risk is greatest in central and southern Italy (Figure 8), although most of the country faces at least a moderate degree of risk. Most insurance market exposures are concentrated in northern Italy in less hazardous regions, but accumulations of risk can occur. Detailed modeling of catastrophe exposures can assist in the process of actively managing an insurance portfolio. Insurance companies that control their accumulations and maximize diversification will be at a distinct advantage in the event of an earthquake on the scale of the 1908 Messina Earthquake.

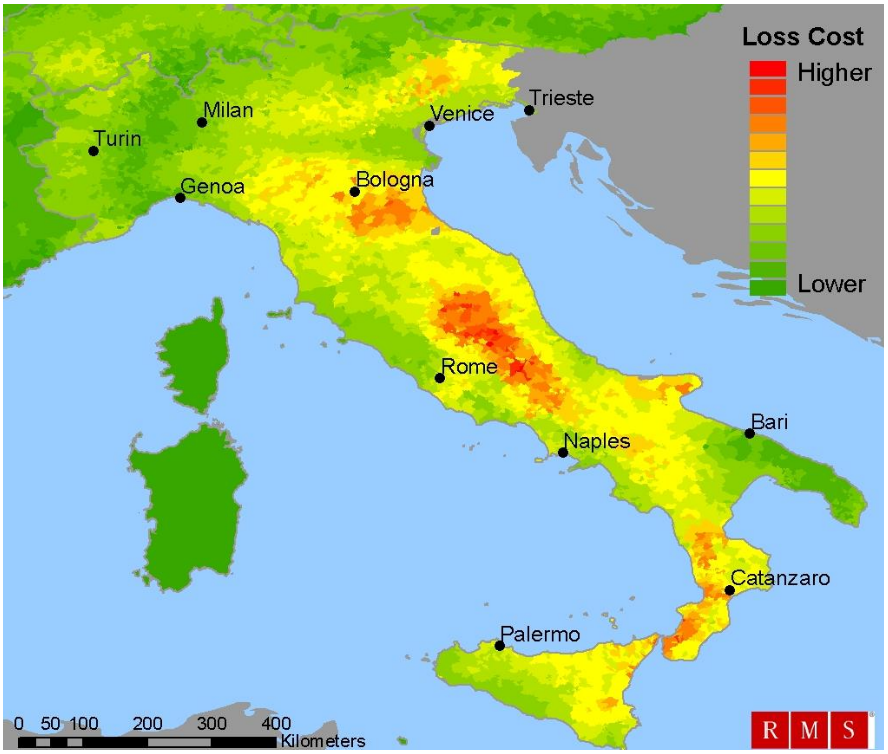

Figure 8: Earthquake risk in Italy as modeled by the RMS® Europe Earthquake Model

In Europe in 2008, there is growing pressure from regulators to demonstrate comprehensive risk management strategies. In a climate of increasing regulatory focus on solvency and capital adequacy requirements through EU legislation, such as the proposed Solvency II, it is becoming increasingly important that insurance companies actively manage their portfolio risk. Catastrophe loss models, such as the RMS® Europe Earthquake Model and other RMS models, can help quantify the risk from natural perils at a range of return periods important for risk management.

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