BOOKS & ARTS

No crystal ball for natural disasters

Floods and fires aside, the tricky science of prediction is explained in a book that treads a careful line between analysis and anecdotes of awful events, says Andrew Robinson.

Megadisasters: The Science of Predicting the Next Catastrophe
by Florin Diacu
Princeton University Press/Oxford University Press: 2009. 216 pp/272 pp. $24.95/£16.99

Mathematician Florin Diacu has some confidence in forecasts. In *Megadisasters*, he describes the history and current state of prediction science. He considers tsunamis, earthquakes, volcanic eruptions, giant whirlwinds, rapid climate change, cosmic impacts, financial crashes and pandemics, and asks how useful chaos theory and mathematical modelling have proved in predicting these. Broad in scope though this may be, one would also have expected a chapter on wildfires — given their catastrophic recent effects in Australia, California and Greece — and one on floods. The latter are statistically the most frequent and lethal of natural disasters, whether as independent events or in conjunction with other disasters, such as the tsunami of 2004 or Hurricane Katrina in 2005.

The book's two most outstanding chapters address cosmic impacts and earthquakes. These events illustrate opposite poles of the prediction spectrum. The rate of collisions between large asteroids and Earth is accurately determined and widely accepted by scientists and governments. In contrast, official attempts at earthquake prediction are notoriously inaccurate; for example, although it was forecast in 1985 that a magnitude-6 quake had a 95% probability of occurring before 1993 at Parkfield, California, no such quake materialized, whereas in 1989 a bigger one did occur at Loma Prieta much further north.

This focus reflect's Diacu's interests. Celestial mechanics is his main field of research, and earthquakes have been part of his life since childhood — he grew up in quake-prone Romania and now lives and works in Victoria on Vancouver Island, Canada, near a plate-tectonic junction. Educated during Romania's communist dictatorship, the logic and freedom of mathematics were Diacu's release. Mathematical models of our complex world are essential, he argues; however, they are a useless "mirage of the crystal ball" without sufficient data and honest thinking.

Although cosmic impacts are a known hazard today, it was not always so. Well after the era of Isaac Newton and Edmond Halley, late-eighteenth-century scientists were reluctant to recognize meteorites as intruders from space, even when presented with fragments and exposed to independent witness reports.

Quake survivors in Beichuan, China, at a destroyed market in 2008.

P. BRONSTEIN/GETTY

Perhaps the pieces were ejecta from volcanoes, they theorized. Today, the massive Tunguska explosion over Siberia in 1908 is attributed to a small meteorite, and a larger cosmic collision with Earth 65 million years ago is the predominant theoretical explanation of the extinction of the dinosaurs.

The passing of an asteroid within 700,000 kilometres of Earth in 1989 encouraged the US Congress to allot funds for watching the Solar System more carefully and for devising protective responses, a project loosely known as Spaceguard. The name comes from Arthur C. Clarke's novel *Rendezvous with Rama* (Harcourt Brace Jovanovich, 1972). Diacu does not mention Clarke — surprising in a book on prediction — but he does provide a compelling analysis of collision risks and the responses that may be required in the 2030s, when asteroids XF11 and Apophis are predicted to come very near to Earth.

Bombardment of a near-Earth object with a nuclear missile is probably not advisable, writes Diacu, because "the orbits of the pieces formed after the explosion could get out of hand. To compute them might take longer than the time to impact." One suggestion for changing the momentum and direction of a hazardous near-Earth object away from Earth is to alter the heat radiation from its surface by coating it with either black or white dust or by wrapping it in aluminium foil.

With earthquakes, the prediction problem boils down to the failure of various models of earth movement to account for quake data, such as the unexpected existence of mid-plate earthquakes. Diacu chooses not to mention seismologist Harry Fielding Reid's long-dominant 'elastic rebound' model of faults, proposed after the 1906 San Francisco earthquake. Without an understanding of what happens underground, forecasting is inevitably hit-and-miss.

Chinese seismologists gave some hope in the 1970s by successfully forecasting the 1975 Haicheng earthquake, which may have saved 150,000 lives. But the 1976 Tangshan earthquake struck apparently without warning, and killed at least 250,000 people. A month later, an evacuation order was issued for a devastating earthquake that was forecast for the Guangdong region, but never occurred. The Haicheng warning may have been a lucky coincidence, assisted by the preparedness of the people through state-sponsored education and their fear of being indoors during quakes. "At worst, earthquakes are part of a chaotic system, so long-term predictions will always fail," notes Diacu. By contrast, he points out, short-term warnings do have a chance of success.

Books about natural catastrophes for the general reader must tread a tricky path between the awfulness of such events, anecdote and analysis. Diacu offers some of each, but does not always manage to integrate them. Nonetheless, his keynote is a welcome balance between pessimism and optimism. ■

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