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Obituary

Nicholas Ambraseys 1929-2012

Nick Ambraseys who died 29 December 2012 at age 83, will be remembered for his remarkable contributions to the study of historical earthquakes. For the re-evaluation of earthquakes in countries surrounding the Mediterranean he brought an unusually diverse set of language skills, historical knowledge, engineering wisdom and innate common sense. His interpretations of historical earthquake disasters were guided by more than 30 post-mortem earthquake engineering studies of 20th century earthquakes and their impact on traditional and recent construction. His interests extended to the east to eventually embrace earthquake histories in Afghanistan, India and Hong Kong, to Central America, to Scandinavia and Iceland and to parts of Africa. He leaves a legacy of more than 300 articles and six books, in addition to numerous reports.

Born in 1929 in Athens, he grew up fluent in English, French and Greek, with a working acquaintance of Arabic from his mother. In 1952 he received a degree in rural engineering from the National Technical University in Athens and chose to do his National Service in the Hellenic Navy. His first three articles (1954-7) record his interests in sewer engineering and the dynamics of fluid flow, but his next seven (1957-60) reflect an awareness of the hydrodynamics of seismic excitation. These interests were triggered by the 1956 Morgos Mw=7.8 earthquake, which occurred in the eastern Aegean while he was completing his PhD (*The Seismic Stability of Earth Fill Dams*, 1958) at Imperial College, London.

The 1956 Mw=7.8 earthquake and its Mw=7.2 aftershock were accompanied by a major tsunami, the largest Aegean event in the 20th century, which we now know was enhanced and complicated by submarine slides triggered by earthquake shaking [1]. His task as a 27 year old faculty member of the Department of Fluid Mechanics at the National Technical University was to study the effects of the tsunami on harbour works around the Aegean. His analysis evinced a quantitative curiosity in previous damaging tsunami in the Mediterranean, whose severity he described by modifying Sieberg's 1927 tsunami scale [2,3]. The scale parameterized tsunami by their coastal effects, and was known for many years as the Ambraseys-Sieberg tsunami scale. It has now been superseded by an energy-related scale, in much the same way as the felt effects of earthquakes (intensity) have been replaced by moment magnitude scales.

The historical study of the 1956 earthquake, a theme of secondary interest in his 1960 article, revealed to him numerous deficiencies in the history of tsunami, and of their causal earthquakes. He apologized in this article for the fact that the verification of the dates and locations of most of the entries on his list had been aggravated by the absence of primary sources cited by most of the authors he had consulted to make the list. It was at this time that he conceived the only possible solution to the problem of correcting the historical seismic record—to start a new history of earthquakes using only authentic first-hand quantifiable accounts.

This to most scientists, or engineers, would have been an impossible (and therefore unthinkable) task on the scale he proposed. It took him the better part of the next 25 years to accumulate sufficient materials to correct parts of the record, and the next 25 to write up a coherent story for the remainder, and as he himself notes, it was merely the start of a process. His ability to read a dozen living and two dead European languages provided a platform for these early archival searches. He visited all the great libraries of Europe, Russia, Iran and Iraq, browsing among historical manuscripts and consular records that had hitherto been the hunting grounds of sociologists and historians indifferent to the details of earthquakes and

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their effects. He encountered and corrected numerous errors in the works of previous seismologists, based as they were on historians, who, through no fault of their own, often wrote years after the events they described thereby muddling places and dates. His articles on individual events and sequences of earthquakes attempted to correct for inflation, exaggeration, chronological errors and conflation. The last two of these errors were responsible for multiple entries of the same earthquake in previous catalogues.

By 1970 he had established the methodology and utility of the historical earthquake record. At the beginning of his quest, he explained [4] that it was not certain how quantitatively useful the historical record would prove, except that an additional 25 centuries of data might usefully complement the short but steadily growing instrumental record. In 1971 it was becoming increasingly clear that historical research reveals spatial patterns in seismic energy release that are totally inaccessible to the short instrumental record, a theme that he ultimately illustrated with compelling examples from Turkey, Iran, the Marmara Sea and the Dead Sea fault zone [5].

The corollary of historical variations in seismic productivity for the earthquake engineer desirous of converting observed hazards into future seismic risk was not lost on the seismic engineering community. One of the tools for estimating the recurrence of future damaging earthquakes is based on the famous Gutenberg-Richter relationship, $N=a+bM$, which basically indicates that the number of earthquakes in a given area, of a certain magnitude, is typically 10 times more numerous than the number of earthquakes with the next largest magnitude. In most instrumental catalogues, $b=1$ and 'a' is a constant; hence it is graphically possible to estimate the probable recurrence rate of infrequent large earthquakes. Ambraseys' discovery questioned the stability of the constant 'a', which in some regions fluctuated significantly over centuries. A well behaved 'b-value' (easily determined from a short instrumental seismic catalogue) is of little value for the forecast of future seismic productivity in regions where the 'a value' cannot be relied on to remain constant. The value of the new historical record was thus demonstrated.

Between 1963 and 1981, during the painstaking compilation of historical earthquake data, which would have been a lifetime's work for a dedicated historian or scientist, Ambraseys undertook numerous engineering investigations of earthquakes as they occurred, often leading earthquake investigation teams for UNESCO, and at other times accompanying colleagues and students in field studies of earthquake ruptures in Turkey, Iran and elsewhere. In these reports and publications, Ambraseys has left a legacy of data suited to quantifying rupture lengths, surface slip, earthquake magnitude and observed Intensity. He subsequently mined these materials in theoretical articles on scaling laws, and comparisons of magnitude scales. An often-cited example of the new dimension he brought to earthquake field studies is the several articles he co-authored on the Dasht-e-Bayaz surface rupture of 1968, which had clearly slipped on numerous occasions in past millennia, as evinced by multiple offsets of the qanat systems, the traditional underground aqueducts of the Iranian desert [5,6,7].

Synthesizing and building on his more than 300 articles are his five books co-authored with Melville, Finkel, Sigbjörnsson and Adams, and his final t*our de force*—the History of Mediterranean Earthquakes published in 2009 [5]. The first of these books written with Charles Melville in 1982, *A History of Persian Earthquakes* [8], was unprecedented in its breadth and depth, drawing on history, historical geography, changes in population density, administrative customs and trade routes, and then moving on to a detailed analysis of historical archives and their interpretational uncertainties. There were 30 pages of detailed footnotes as well as maps of historical fractures and intensity patterns, listings of structural damage, and a concluding section on engineering seismology, seismic moment release patterns, scaling relations and attenuation. The work is prefaced with an apology that reads: "one disadvantage of an interdisciplinary study lies in the demands it makes on its audience". The book was a landmark demonstration of the significance of the historical earthquake record. It has provided a template for subsequent historical earthquake studies and their relevance to earthquake engineering.

Although almost two thirds of his scientific publications concerned historical earthquakes, his contributions as a teacher and practitioner of earthquake engineering were no less important. In 1958, following his PhD at Imperial College on the seismic stability of earth-fill dams, he was appointed to successive positions in the Department of Civil Engineering, as Lecturer (1958), Reader (1968), and Professor (1974). After his retirement in 1994, he was appointed a Senior Research Investigator, and there was no diminution in his research output. Almost one third of his 320 articles, and four of his six books were written after his retirement. He also consulted on the design and siting of nineteen large dams in seismic environments in Pakistan, India, Europe, Africa and Hong Kong.

The quality of his engineering and historical research contributions has been rewarded by many scientific honours from learned societies: the Busk Medal for Scientific Discovery from the Royal Geographical Society (1975), Fellow of the Royal Academy of Engineering (1985), Honorary Fellowship of the Society of Earthquake Engineering and Structural Dynamics (1986), Honorary Fellowship of the International Association of Earthquake Engineering (1992), a degree in Honoris Causa from University of Athens (1993), Member of the European Academy (1997), Award of the Freedom of the City of Skopje (1998), Fellowship of the City and Guilds of London Institute for outstanding achievement (2000), the William Smith Medal of the Geological Society of London (2002), the Harry Fielding Reid Medal of the Seismological Society of America [9], Fellow of the Institution of Civil Engineers, Fellow of the Geological Society of London, and Fellow of the Royal Geographical Society. He was a fellow of the Academy of Athens and actively participated in its sessions. He was co-founder of the *Journal of Earthquake Engineering* and has served as editor of numerous journals on soil mechanics and earthquake engineering. He gave

the British Geotechnical Society's 2004 Rankine Lecture, and in 1987 the First Mallet-Milne Lecture, of the Society for Earthquake and Civil Engineering Dynamics, London. A biannual distinguished lecture award was named in his honour by the European Association for Earthquake Engineering.

For half a century Ambraseys educated readers with insights into the destruction of ancient and modern cities and ports, documented by archaeologists, biblical writings, palace accountants, court historians, castle administrators, travellers diaries., private letters, newspapers, and secret consular reports. There is little doubt that the thousands of printed pages he published during his career will themselves become a mine of information to be explored by the next generation of earthquake seismologists, though few will command the breadth of tools and insights he brought to the subject.

Ambraseys was a kind man, full of fun and encouragement for young scientists and engineers. His colleagues will remember him for his endless store of amusing anecdotes and for his boundless curiosity. He will be sadly missed by his many friends.

Partial bibliographies of his 320 articles may be found at the Earthquake Engineering Online Archive [10] and the Imperial College homepage [11]. A numerical listing will appear as an online supplement to *Seismological Research Letters* [12].

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Roger Bilham
Cooperative Institute for Research in Environmental Sciences (CIRES), Department of Geological Sciences, University of Colorado,
Boulder, Boulder, CO 80309-0216, USA
E-mail address: Roger.Bilham@colorado.edu