

Earthquake Deaths in the Third World: Preventable or Inevitable?

Laura Soul

“Severe Earthquake Hits Los Angeles; at least 30 killed; freeways collapse” was the front page headline of the *New York Times* on 18th January, 1994. In its place on 27th December, 2003 was “Powerful Earthquake in Iran Kills Thousands”. In the Iranian city of Bam, where the earthquake hit, the final death toll was more than 43,000 out of a population of 150,000, and around 80% of the city was razed to the ground (1). In contrast, the Northridge earthquake in Los Angeles killed 72 out of a population of more than 3 million (2,3). Although the damage to buildings cost billions to repair (3), the human cost was nothing compared to that in Bam, although the Northridge earthquake was of a lower magnitude (4). Similar discrepancies between developed and developing nations can be found all over the world, but what is behind them? Is it just the difference in wealth, or are there deeper underlying causes? Most importantly, can anything be done to keep the death toll down?

The cause of the Los Angeles earthquake was slipping on a ‘blind thrust fault’—one that doesn’t reach the Earth’s surface (5). No one was aware that the fault was there, but low magnitude earthquakes are frequent in the Los Angeles area (6) and higher magnitude ones occur every few years. The cause of the Bam earthquake was the same, but big earthquakes are less common in that part of the world. Isolated cities in the Middle East commonly sit next to faults without realising the danger. Indeed, the regions around faults are often some of the few habitable places in harsh

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desert environments. The faults raise the water table behind them, providing a source of fresh water (7). Structures called *qanats* are built to bring water to nearby settlements.

The majority of buildings in Bam were made of sun baked clay bricks (1). In an earthquake, these buildings are extremely unstable and crumble into mud. This contributed to the main cause of death in Bam: crushing or suffocation when mud roofs fell in (1). There had been some attempt at building earthquake safe buildings in Bam, but even public buildings—including hospitals, fire and police stations, the university and many schools—were destroyed during the earthquake (1). This was mainly due to a lack of building materials, as well as construction workers misunderstanding the guidelines (8).

In contrast, all new buildings in Los Angeles County must adhere to earthquake safety guidelines. These codes are well enforced: new buildings are inspected and if old buildings are not up to standard, they must either be adapted to the code or knocked down. Iran does have a ‘Code of Practice for Seismic Resistant Design of Buildings’ (8), but this was introduced long after many of the buildings in Bam were constructed (8). Prior to the earthquake, the regulations were poorly enforced because people just

didn’t see earthquakes as a threat (7). Even now, there is no controlling body to ensure that the guidelines are adhered to, and new buildings are rarely inspected (8).

There are several technologies designed to protect

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buildings in earthquakes, and many more are being developed (9). A technology in common use in California is seismic isolation, in which the building is not solidly attached to the ground. The most common method is to use cylindrical bearings made of rubber and steel to attach the building to the foundations. These are exceptionally strong, but allow movement so that the magnitude of the seismic waves is reduced by up to 75% (10) by the time they hit the building. Whilst the technology cannot prevent all damage to the buildings, it does stop them from collapsing and killing people. In California, this sort of



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technology is applied to all important buildings such as schools, hospitals and government offices. Normal housing, whilst not often implementing seismic isolation technology, still adheres to the strict guidelines. However, the technology is very expensive, and still cannot completely prevent damage (9)—it took around \$12.5 billion (3) to repair Los Angeles after the earthquake. The vastly lower death toll comes at a huge financial price.

The people of Bam, especially the average citizen, don't have the money to implement seismic isolation systems in all their buildings. This is not, however, as big a problem as one might expect, especially in terms of keeping the death toll down. In a city like Bam, now that the problem has been recognised, thousands of lives can potentially be saved. Keep buildings low, light and strong. Use metal, plastic and concrete as building material rather than mud bricks. Even if this cannot be afforded, using timber tie-beams and frameworks does a lot to increase the structural integrity of a mud brick building (8). No matter how much structural damage it takes, if a building doesn't collapse, it won't kill anyone, thus removing the major cause of death (1).



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In California, people are instructed to duck under cover during an earthquake, in order to protect themselves from injury from falling objects. It may seem that giving the same instructions to Iranians who live in danger zones would be a sensible precaution, but it would be largely redundant at this stage, because it is often the buildings themselves that fall down, not the objects within them. This sort of education would not be very useful in developing countries. On the other hand, education to help people understand the building guidelines, and to emphasise the importance of adhering to them, could make a significant difference.

In the megacities of the developing world, there are millions living in unsafe

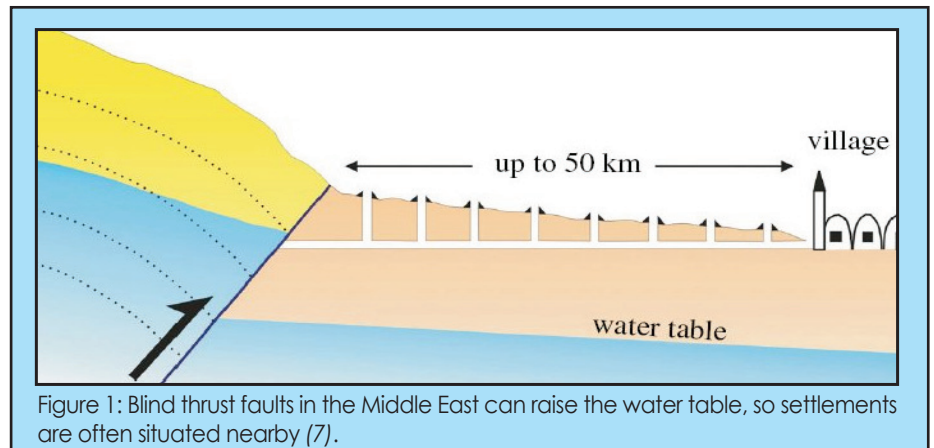


Figure 1: Blind thrust faults in the Middle East can raise the water table, so settlements are often situated nearby (7).

buildings. Without new solutions, deaths are inevitable. However, it is possible to make a difference and lower the death toll. It would undoubtedly be easier for places like Bam to protect themselves from earthquakes if they had huge sums of money, but this is not a necessity. What is desperately needed is for governing bodies to take control

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of the situation. People need to be educated, and building guidelines must be clear and rigorously enforced. Perhaps most importantly, experts must be brought in to survey other potential earthquake areas, so that cities like Bam can be warned. A greater interaction between government, geologists, engineers and citizens could go a very long way in a very short time.

Laura Soul is a 2nd year reading Physical Natural Sciences at New Hall.

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