BOOK REVIEW

Earthquakes in Human History: 
The Far-Reaching Effects of Seismic Disruptions


Reviewed by Robert Reitherman,a) M.EERI

The premise of this book, written by earth science professor de Boer and science writer and former geologist Sanders, is plain from the title. Unfortunately, there’s an unintended double entendre in the subtitle: In trying to argue its thesis, the book occasionally reaches a bit too far.

There are also positive aspects to the book, and they should be acknowledged at the outset. It is well written and gathers a great deal of geologic and historical information, although the compilations consist largely of paraphrasings from secondary sources and it lacks any engineering content. Each chapter takes up one earthquake or period of history, such as earthquakes documented in the Bible, an earthquake in ancient Greece, and the 1811-1812 New Madrid, 1906 San Francisco, 1923 Great Kanto, 1970 Peru, and 1972 Nicaragua Earthquakes. In each case, there is a significant interplay between earthquakes and history. The authors deserve credit for searching out the long-term effects of earthquake disasters, because the longitudinal threads on the scale of the history of an entire country and across decades or centuries are difficult to trace. The weakness of the book is in tying all those threads up so neatly even when there aren’t enough facts to hold the fabric strongly together. For the seismically knowledgeable reader, useful historical material can be drawn from the book while leaving some excessively broad generalizations behind such as the recurring theme featured on the book jacket about earthquakes’ “destructive powers beyond our control” that threaten “humankind’s fragile existence.” The book’s overstatement of the impact of earthquakes may seem “good for business” for those in the earthquake field—educators, researchers, practitioners. To the contrary, that overstatement obscures how

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a) Consortium of Universities for Research in Earthquake Engineering (CUREE), 1301 S. 46th Street, Richmond, CA 94804
effective our current earthquake loss mitigation capabilities are and thus the need to efficiently apply them.

Was the fall of ancient Sparta in the fourth century BC caused by, or triggered by, an earthquake that occurred a hundred years before? It would not be easy to prove that the decline of Sparta over a period of a century was due to the “catalytic effect” of the earthquake that occurred in 464 BC even if that earthquake was the only significant event in Sparta’s history during that timespan. In fact, readers with even a passing interest in ancient Greece will recall that the mid-fifth century to mid-fourth century BC period was a busy one indeed in that part of the world. Before the earthquake that occurred on the Sparta Fault in 464 BC (or sometimes reported as 465 BC), there was the first (490 BC) and second (479 BC) Persian War. Shortly after the earthquake there were Athenian-Spartan battles that led to their short-lived treaty of 445 BC. Then there was the perennial fighting in the Peloponnesian War (431-404 BC). Note that Sparta, however weakened by death and destruction it may have been from the 464 BC earthquake, was still able to defeat Athens in the Peloponnesian War, a piece of data that does not fit the authors’ thesis. All through this period Spartan soldiers fought and died in large numbers due to wars, not earthquakes. The authors, though unable to put a specific number on the Spartan earthquake casualties, argue that the seismic thread of the decline of Sparta can be extracted from that tangle and traced back to the fatalities in the 464 BC earthquake that included “not only Spartan soldiers but a great many women and children as well. Thus in the following years there were many fewer births among the Spartan soldier caste, leading to the weakening of Sparta’s army,” and this “foreshadowed Sparta’s gradual deterioration and disappearance from the world stage.” (p. 46).

It was the Battle of Leuctra (371 BC) that marks the fall of Sparta and the rise of Thebes, an event in which a key role was played by the brilliant Theban leader and general Epaminondas, whose oblique-attack phalanx tactic is a prominent chapter in military history but not mentioned in the *Earthquakes in Human History* book. Historians writing about the fall of Sparta have ascribed it to the above non-seismic events, chiefly Sparta’s aggressive over-extension, its excessive exclusivity in citizenship, and the way it was over-matched by the rise of the Theban military force. The “seismic determinism” minority viewpoint of the book requires compelling evidence if it is to overturn that consensus, but such is not presented in this book. Concerning, for example, that decisive defeat of Sparta in 371 BC,
the consensus view can be summarized as: “Perhaps the Spartan defeat needs no explanation other than Theban superiority,” and if a shortage of Spartan citizens was a contributing factor, it was due as much to the exclusivity of the way Spartans defined and limited their citizenship and purged it of those who incurred debt as it was to “demographic disasters such as the earthquake of 465.” (Petit and MacMullen, 2002, p. 252)

There is merit in merging historical, geological, and engineering knowledge to reconstruct the effect of an ancient earthquake, a field in which individuals such as Emanuela Guidoboni of the Storia Geofisica Ambiente (SGA) in Bologna have made important contributions. Those accomplishments require detailed analysis of individual cases, and care must be taken to avoid too broadly generalizing from the particular to the general. See for example the meticulous historical-seismological detective work required just to reconstruct ground motion amplification in one city from earthquakes going back several centuries. (Guidoboni et al., 2003) The knack of such a scholar is to do diligent research to document an ancient earthquake, then to reach with generalizations only so far as that documentation supports.

One of the “far-reaching” effects of the 1755 Lisbon Earthquake according to the authors was that “primarily through Voltaire’s writings it ushered in the end of ‘the age of optimism.’” (p. 105) As the book notes, Candide (1759) post-dates the earthquake, refers to the earthquake, and featured Voltaire’s rejection of the philosophical view that this was the best of all possible worlds and that it was benevolently directed by a supreme being. Voltaire’s “Poème sur le désastre de Lisbonne,” which he started to write shortly after hearing the news of the disaster and published in 1756, makes points similar to those in Candide. These facts seem to support the authors’ thesis that the earthquake in 1755 molded Voltaire’s philosophy, which in turn led the way for the Enlightenment.

However, it is also true that prior to the earthquake Voltaire was recognizably the Enlightenment philosopher we know well today, authoring satirical, skeptical, and irreligious or non-religious works. History of Doctor Akakia, along the lines of the later Candide, is a satire of the optimistic theorizing of that European era that God had created scientific principles so that the world could be created and operated so perfectly. It was published in 1753. Also not cited in Earthquakes in Human History is Voltaire’s Elements of Newton’s Philosophy (1738), written after several years’ stay in England, where he found Newton’s physics an inspiring dose of rationalism. Elements was co-authored by Émilie du Châtelet,
Voltaire’s long-time lover, who followed up with her French translation of Newton’s *Principia*. The dissemination of the scientific theme of the Enlightenment and spread of knowledge of Newton is admittedly very significant, and du Châtelet’s translation was published (posthumously) the year after the 1755 earthquake. However, she started work on it in 1745, thus undercutting the theory that the 1755 disaster was influential.

In discussing the 1755 Lisbon Earthquake, the broad statement is made that “tsunamis travel at 400 to 500 kilometers per hour,” (p. 95) a figure that looked suspect and required some fact checking. A more accurate statement, and the one used by the International Tsunami Information Center in Honolulu, doubles the upper end of the range to 1000 kilometers per hour. Note that the warning time with a 1000 km/hr velocity is only half that associated with the figure of 500 km/hr, a misunderstanding that does not err on the side of conservatism. The velocity of a tsunami wave varies as the square root of the product of gravitational acceleration (g) and depth of water. Solving for 400 kilometers per hour, plugging in 10m/s\(^2\) for g on our calculators, and making the units consistent, we find that the associated water depth would be a little over 1200 meters, which is less than one-third the average depth of the Atlantic, Indian, or Pacific Oceans. (Actually, the precise figure calculated is 1234.5679 meters--if only the 9 had cooperated this would have been the discovery of a very random route to a very orderly number).

Concerning the 1906 San Francisco Earthquake, the authors assert: “Stock markets, too, lost heavily as a result of the disaster, helping to trigger a nationwide money panic in the following months.” (p. 158) No evidence for that statement is provided. The conclusion of Christopher Douty (1977, p. 307), who devoted a PhD dissertation to studying economic data on that particular 1906 earthquake, reached a different conclusion: “It appears that the only serious financial problems in the post-disaster period grew out of the 1907 recession and were largely unrelated to the San Francisco catastrophe.” In other words, the national recession wasn’t caused by, but instead had an effect on, events in San Francisco. The standard explanation of the cause of the recession is the attempt by Augustus Heinze to corner the copper market, defaulting on his sizable Knickerbocker Trust loans, revealing a web of inter-locking directorates of major banks, triggering a run that began to spread until J. P. Morgan loaned enough money to stabilize the situation. In the process, banks across the country then began to increase reserves, loaning out less money and at higher rates, thus
decreasing investment and spending, leading to unemployment. This economic story line of cause-and-effect, not mentioned in this book, has nary an earthquake in the cast.

The authors make the following statement about surface faulting in arguing their thesis that people have failed to learn that earthquakes are “destructive powers beyond our control”: “Economic pressures and expediency have led to continued building in risky locations…It is not unusual to find schools, churches, banks, supermarkets, oil refineries, bridges, dams, freeways, and water reservoirs located along the trace of the San Andreas fault.” (p. 162) To the contrary: It is unusual to find such examples. The Alquist-Priolo Earthquake Fault Zone Act (current name), passed in 1972, and not mentioned in the book, has had an effective role since then in controlling exposure of construction to the hazard of surface fault rupture in California, and largely by geographic chance, relatively little had been built across the trace of the San Andreas Fault before then. As of the year the Alquist-Priolo Act was passed, consider this data point: Out of 1,203,121 dwellings in the San Francisco Bay Area, only 237 were within 50 meters of the surface fault trace of the San Andreas. (Algermissen, Rinehart, and Stepp, 1972)

True, the Alquist-Priolo law does not include within its scope non-inhabited structures such as bridges, but is it usual or unusual to find a bridge that crosses or is “along the trace of” the San Andreas? The Crittenden railroad bridge across the Pajaro River is a routine stop for San Andreas Fault field trips, and there is a very small bridge crossing the fault at Parkfield in Central California, but then it becomes difficult, not easy, to name another. The I-10/I-215 interchange in Southern California is one prominent example where a freeway and its bridges had to cross a fault, but the relevant fault in this case is the San Jacinto, not the San Andreas. Crystal Springs Dam in the San Francisco Bay Area is very near to the trace of the San Andreas, (but it performed quite well in 1906—evidence contrary to the authors’ thesis that they do not mention). Can one name another example of a dam on the San Andreas Fault, let alone point to several that are “not unusual to find”? While one should not trivialize the seismic risk of an oil refinery, it is not being located on the San Andreas Fault that makes these facilities in California vulnerable, but rather exposure to ground motion from faults some distance away. An inquiry to a geologist with extensive experience with the statewide mapping of earthquake faults over past decades resulted in finding one oil refinery anywhere in the state with a fault trace through its site—though this one data point had to do
with a fault other than the San Andreas that is the preoccupation of the *Earthquakes in Human History* book.

In one passage talking about the after-effects of the 1906 San Francisco Earthquake, the book states that height limits are advocated by seismic experts—but repressed by economic expediency: “Not all the lessons of 1906 have been learned, however….Geologists and structural engineers have urged height restrictions for buildings in earthquake-prone areas, but their advice is frequently ignored for the sake of greater immediate return on investment.” (p. 162) This claim is not true. Structural engineers and earth scientists involved in Structural Engineers Association of California seismic code development in California since the publication of the Blue Book in 1960 (SEAOC, 1960) and its implementation in the Uniform Building code, or nationally since the 1980s via the Building Seismic Safety Council and implementation in the NEHRP Provisions, have not called for height limits. (Height limits were only thought to be an effective feature in seismic codes long ago during the first few decades of the twentieth century, until structural dynamics and earthquake engineering capabilities developed. Some specific structural requirements were placed on structures over 160 feet in height in the Uniform Building Code after World War II as these taller buildings began to be built in Los Angeles and San Francisco, but there was no restriction).

There are vulnerable short and tall structures, but in most cities and towns of the world there are many more of the former. Readers of *Spectra* can picture the typical earthquake response spectrum, that familiar graph that looks like the Big Dipper with the cup at the left-hand side of the chart, emptying downward. The vertical axis is acceleration; the horizontal axis is the range of periods of vibration of the building from short period or high frequency (usually a short building) at left to long period (tall building) at right. A short building at a typical site has a response high up on the plateau of acceleration. A tall building has proportionally much less response, lying on the graph out where the curve tails off lower and lower (the Big Dipper’s handle). Tall buildings also receive more engineering attention than much of society’s low-rise construction. Tall buildings—all buildings—have their seismic issues that seismologists and engineers must address, but to single the tall ones out distorts the actual picture of societal risk.

The authors also touch on geotechnical engineering, continuing their theme that engineers have failed to learn from earthquakes such as 1906 or that economic forces have stifled them:
“Many of San Francisco’s downtown skyscrapers have foundations sunk into filled land, and there is no evidence that they will not fail in a strong earthquake.” (p. 162) Even with the double negative hedging, the statement is still false. According to primary engineering sources documenting the performance of specific structures in 1906, “It is believed that every building whose foundations were well and strongly established—upon deep piling, as in the Union Ferry Building and the Merchants’ Exchange [both tall buildings still standing noticeably plumb to this day]…escaped injury by the earthquake to the foundations themselves, nor did the superstructure owe any damage to inefficiency in those foundations.” (Gilbert, Humphrey, Sewell, and Soulé, 1907, p. 143) Three of the structures they studied stood on fill where the waters of the Bay had washed only a few decades prior, and approximately two dozen of the large, individually investigated buildings were located on land quite near the former water line where soil conditions are similar. The generalization that “there is no evidence” that foundations in filled ground areas for tall buildings in San Francisco “will not fail in a strong earthquake” is untrue, even if we cite that one earthquake, let alone enter into evidence the vast body of geotechnical engineering knowledge developed in recent decades.

The book extends its theme related to the recurrence of the 1906 San Francisco Earthquake to social science: “Most [geologists] are hesitant to make a firm prediction. If an imminent quake were predicted, and the prediction believed, it might well cause panic.” (p. 163) Social scientist readers of Spectra are familiar with the large body of research that tends to the opposite conclusion: An earthquake prediction probably would not cause panic, and a prompt and clear communication of any such valid warning would be the best course of action. The conclusions in early works such as Haas and Mileti (1976) as well as more recent reviews consider the “public will panic” theory a red herring, not a valid red flag: “the unfounded but widespread belief that the public will become unnecessarily alarmed if warned about a low-probability but high-consequence event still prevails.” (Mileti, 1999, p. 196) The reason most earth scientists “are hesitant to make a firm prediction” is simply because they don’t yet have the ability to do so, a far different motive than keeping a warning of an earthquake secret because it would cause panic.

More troublesome than mere error in fact (if an error in fact can ever be merely mere) is the fatalist argument behind these and other examples, a fatalism clearly stated on the dust jacket: “this book is an unequaled testament to a natural phenomenon that can be not only
terrifying but also threatening to humankind’s fragile existence, always at risk because of destructive powers beyond our control.” In this book, the illness of sensationalism, which fact has never been able to eradicate, is made even more communicable when spiced up with the motive of “economic pressures and expediency.” “Destructive powers beyond our control” was the same theme as in the May, 2004 NBC miniseries on TV, called “10.5.” The distressing aspect to that show wasn’t just that pseudoscientific magnitude number. What was more distressing was that this 10.5 figure combined with another number, 19.4 million. That’s the number of people in the USA that Nielsen Media Research estimated watched the show and who were exposed to its hyperboles.

Consider a related case, the large readership of a series of articles on earthquakes in The New Yorker by popular writer John McPhee. McPhee’s articles were compiled into Assembling California, (McPhee, 1993) and given even broader circulation. In my Spectra book review of it (Reitherman, 1993), a number of factual errors were pointed out, errors that, while different in the details from those in Earthquakes in Human History, painted a picture quite similar to de Boer’s and Sanders’ of destructive hazards that people (especially Californians) fail to heed. To cite only one example, according to McPhee’s book, in the San Francisco Bay Area, the “characteristic landforms of faults are obscured beneath “tens of thousands of buildings and homes.” Again, “landforms,” like “along the trace of the fault,” is wording that hedges ones bet and could get the author off on a technicality. However, in overall impact that kind of statement is misleading concerning the relative risks posed by surface fault rupture and ground shaking, as well as ignoring the effectiveness of earthquake engineering and public policy in dealing with earthquake risk. Unfortunately, misrepresentations of the earthquake threat in a publication like The New Yorker (circulation 987,000) reach many more minds than all the issues of Spectra published over its past twenty years of publication.

I won’t revisit my critique of that earlier book by McPhee except to repeat a conclusion that can point in an optimistic rather than critical direction. While many popular-science treatments of earthquakes reach vast audiences with inaccurate content, there are also some widely available works that are able to combine “good science” with a good story. One I cited in that 1993 book review was Earthquakes, by Bruce Bolt (Bolt, 1978, 2004), which solidly spans the earth science, engineering, societal, and historical aspects of earthquakes. It is a handy reference for those whose careers focus on earthquakes, and it is also
understandable for a high school or college student learning about the subject for the first time. To end this book review on a positive note: Bolt’s book has enjoyed a large readership and is now available in its fifth edition.

REFERENCES


SEAOC, 1960. Recommended Lateral Force Requirements and Commentary. (Published without the Commentary in 1959.)