L'Aquila earthquake: one year on

When a powerful earthquake struck Italy's Abruzzo region last year, UK Earth scientists were on the scene quickly to help authorities understand what had happened. Richard Phillips describes what they found.

Max Wilkinson

Richard Phillips

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At 3.32am on 6 April 2009, a magnitude Mw6.3 earthquake hit the mountainous region of Abruzzo in central Italy. An event that lasted just a few seconds would result in a final death toll of 307, with 70,000 people made homeless and much of the historic medieval town of L'Aquila and the villages around it damaged or destroyed. In economic terms, this brief event cost Italy an estimated €4 billion.

Unfortunately, the people of Italy are no strangers to such natural hazards; since the mid-14th century it is estimated that there have been around 300,000 earthquake-related fatalities throughout the country. In Abruzzo alone, earthquakes have killed up to 40,000 people since an event in 1703 that razed L'Aquila, followed by a devastating quake near Avezzano in 1915. Despite these distressing figures, large magnitude earthquakes are relatively infrequent in Italy. Given this, what can Italian civil authorities do to reduce the long-term earthquake risk in their country, and how can they limit the cost of reconstruction? To answer these questions, it is useful to examine what happened in L'Aquila.

Initial response

Five hours after the main earthquake, a group of UK scientists began preparing to head out to Abruzzo. In close collaboration with Italian scientists, we aimed to help find the ground rupture produced by the earthquake and to monitor any subsequent change in ground deformation using advanced laser technology.

Coordination of the relief effort was impressive and rapid. Within a short time, the authorities had deployed 12,000 rescue and support workers from across the country. 'Tent cities' surrounded the main towns, emergency plans for the construction of new housing were rapidly initiated and, across the region, hundreds of geologists and geophysicists were working to answer the questions of what, why and where next?

Watching such awful events on television does not quite prepare one for the reality of the situation. Although the local people were generally calm and were coping as best they could, the tension and distress were palpable. I was particularly struck by a question asked of me by a member of staff at a hotel where I had previously stayed. Seeing us at work, she approached and asked directly, 'Why didn't you tell us? Why L'Aquila?' These were important questions, and ones I could not easily answer. It may be that precise earthquake prediction is simply not possible, but why did the earthquake happen here and how can we mitigate the effects of future events?

Why L'Aquila?

The Abruzzo region lies at the centre of the Apennine mountain chain. This jagged spine of Italy runs from the northwest down to Calabria in the south. The Apennines exist due to the continued collision between the Eurasian and African plates. Over the last two million years though, the Apennines have essentially been pulled apart by a set of complex tectonic events. The ongoing result is a system of active faults running parallel to the range and which are responsible for the region's earthquakes. Many of these events are recorded in prominent changes in land level along fault lines. These linear features, called bedrock scarps, are common around L'Aquila signifying a long history of seismic activity: since the 14th century, the town has been hit by eight major events. The worst occurred in 1703, killing an estimated 5000 people and devastating the town.

Few scientists were surprised by such an event in this region, but some were puzzled by the location of the ground rupture. None of the obvious bedrock scarps appeared to have been affected and much attention was placed on scouring local faults for the signature of a fresh earthquake rupture. With the help of satellite remote sensing provided by the University of Oxford and the Istituto Nazionale di Geofisica e Vulcanologia, attention returned to a fault near the village of Paganica, east of L'Aquila.

Initially, surface evidence of the earthquake was limited to ground cracks, sometimes just a few millimetres wide that snaked through the village and across fields. Following more detailed investigation, geologists discovered ground ruptures displaying up to 15cm of vertical movement. Despite the lack of dramatic surface rupture, this fault was responsible for the devastation in surrounding towns, of which L'Aquila and the village of Onna fared the worst.

One year on

What became evident following the L'Aquila event is that the earthquake ruptured almost entirely through gravel-rich soil. The nearby village of Onna was worst hit because it is built on this soft subsurface, which amplifies ground shaking. Using laser technology, termed LiDAR, or Light Detection and Ranging, the UK consortium was able to periodically monitor the rupture's development over the four months following the event. Following formation of the original rupture, a further 1.5cm of vertical movement was recorded over 124 days after the earthquake.

This small displacement may seem inconsequential, but it is enough to concern engineers. This was exemplified by the decision to recommission a ruptured 40-inch-diameter high-pressure water pipe, supplying drinking water to the L'Aquila valley. Following the earthquake, continued movement across the fault resulted in the pipe rupturing for a second time. Such events clearly hamper efforts to mitigate further damage during any relief effort.

Away from the fault, however, reconstruction could continue unhindered by continued ground movement. Within eight months, 4500 new dwellings had been designed, planned and built on eight sites, providing accommodation for 12,000 displaced people. Each dwelling followed strict building regulations to ensure that they would withstand similar earthquakes. These regulations were strongly enforced because, despite a building code in place since 1981, new buildings such as the main hospital and a university housing block had been severely damaged during the earthquake.

Should we rely on a similar post-event relief effort next time? Clearly, the answer has to be no; the economic and human cost is too high and could be significantly reduced. Governments need to ensure that they employ detailed long-term seismic hazard assessments before defining, and enforcing, strict building codes. And for those who live in tectonically active regions a comprehensive education programme is needed, to make sure that the public is aware and prepared for future hazards. Such assessment and mitigation plans are already in place in Italy, Japan and California; we should ensure that poorer countries, such as Haiti, receive the support they need to do the same.

MORE INFORMATION

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The UK LiDAR survey team included: Dr Ken McCaffrey and Max Wilkinson (University of Durham), Dr Gerald Roberts (UCL-Birkbeck), Professor Patience Cowie (University of Edinburgh) and Dr Richard Phillips (University of Leeds).

FURTHER READING

Walters, RJ, Elliott, JR, D'Agostino, N, England, PC, Hunstad, I, Jackson, JA, Parsons, B, Phillips, RJ, Roberts, G (2009). The 2009 L'Aquila earthquake (central Italy): a source mechanism and implications for seismic hazard, *Geophysical Research Letters*, 36, doi:10.1029/2009GL039337.