

Putting science on trial

Warner Marzocchi warns that the decision to sentence seven earthquake experts to six years in prison during the recent trial in L'Aquila could set a dangerous precedent for science

“Do not judge human action by what happens,” wrote the Swiss mathematician and pioneer of probability theory Jacob Bernoulli at the beginning of the 18th century. What Bernoulli meant was that someone who takes a decision under uncertainty would not necessarily always take the same decision after the event. However, if this basic concept is not withheld then scientists, decision makers – and indeed anybody involved in public safety – could end up being prosecuted after the occurrence of an unlikely event.

That is exactly what seems to have happened during a recent trial in Italy. On 22 October seven experts who attended a Major Risk Committee (MRC) meeting were sentenced to six years in prison on charges of manslaughter for underestimating the risk before the devastating 6.3-magnitude earthquake that struck the hillside city of L'Aquila on 6 April 2009, which caused more than 300 deaths. The people prosecuted were: Franco Barberi, a volcanologist at the University of Rome; Enzo Boschi, former president of the Istituto Nazionale di Geofisica e Vulcanologia (INGV); Gian Michele Calvi, a seismic engineer at the University of Pavia; Claudio Eva, a seismologist at the University of Genova; Mauro Dolce and Bernardo De Bernardinis, both seismic engineers at Italy's Civil Protection Department; and Giulio Selvaggi, a seismologist at the INGV.

This draconian sentence, which is likely to be appealed, has raised widespread concern and shocked the scientific community to the core. The trial and the verdict represent an extremely worrying precedent and mean that any scientist now offering their services in the interests of public safety will have to consider what they say very carefully indeed.

Predicting the unpredictable

The tragic event on 6 April 2009 followed a sequence of seismic events that started at the beginning of the year, with the largest shock – a 4.2-magnitude earthquake – occurring on 30 March. A day later, the seven experts met in L'Aquila and two of them then gave a press conference that prosecutors said sent



Devastated Heavy damage in the village of Onna, near L'Aquila in Italy, caused by the April 2009 earthquake.

an overly reassuring message. The minutes of the meeting, which were released after the quake, contained three main conclusions: that earthquakes are not predictable in a deterministic sense; that the L'Aquila region has the highest seismic hazard in Italy; and that the occurrence of a large earthquake in the short term was unlikely.

The need for the MRC meeting arose from the release of contradictory information from local authorities and from the apparent anxiety of the public generated by some earthquake predictions made in March 2009 by Giampaolo Giuliani, a technician at the National Institute of Nuclear Physics in Gran Sasso, who had used his own personal method based on radon measurements. It is common knowledge amongst seismologists, however, that radon is not a reliable earthquake precursor – indeed, some of his predictions turned out to be false alarms, and there is no proof that he actually predicted a large earthquake.

After the earthquake, the members who participated in the MRC meeting were charged with manslaughter by Fabio Picuti, the L'Aquila prosecutor, for having provided an inadequate risk assessment that led to scientifically incorrect messages being given to the public. The trial eventually ended after 13 months on 22 October with Judge Marco Billi handing out their six-year sentence at a court in L'Aquila.

Understanding risk

Both the accusation and verdict leave me very confused. Prosecutors repeatedly claimed that the trial was not a matter of science. Yet, during the trial several scien-

tists were called to challenge statements made by the experts. Some of them – in opposition to what is generally believed by seismologists – disputed the validity of the probabilistic seismic hazard analysis, which quantifies the chances of exceeding different ground motion levels at different sites, taking into account all possible sources and all known uncertainties. This analysis is standard procedure used in many countries to define building regulations and had in fact been used to identify the L'Aquila region as one at risk.

Another scientist at the trial alleged that the seismic sequence could be a clear sign of an impending large earthquake. Yet most seismologists agree that it is not possible to identify *a priori* a seismic sequence that anticipates a large shock with respect to the many other seismic sequences that do not end with a big earthquake. In addition, the prosecutor, judge and lawyers discussed in court the results and reliability of different earthquake occurrence models. Their naive, if not totally incorrect, interpretation of scientific results would have bewildered any scientist.

Similarly, the prosecutor talked about “negligence” and “underestimated risk”, implying that he actually knew what the real risk was and what was the best practice to adopt in these circumstances. The accusation implicitly follows this logical fallacy: “if scientists say that an event is unlikely, but this event actually happens, this means that the scientists are wrong”.

So was a mistake made at the March 2009 MRC meeting? This is a very tricky question, and we have to put the situation in

context. During a minor seismic sequence, the daily probability of a damaging event increases, but it remains almost always much below 1% (an unlikely event). Before 31 March 2009, in Italy and in many other countries, there were no protocols for providing scientifically based advice and communicating risk to an affected population. It was an issue that rarely received attention in the seismological community.

It is not surprising, therefore, that the MRC meeting was brief and the conclusions apparently trivial (even though substantially correct) and largely foreseeable in advance. Seismologists and decision-makers learned a great deal from the L'Aquila event, but I think it is unfair to use – as the prosecutor did – what we have learned *after* the event to accuse people about what happened before it took place. We have to be aware that this will happen again in the future. The next natural disaster is also likely to teach us something new that we do not know now. But can it be right to use what we will learn from that to accuse scientists for what they know (or don't know) now?

Wider impact

An international commission was formed after the L'Aquila earthquake that was led by Thomas Jordan, director of the Southern

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California Earthquake Center, which I was also a member of. Beyond underlining once more that our best defence against earthquakes is to construct buildings according to a sound seismic building code, the commission emphasized the need to establish transparent and objective decision-making protocols to manage the seismic hazard in the short term, and the vital importance of effective communication.

Sadly, the result of this trial will dramatically slow down any progress in this direction because scientists will now want to have legal protection before making any sort of public statement. Indeed, it was for this reason that the new president of the MRC – the former CERN director-general,

Luciano Maiani – along with two other members of the MRC presidential office, Giuseppe Zamberletti and Mauro Rosi, resigned immediately after the verdict.

This trial is having – and will continue to have – a huge impact on seismologists and decision-makers, who will be afraid to say or to do anything. I expect that this verdict may also affect many other scientific fields where important decisions have to be made under large scientific uncertainty.

I hope that these fears will not be realized, and that efforts to inform the public about earthquake hazards and actions that can reduce the risk may be resumed. In the meantime, citizens and decision-makers need to be better educated about the kind of scientific information that scientists can provide, its relative uncertainty, and its limitations. In particular, it should be recognized by all that unlikely events will always occur – not just in seismology but also in many other sciences where hazards are involved.



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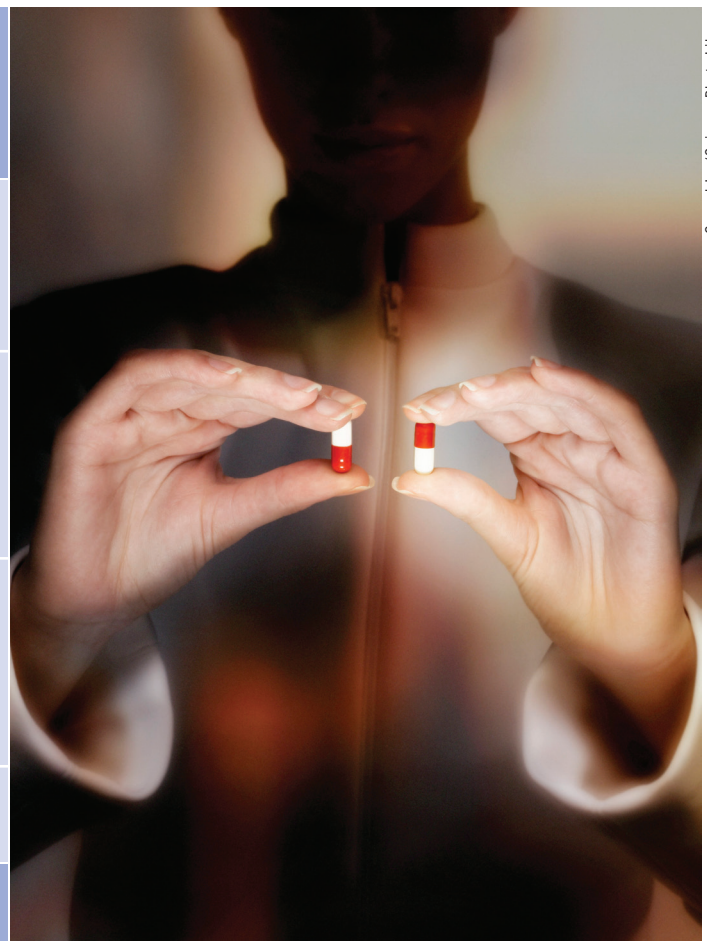
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