

New initiatives for earthquake risk reduction

Planning for the threat of disaster

by Roger Musson, *Edinburgh*

Historical evidence from all centuries shows that earthquakes have been a constant problem as long as mankind has built houses to live in. Seismology, the study of earthquakes, has therefore always had as a main goal not just understanding the processes that cause earthquakes, but finding some way to reduce the disastrous impact of earthquakes on society. It is recognised today that the key to earthquake risk reduction involves three key communities in addition to the earth scientists:

engineers, planners and insurers. Engineers design safer buildings to resist earthquake shaking; planners prepare for the likely effects of earthquakes on existing structures, so that an efficient response can be mounted when an earthquake strikes; and insurers are involved in financing reconstruction and encouraging safety measures through lower premiums.

All three need accurate advice from the earth scientist on what the level of earthquake hazard really is. The engineer

wants to build safely, yet avoid expensive over-design. The planner has to know what sort of scenario to plan for. And the insurer needs to cost his investments accurately to maintain economic sustainability. So getting an accurate representation of the earthquake hazard is important to many people.

Quantitative studies of earthquake hazard really began in the late 1960s, and BGS (then the Institute of Geological Sciences) was one of the early adopters in the UK of these techniques, and was already supplying advice to the engineering community in the UK and overseas on earthquake hazard parameters for design purposes as early as the mid 1970s. It was during the 1980s that a huge increase in seismic hazard methods occurred world-wide, but this was largely focused on the needs of the engineers to find safe design values for new structures, especially nuclear facilities.

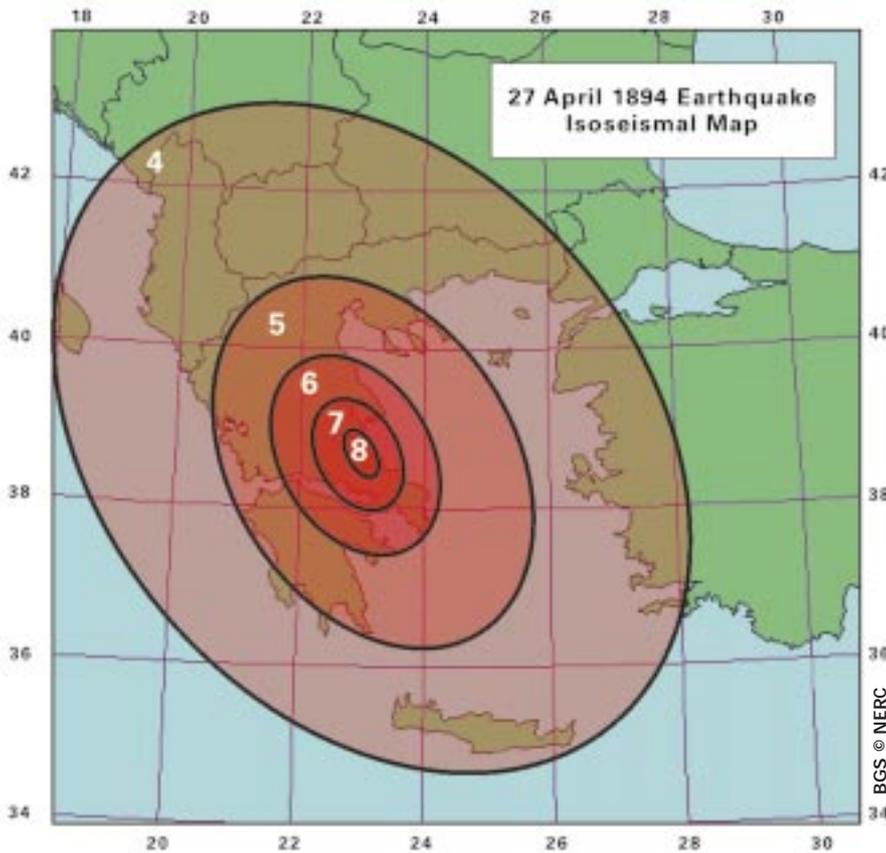
But now it is being realised increasingly that the needs of the planners and insurers have been overlooked. Whereas the engineer is interested in physical measures of ground movement, such as peak ground acceleration, the planner and insurer are more interested in consequences in terms of earthquake effects.

And here another branch of seismology comes into play. As long ago as the 19th century it was realised that the distribution of effects of an earthquake could usefully be mapped by applying a numerical classification of different earthquake strengths. This classification is known as an intensity scale (similar to the Beaufort Wind Scale) and represents different strengths of shaking (chiefly as revealed by different degrees of damage) by a series of integers. The study of earthquake intensity is known as macroseismology. Early intensity scales were over-simplistic and did not accurately reflect the real pattern of earthquake damage distributions. In 1988, a resolution was passed by the European Seismological Commission to revise the best of the scales existing at that time and bring it up to date to reflect modern experience. The resulting international project, which was supported at all stages by the BGS, ran chiefly from 1990 to 1992, and after a six-year testing period the final version of the new scale, named the



Russ Evans, BGS © NERC

Damage at Gölçük, Turkey, from the earthquake of 17 August 1999. The high death toll was largely due to inadequate civil defence measures.



Isoseismal (intensity contour) map of a historical earthquake in Greece. Study of such maps can be used to estimate the likely effects of future earthquakes in the same area.

European Macroseismic Scale, was published in 1998.

The importance of this is that the new scale recognises the probabilistic nature of earthquake damage distributions in a way that older scales (such as the Modified Mercalli Scale) do not. It is therefore a powerful tool for estimating the effects of future earthquakes. By examining the pattern of effects of past earthquakes, one can build up a picture of the relationship between the strength of earthquake shaking, size (magnitude) of earthquake, and distance from the epicentre — this is known as an attenuation law. Quite simply, it records the extent to which buildings were damaged as a function of distance and earthquake parameters. To perform an assessment of the risk in the future, it is only necessary to replay the attenuation in the other direction. In other words, if one knows that there is a danger of a certain type of earthquake occurring, one can estimate at any distance what the

intensity should be, and from that, what the damage distribution is likely to be.

What makes this technique especially adaptable is that the new intensity scale provides a framework for comparing the resistance of buildings of different types to earthquake shaking. So, from examining the damage pattern to old houses in a town during a historical earthquake, one can estimate what would be the effect of a similar earthquake on new construction in the same town if the earthquake was to recur. There are some extra complexities - the spatial pattern of earthquake shaking is also affected by properties of the earthquake-generating fault, and further complicated by the local geology; but both these can be accounted for in calculations.

By combining estimates of the probable damage with the probabilities of a large earthquake occurring, it is possible to come up with quantitative assessments of the earthquake risk to different communities in terms of the probability of

different levels of loss. Also, when an earthquake has just occurred, it is possible to use such techniques to come up with a quick assessment of how badly different communities are likely to have been struck, which is of immediate value in planning a disaster response.

The earthquake threat will not go away in the 21st century; it is very clear that long term world seismicity rates are stable. We can expect the same number of earthquakes in the 21st century as in the 20th, and in much the same places. The question is will we have more or fewer disasters? Though the seismicity may stay the same, the size and number of cities is increasing dramatically. There are more buildings there to be destroyed than ever before. The potential for more disasters to hit the headlines is there. But so is the potential to have fewer disasters if communities are protected by adequate civil defence measures. Through the development of new advances in macroseismology and seismic hazard and risk assessment, in international projects and commercial customer responses, the BGS is actively involved in promoting earthquake risk reduction in the century ahead.

In the event of an earthquake in the UK with an epicentre on land and a magnitude above 3 ML, or an offshore event large enough to be widely felt, or any other event particularly notable in its effects, BGS conducts a macroseismic survey. This usually takes the form of a questionnaire published in local newspapers, which people can fill in and send back to us. We are always happy to receive reports of earthquakes being felt in the UK even for small tremors for which formal surveys are not conducted.

Local macroseismic surveys make good school projects. If an earthquake is strongly felt in your local area, we would be interested in co-operating with schools wishing to make a class project out of plotting the local effects of the earthquake.

Earthquake questionnaires can be obtained from our website at:
<http://www.gsrq.nmh.ac.uk/hazard/quest.htm>

Or you can write to us at this FREEPOST address:

British Geological Survey, Global Seismology Research Group, FREEPOST, Edinburgh, EH9 0LX, UK