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Summary: Despite repeated citation by elementary texts on seismology (and hence by the popular press) of an earthquake involving 300,000 deaths in Calcutta in 1737, it is very probable that no earthquake occurred. A cyclone drove numerous ships ashore, but the death toll in Calcutta was a fraction of its total 1737 population of 3000. One of the primary sources cited incorrectly by investigators prior to the present account, is identified and attributed to London Magazine (1738).

The 1737 Calcutta Earthquake and Cyclone evaluated

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Abstract Catalogs of historically devastating earthquakes (e.g. Dunbar et al. 1992) contain an entry for an earthquake in Calcutta in 1737 that is held responsible for the loss of 300,000 lives thus rendering it one of the three most disastrous earthquakes in history. Yet evidence for a severe earthquake is weak, consisting of anonymous reports conveyed to Europe 6 months later by merchant ships returning from Bengal. Official accounts of the disaster submitted to the East India Company headquarters in London list 3000 fatalities and omit mention of an earthquake. If the 11 October 1737 Calcutta earthquake is to remain on lists of catastrophic earthquakes the following issues need to be resolved: the discrepancy between the 1737 urban population of Calcutta (<20,000) and the number of claimed fatalities, the difficulty in distinguishing between damage from shaking and hurricane force winds and flooding that occurred during the same night, and the contradiction between the numbers of nocturnal deaths and the apparent earthquake resistance of thatched roof dwellings typical of 18th century rural Bengal. It is possible that earthquake damage may have been minimal or non-existent.

Introduction

Calcutta is located on the sediments of the Brahmaputra/Ganges delta and although local earthquakes occur (Khattri, 1992; Krishna, 1992), it is not closer than 300 km to the principal faults of the Indo-Asian plate boundaries in Burma and the Himalaya. The current population of Calcutta is more than 10 million, a number that is expected to increase 50% by 2010 (United Nations, 1993). Because of this growth in population a great earthquake near Calcutta would now be many times more devastating (Bilham, 1988) than in 1737 when its population may have numbered fewer than 20,000. However, several aspects of the 1737 event suggest that if an earthquake occurred, the resulting damage from shaking may have been small compared to the damage from hurricane force winds and accompanying floods.

The earthquake appears in western catalogs following Oldham's description of the event in his catalog of Indian earthquakes compiled in 1883. Although Oldham admits to both a cyclone and earthquake he makes no attempt to distinguish damage attributable to each. His evidence for shaking intensity is derived from passages in London magazines indicating possible toppling of buildings and liquefaction. Subsequent authors have been indifferent to the possibility that seismic shaking may have contributed little to the loss of life in 1737, or to the possibility that no earthquake may have occurred. This article is organized along the following lines: historical accounts of the event are first reproduced to indicate the consistency and quality of data available for study, followed by a discussion of 18th century population estimates and building methods inferred from writings and drawings of the time. I conclude that inclusion of the 1737 Calcutta earthquake in lists of catastrophic earthquakes appears to be unjustified.

Historical accounts of the Calcutta event

Oldham (1883) cites the following passage which he ascribes to Gentleman's Magazine, June 1738-**1739** :

"October 11 night 1737 CALCUTTA. In the night between the 11 th and 12 th October 1737, there happened a furious hurricane at the mouth of the Ganges, which reached 60 leagues up the river. There was at the same time a violent earthquake, which threw down a great many houses along the river side; in Golgotta (Calcutta) alone, a port belonging to the English, two hundred houses were thrown down, and the high and magnificent steeple of the English Church sunk into the ground without breaking. It is computed that 20,000 ships, barques, sloops, boats, canoes, &c., have been cast away. Of nine English ships then in the Ganges,

eight were lost, and most of the crews drowned. Barques of 60 tons were blown two leagues up the river; three were lost with their men and cargoes; 300,000 souls are said to have perished! The water rose 40 feet higher than usual in the Ganges"

The steeple of the church is described as being "lofty and magnificent" and as constituting the chief ornament of the settlement".

He adds the comment "This most destructive earthquake and hurricane has not been recorded in the principal earthquake catalogues". However, the entry in *Gentleman's Magazine* of June 1738 reads as follows (my additions in square parentheses):

"On *September* 30, last happened a furious Hurricane in the Bay of *Bengal*, attended with a very heavy Rain which raised 15 Inches of Water in 6 Hours, and a violent Earthquake, which threw down [an] abundance of Houses; and as the Storm reached 60 Leagues [300 km] up the River *Ganges*, it is computed that 20,000 Ships, Barks, Sloops, Boats, Canoes, &c have been cast away. A prodigious Quantity of Cattle of all Sorts, a great many Tygers, and several Rhinoceroses were drowned; even a great many Caymans [crocodiles] were stifled by the furious Agitation of the waters, and an innumerable Quantity of Birds was beat down into the River by the Storm. Two English ships of 500 Tons were thrown into a Village above 200 Fathom [309 m] from the bed of the River *Ganges*, broke to Pieces, and all the People drowned pellmell among the Inhabitants and Cattle. Barks of 60 Tons were blown two leagues [10 km] up into the Land over the tops of the trees. The Water rose in all 40 Foot higher than usual. The *English* ships drove ashore and broke to Pieces were the *Decker*, *Devonshire* and *Newcastle*; and the *Pelham* is missing.

A *French* Ship was drove on Shore, and bulged; after the Wind and Waters abated they opened their hatches, and took out several Bales of Merchandize &c., but the Man who was in the Hold to fling the Bales suddenly ceased working; nor by calling to him could they get a Reply; on which they sent down another, but heard nothing of him, which very much added to their Fear; so that for some time no one would venture down. At length one more hardy than ye rest went down and became silent and unactive as the two former, to the Astonishment of All: They then agreed by Lights to look down into the Hold, which had a great quantity of water in it; and to their great surprize, they saw a huge alligator staring as expecting more Prey; it had come in thro' a Hole in the Ship's Side, and 'twas with Difficulty they killed it; when they found the three Men in the Creature's Belly"

(The *Gentleman's Magazine*, Historical Chronicle, June 1738. Volume 8 Page 321)

Although Oldham reproduces verbatim the second paragraph of *Gentl. Mag.* as a footnote to his entry there are several differences between these two accounts, a discrepancy noted by Blechynden (1905). Although the general facts are common and follow in the same order, there is no mention of St. Anne's Church in *Gentl. Mag.* An explanation for the apparent inconsistency is that Oldham appears to have reproduced, with minor alterations and omissions, an account of the event printed in *London Magazine* of 1738. Two relevant entries are reproduced below:

"Friday 26 May 1738. The Bedford from the E. Indies brought advice of a most terrible Hurricane at Bengal, which demolished many Houses, kill'd vast numbers of Inhabitants and destroyed and damag'd several of our East-India Ships."

(*London Magazine* May 1738 p.257)

"We had the following Particulars (among others) of the dreadful Hurricane that happen'd in India, mentioned in our last. p257. In the night between 11th and 12th Oct. last, there happened a furious Hurricane at the mouth of the Ganges, which reached 60 leagues up the River. There was at the same Time a violent Shock of an earthquake, which threw down a great many Houses along the River Side; in **Galgota** alone, a Port belonging to the English, 200 Houses were thrown down; and the high and magnificent Steeple of the English Church sunk into the ground without breaking. It is computed that 20,000 Ships, Barks, Sloops, Boats, Canoes &c. have been cast away. Of 9 English ships then in the Ganges, 8 were lost and most of the Crews drowned. Barks of 60 tons were blown two leagues up into the Land, over the tops of high Trees. Of the 4 Dutch Ships in the river, 3 were lost, with all the Men and Cargoes. 300,000 souls are said to have perished. The Water rose forty Feet higher than usual in the Ganges."

(*London Magazine* June 1738 p. 311)

Thomas Oldham was was not the first a 19th century writer to attribute the passage erroneously to *Gentl. Mag.* The citation error can be traced to John Hawkesworth who was one of several authors who wrote under the pseudonym Asiaticus (C. Oldham, 1926). Hawkesworth was a merchant who attributed his sources somewhat

vaguely; thus in *Asiaticus*, 1801 (p.30) he attributes the June *London Magazine* passage to "Gentleman's Magazine for these times" and in *Asiaticus*, 1803 (p. 5) to "Gentleman's Magazine, printed in London in 1738-9", an attribution similar to that of Oldham (1883) and *India Gazette* (1833). Few copies of *Asiaticus* were printed, but extracts were published in 19th century newspapers that were widely available (*India Gazette*, 1833; *Asiaticus*, 1869). Clearly the accounts in *Gentl. Mag.* and *Lond. Mag.* are from an undisclosed primary source or sources currently unavailable to us, but presumably conveyed or written by a passenger or crew member from merchant ships that survived the storm. The Duke of Bedford sailed early January conveying official dispatches and letters to London in late May 1738, although the Bengal Public Consultations describing the storm (Range 1, Volume 12, 1737) conveyed to London on the Duke of Dorset, were not received by the Court of Directors until 29 June (handwritten note inside back cover). An account of the storm dated 31 Dec. 1737 by eyewitness Sir Francis Russell (Wilson, 1907; Hyde, 1901), a great grandson of Oliver Cromwell, emphasizes the virulence of the storm on the night of 30 September and the damage to shipping but makes no mention of an earthquake:

"Such a scene of horror as that night was I never saw or heard off. Such Terrible gust of wind like the loudest thunder, and torrents of rain, that I expected every moment the house I live in, which I believe the strongest in the town, wou'd have fallen on my head. The noise was so violent above Stairs, that myself and family was obliged to go down and stay below till morning with poor Mrs. Wastell and her children, who fled to our house for Shelter, the doors and windows of hers being burst from the walls. But Good God, what a Sight was the town and the river in the morning. Not a ship but the Duke of Dorsett to be seen in the river where the evening before was above twenty-nine sails of vessels great and small, many being drove ashore, some broke to pieces, and others foundered. And this which is Scarce creditable in a river hardly a mile wide, there was no ebb tide for near 24 hours. Our church steeple was blown down, as also eight or ten English houses, and numbers belonging to the black Merchants. The whole town looked like a place that had been bombarded by an enemy. Such a havoc did it make that it is impossible to find words to express it. All our beautiful shady roads laid bare, which will not be the like again this twenty years. Inclosed is a list of Shipping with the damage each Sustained which I forgot to inclose to Captain Gough so you'll taken an opportunity to show it him. I thank God I have no greater Share of this calamity than what my proportion of refitting the freight ships drove ashore will amount to, which may be five or six thousand rupees for my part of all additional charges, and about half that in Damage done my houses in town and country. I saved all my fine trees in the country that were blown down by replacing them while the earth was soft, as they might have done by those on the roads had the same care been taken. All our boats and small crafts being also destroyed, rendered impossible for us to help for some days our distressed ships, who lay ashore by the Governor's garden three miles below town, except the *Newcastle* who lay high ashore and bilged over against the fort, nor was the least assistance afforded our own ships till all possible assistance had been first sent the Company's ships, and I believe they were the first afloat except the *Hallifax*, who cou'd not be got off till her goods were out, though I reckon this will hardly meet credit in England. And I am sure no men in the world could in the distress we were in have got men and boats and necessaries sooner than we did, though I believe many thought they were not served soon enough and yet would give no grains of allowance for the Difficulties we laboured under in being forced to get boat from remote places the storm had not reached"

The dates in the above accounts are consistent with the two calendars operating in Europe until 1752 when the old (Julian) calendar was abandoned in British possessions. Thus the Calcutta date of 30 September corresponds to the European date of 11 September on the new calendar. However, in the following account reporting news conveyed by a French ship arriving in Rotterdam in 1738, brought to my attention by Prof. N. Ambraseys, hurricane-force winds and seismic events suggestive of aftershocks are reported for the night of 10 September 1737, a 10 day date conversion perhaps caused by ignoring that the year 1600 in the new calendar was a leap year:

"L'Equipage d'un Vaisseau arrivé ici des Indes a confirmé la nouvelle qu'on avoit deja reçûe en France par le vesseau *le Philibert*, des dommages causés dans le Royaume de Bengale par le débordement du Gange. Selon le raport de cet Equipage, il s'eleva la nuit du 10 au 11 Octobre de l'annee dernier, une violente Tempête, accompagnée de fréquentes secousses de tremblement de terre, et la Mer s'étant enflée considérablement, elle resoula les Eaux du Gange, qui sortit de son lit, et inonda tout la Pays voisin. Plusieurs Bourgs et Villages ont été entièrement submergés, et on prétend qu'il a péri plus de cent mille personnes. Plusieurs Vaissaux et un grand nombre d'autres Bâtimens, qui étoient dans le Golfe de Bengale, ont fait naufrage. Quelques-uns de ceux qui n'ont pas été brisés contre les écueils ont été portés par le vent et par les courans dans le milieu des terres, et ils se sont trouvés à sec après que les Eaux se sont retirées. "

(*Mercur de France*, 1738, Juin, p.1200 Paris)

In contrast to these three press accounts which speak of hundreds of thousands of fatalities and earthquakes, the records of the East India Company contain not a single mention of an earthquake: "By the violence of the storm, the Church Steeple and many large Brick Houses fell, and almost all in the town were greatly damaged (Bengal Public

Consultations, pp. 297-299, 1737) : The late stormy weather has blown down the Mohanna flag-staff, the masts are broken to pieces. All the Mud walls of the factory next to the Dutch ground are tumbled down." (Bengal Public Consultations, p. 324. 1737).

Administrators of the Port of Calcutta were required to report to the Directors of the East India Company in London all activities of relevance to the company. This included repairs to buildings and justifications for these repairs. The destruction of 1737 was the single largest event since the establishment of the town and its effects are apparent in East India records for several years. In the weeks following the event the administration at Calcutta convened several meetings to address the damage caused to the town. Thomas Joshua Moore, the company's zamindar (collector of duties and rents), stated in his report on 26 October (Gregorian) that the ravages of the storm had rendered the inhabitants of the black town destitute and that "hardly twenty Thach't houses were standing the next day". He advises the suspension of the collection of revenues because of the destitute condition of the people and mentions that "what still adds to the Calamity is that by the force of the wind the river over flow'd so much that a great Quantity of Rice was quite spoil'd", causing the market price of rice to climb, and that "near 3000 Inhabitants were killed as great a number of large Cattle besides Goats and Poultry destroy'd. There is great damage to the Company's Out guards of the Towns, the Publick Catcherry, the Gates of the Town and several other places" about which he promises to provide detailed damage reports after further examination. Two days later on 28 October he indicates specific damage: of 32 company buildings, 24 are listed as being beyond repair. Of 22 gates in the town walls 14 are "broke to pieces" and the door of a greatly damaged pukka gate "is quite blown out from the wall". Pukka construction was considered a superior construction method using a mixture of brick-dust, lime, molasses and cut hemp to form a tough structure. The brick building constructed in 1733 for the Zamindar to hear petitions (known as a Catchery) needed repairs. "Several Bridges large and small for draining the towns", were destroyed and the river banks near the market place eroded so much that there was no space to construct temporary warehouses to import relief supplies of grain. Damage to shipping was extensive (Bengal Public Consultations, 332-334, 1737).

In a general letter from Bengal to the Court dated February 8 1739 the effects "occasion'd by the storm" are summarized. The storm "levelled most of the Walls of the Town, shattered and threw down many of the Buildings and blew up the Bridges, the Tide some days after broke in upon and carried away some of the Wharfs, Slips and stairs, the Places most Damified are the Peers on the Factory Wharf, Wharf and Slips at Soota Loota [Suttanuttee], Walls round the burying place and Powder magazine and the factory Points, Church Steeple was overthrown." A famine developed which required a prohibition on the exporting of rice from the city and a suspension on duties imposed on its sale for approximately a year.

Discussion

Oldham was impressed by three facts in the accounts available to him: the mention of a violent earthquake, the large number of fatalities, and the observation that the spire of the Church of St. Anne sank into the ground without breaking. These issues are discussed below:

A violent earthquake

All accounts in Europe from merchant ships mention earthquake violence, although the more explicit London Magazine indicates "a violent Shock of an earthquake, which threw down..." suggesting a mainshock with accelerations equal or greater than Mercalli Intensity VIII. The apparent aftershocks mentioned in the French account would appear to require at least Intensity V for them to have been detected by people experiencing simultaneously a hurricane and widespread flooding.

However, although a large number of brick buildings were damaged beyond repair it is not at all clear that they were damaged by shaking. The masonry of Fort William, the Armenian Church and St. Anne's church were evidently undamaged. Flooding of sufficient depth and turbulence to move ships onshore and to drown crocodiles (alligators do not populate India) presumably involved tremendous currents which may have easily toppled brick structures, town gates and bridges in their way. Most dwellings in Calcutta were constructed of mud with straw roofs and even quite elaborate houses and storage warehouses were constructed from these materials. Bhattacharya (1954) observes that only after the great storm of 1737 was widespread masonry construction considered desirable.

The lightweight construction of most of the houses in which the native residents of Calcutta and Bengal lived are thus unlikely to have caused fatalities by their collapse from shaking. It is considered more probable that flooding and hurricane-force winds were the principal causes of death to animals and people. Moreover, although the buildings of the East India company offices and warehouses were constantly being repaired, the frugality of the Court of Directors in London ensured that this occurred only as they approached a state of near collapse. In 1727 the kitchen building constructed from mud and thatch was blown down (Bengal Public Consultations 27 Feb. 1727). In 1728 warehouses were in such tottering condition that they collapsed under heavy rains (Bengal Public Consultations 3 Oct. and 11 Nov. 1728). The remedy in this fight against decay and fire was to rebuild the structure "of brick as

cheap as possible". Some brick buildings were destroyed by the events of September 1737, but nearly all straw constructions were destroyed.

Population of Calcutta in 1737

The number of claimed earthquake fatalities far exceeds the number of people that lived within the walls of Calcutta at the time. Moreover, the 104 burials recorded in the St. Anne's Church register at Calcutta for 1737 (Hyde, 1901), though higher than in previous years and reflecting mortalities in part of the Christian population and little of the native population, exceeds the mean annual number of burials for the preceeding and following decades by only 21% (Figure 1). The city had been founded in 1690 on the banks of the Hooghly, a tributary of the Ganges, by Job Charnock (after whose tombstone Holland (1900) named the igneous Charnockite series), and may have risen to 10,000 at the turn of the century. The population had grown to only 45,000 by the time of the first official census in 1757. An estimate of the population of Calcutta in 1737 is purely speculative but it may have been less than 20,000 based on population estimates of 10,000 to 12,000 by Hamilton (1727) between 1705 and 1720. An urban Calcutta population of 300,000 did not develop for a further century (Chaudhuri, 1990). Dacca in 1737, 250 km to the east, was the largest city in Bengal with a population little reduced from its estimated population of 900,000 following the shift of the provincial Mughal capital from Dacca to Mushidabad 21 years earlier (Ahmed, 1986). I have not encountered evidence for a natural disaster visiting Dacca in 1737, although further search might provide materials indicating the regional extent of monsoon damage or seismicity.

In the absence of independent reports of fatalities, one must conclude that either the 300,000 deaths estimated by *Lond. Mag.* was an exaggerated version of the 3000 reported by T.J. Moore to the East India Company, or that the sources available to *Lond. Mag.* and *Mercure de France* but not to *Gentl. Mag.* estimated fatalities throughout low-lying Bengal from sources unavailable to us. Strong winds and loss of life during cyclones recur throughout Calcutta's history. For example, the cyclone of 1864 caused extensive damage to steam shipping in Calcutta, severing 2 church steeples, destroying 89,440 native dwellings, 92 European dwellings, and causing the deaths of 43 people (Downing, 1907).

St. Anne's Church

The implication in Oldham's mention of St. Anne's Church is that earthquake shaking may have been sufficiently energetic for the spire of the church to sink without breaking perhaps by liquefaction processes. One interpretation admitted by the passage is that the church infrastructure sank entirely as is articulated by Baird-Smith (p.968,1844). St. Anne's Church is believed to have been 7 m wide and 27 m long and surmounted at its west end by a masonry tower on which a tapering octagonal spire made of wood was completed in 1716 (Hyde, 1892, 1901). The construction plan of the church is not available but the spire seems to have been at least 20 m high (Plate 1) and perhaps sheathed in copper or lead. The Church was consecrated in 1709, but by 1722 the roof timbers were so rotten as to require replacement. Lightning struck the steeple on 19 September 1724 splintering the timbers of the belfry and requiring substantial repairs (Bengal Public Consultations, Sept. 21 1724, Range 1 Vol. 5).

The great storm of 1737 toppled the steeple (Bengal Public Consultations, 297-299,1738; General Letter from Bengal to the Court, January 29 1739 Paragraph 76, Coast and Bay abstracts of letters received, K.80) but evidently the church and tower remained standing. Mr. Charles Weston who was 6 at the time recalls having to move from their house because of the storm, which caused the steeple of the church "to have fallen prostrate" (Asiaticus, 1803, page 6). The change to St. Annes was recorded in two paintings, one in 1736 by George Lambert (who painted the scenery and buildings) and Samuel Scott (who painted the ships) showing the spire visible above Fort William (Plate 1), and the other by Jan van Ryne from almost the same view published in 1754 showing the tower spireless (Plate 2), along with some imaginary hills in the distance (Losty, 1990). A view from the East, attributed to Lambert, with St. Anne's in the foreground shows a different ornamentation of the spire from his collaborative eastern view. However, none of these artists visited India and the original sources for their paintings are not known. A 1747 anonymous plan (British Library K Top. z 41.) shows a sketch of the western aspect of St. Anne's with no tower and not until 13 January 1749 was replacement of the spire requested "which was thrown down by the storm, the foundation of which being already laid we imagine the expense will not exceed 8000 Rp". Although the repairs were approved grudgingly by London on 17 January 1751, ("but you must be very careful not to exceed the sum you mention"), a sketch of the church dated 1754 shows the three-storey tower of the church surmounted by a squat, masted cupula (Anon. 1754, reproduced in Wilson, 1917, but not in subsequent reprints) supported by four pillars, suggesting that the repair to the steeple was not completed before the 1756 destruction of the church and much of the city by Siraj-ad-Daula, at the time of the events leading to the Black Hole of Calcutta.

The wooden spire of St. Anne's was one of two landmarks used by mariners in 1737. The 55-m-high, nine-towered Navaratna temple constructed in 1731 in the Bengal temple style, referred to by sailors as the pagoda, also lost its top in the storm (Roy, 1991), and although most of the temple has since been destroyed, one small tower survives "much plastered over" (Chaudhuri, 1990). No mention in any contemporary accounts is made of foundations sinking, nor of buildings tilting as a result of the events of 1737. Damage to the principal warehouses and offices of the East India company, although requiring extensive repairs, evidently did not require rebuilding at foundation level

because the requests to the Court of Directors for construction materials in the years following the event are relatively modest (Wilson, 1906). I conclude that no liquefaction occurred in the region of St. Anne's church, and that the spire was blown from its tower by hurricane-force winds. No significant cyclone or earthquake shaking damage is reported to the extant Armenian church since its construction in 1724.

Was there an earthquake?

No mention of an earthquake appears in any of the East India Company reports, and although much of the damage of 11 October 1737 could be attributed to an earthquake, the damage to straw houses and the drowning of people and animals is consistent with uncontained flood waters, and a violent hurricane that occurred at the same time. The possibility that an earthquake-induced tsunami caused the flood damage cannot be excluded, but the evidence for very heavy rain (38 cm in 6 hours) suggests cyclonic weather conditions typical of a late monsoon.

It is a curious coincidence that two natural disasters should occur on the same night unless they are related to a common cause. Such complicity would be unusual but again cannot be excluded. For example, seismicity might have been induced by an extreme cyclonic pressure low followed by sudden loading from flood waters, or perhaps high winds and tsunamis could have been caused by a meteorite impact in the Bay of Bengal. I consider these unlikely and forward the suggestion that the mention of an earthquake may be metaphoric. That is, in keeping with official records, perhaps no earthquake occurred at all. The destruction on the morning after the storm conjured up images of total ruin. Russell, one of the six member Calcutta Council, states that Calcutta looked "as if bombarded by the enemy" (Wilson, 1907). Clearly anyone who had seen the damage from a great earthquake might invoke earthquake imagery in relating the Calcutta hurricane in letters and accounts taken to Europe. Memories of the 1692 Jamaica earthquake, which was followed by marine flooding of much of Port Royal, or the 1730 Hokkaido earthquake, may have been invoked to describe news of Calcutta's ruin. Alternatively, could it be that the ship's crew are reporting the shaking of their vessels caused by abrupt, irregular shoaling of ships at the time of the floods?

Conclusions

An earthquake accompanied by hurricane-force winds and flooding is reported to have occurred in Calcutta on the night of 11/12 October 1737. The number of fatalities estimated in London and French journals is two orders of magnitude larger than the number of fatalities mentioned in official reports (3000), and exceeds the likely population of Calcutta (but not of Bengal) at the time by an order of magnitude. Although official reports discuss only the damage in Calcutta, and it is possible that the 300,000 estimated fatalities include those in coastal villages in what is now East Bengal and Bangladesh, it is evident that this large number of fatalities could be caused by widespread flooding induced by a severe cyclone, but not by earthquake shaking of dwellings consisting largely of thatch.

The silence in official reports about an earthquake or earthquake damage, and the absence of evidence for soil liquefaction suggests that perhaps no substantial earthquake occurred. Minor seismicity is not unknown near Calcutta, and small to moderate earthquakes could indeed have occurred that night. There is little doubt, however, that the number of fatalities resulting from the 1737 event attributable to seismic shaking has been vastly overstated. The listing of this event in catalogs of the world's most disastrous earthquakes is thus indefensible.

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References

- Ahmed, S. U., *Dacca: A study in Urban History and Development*, Lond. Studies on S. Asia, 4, pp. 266. Curzon Press, 1986.
- Anonymous, *Plan of Calcutta*, British Library K Top. z 41.1747
- Anonymous, *Sketch of St. Anne's Church, Calcutta*, Kings Library, Maps and Drawings, British Museum CXV/469, 1754.
- Asiaticus (pseud., John Hawkesworth) (1801), *The East Indian Chronologist: Part the First: Occurrences under the house of Stuart, Part the second: Occurrences under the House of Hanover*, Hircarrah Press, Calcutta, pp. 106.
- Asiaticus (pseud., John Hawkesworth) (1803) *Asiaticus Part the First. Ecclesiastical, Chronological, and Historical*

- Sketches respecting Bengal. Part the second. The epitaphs in the different burial grounds in and about Calcutta. Telegraph Press: Calcutta, pp.86.
- Asiaticus, (1869). Calcutta in the days of yore. *The memoirs of Asiaticus. Ecclesiastical, Chronological, and historical sketches respecting Bengal.* Reprinted from the India Daily News etc. pp.55 "Indian Daily News" Steam Press: Calcutta.
- Baird-Smith, R.(1844). Memoir on Indian Earthquakes, Pt. III, J. Asiatic Soc. Bengal, Vol. 156, 964-983.
- Bhattacharya , S.(1954). The East India Company and the Economy of Bengal from 1704 to 1740, Luzac & Co London, pp 233 .
- Bengal Public Consultations, Fort William, 1704-1740; Range 11, No 1-14. India Office Library, Lond.
- Bilham, R., Earthquakes and Urban Growth, Nature, 336, 625-626, 1988.
- Blechynden, K., Calcutta Past and Present, Thacker & Co., London 1905.
- Chaudhuri, S. Ed. Calcutta the Living City. Vol. 1: The Past., Oxford University Press, pp 276. 1990.
- Downing, J. de G., The cyclone of 1864, in Bengal Past and Present, J. Calcutta Historical Society, 1, 112-122, 1907
- Dunbar, P. K., P. A. Lockridge and L. S. Whiteside, Catalog of Significant Earthquakes 2150 B.C. - 1991 A. D. Including Quantitative Casualties and Damage. U. S. Department of Commerce, NOAA, National Geophysical Geophysical Data Center, Report SE-49, Sept. 1992. (U.S. Government Printing Office: 1992-673-025/69017)
- Gentleman's Magazine and Historical Review, The:, Sylvanus Urban, gentleman, (ed. pseudo), Chatto and Windus, Lond. June 1738. p. 321. Library of Congress Microfiche Collection 05419, Roll 82.
- Hamilton, Alexander, A New Account of the East Indies, 2, Edinburgh, 1727.
- Hyde, H. B., Bengal Chaplaincy in the reigns of William and Mary and Anne, Indian Church Quarterly, 5, 1892.
- Hyde, H. B., Parochial Annals of Bengal, being a history of the Bengal Ecclesiastical Establishment of the Honorable East India Company in the 17th and 18th Centuries compiled from Original Sources, Bengal Secretariat Book Depot, Calcutta 1901.
- Holland, T. H. (1900) The Charnockite Series, Memoirs Geol. Surv. of India , Vol. 28, Pt.2, Calcutta.
- India Gazette, (1833). *The India Gazette*, Calcutta, Vol. III, Wed. 23 Oct. 1833, 907.
- Khattri, K. N. Seismic Hazard in Indian Region, in Current Science, Ind. Acad. Sci., Special Issue, Seismology in India - an Overview, 62, 109-116, 1992.
- Krishna, J., Seismic Zoning Maps of India.in Current Science, Ind. Acad. Sci., Special Issue, Seismology in India-an Overview, 62, 17-23, 1992.
- Lambert, George and Samuel Scott. Fort William from the River Hooghly, Oil on Canvas 78.5 cm x 117 cm. India Office Library. F45. c.17544. in Losty J. P., Calcutta, City of Palaces, The British Library, Arnold Publishers, pp. 136. 1990.
- Lambert, George (attributed) Fort William from the Land Side with St. Anne's Church. Oil on Canvas 81.5x130 cm. Mafarge Assets Corp.c.1730. in Losty J. P., Calcutta, City of Palaces, The British Library, Arnold Publishers, pp. 136. 1990.
- London Magazine, The London Magazine, Foreign Affairs, June 1738, p. 311. Library of Congress Microfiche Collection 01105, Roll 194.
- Losty, J. P.(1990). Calcutta, City of Palaces, The British Library, Arnold Publishers, London, pp. 136.
- Oldham, T. (1883). Catalogue of Indian Earthquakes, Memoirs Geological Survey of India, Vol.19, Pt.3, pp.170.
- Oldham, C. E. A. W. (1926). Asiaticus, in *Bengal Past and Present*, Vol.32(20), J. Calcutta Historical Society, Calcutta, 64-5.
- Roy, S., Calcutta: Society and Change 1690-1990, Rupa & Co. Calcutta 1991.
- United Nations Population Division, Urban Agglomerations, 1950-2025 (The 1992 Revision), 1993.
- van Ryne, Jan, Fort William from the opposite bank of the Hooghly, London, 1754. Line engraving 23.5 cm x 38.5 cm. India Office Library. 1754. in Losty J. P., Calcutta, City of Palaces, The British Library, Arnold Publishers, pp. 136. 1990.
- Wilson, C. R., (1898), A contemporary account of the Great Storm of Calcutta, 1737. J. R. Asiatic Soc., London, 29-33.
- Wilson, C. R. (1906). Old Fort William in Bengal: a selection of official documents dealing with its history. *Indian Records Series*, 2 vols., John Murray, London .
- Wilson, C. R.(1907). A short history of Old Fort William in Bengal, in Bengal Past and Present, J. Calcutta Historical Society, 1, 30-46.
- Wilson, C. R.(1917). Early annals of the English in Bengal, 3 Volumes, 1718-1722, Thacker Spink and Co.

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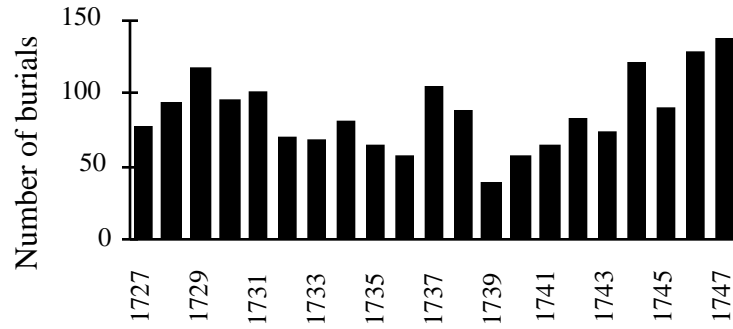
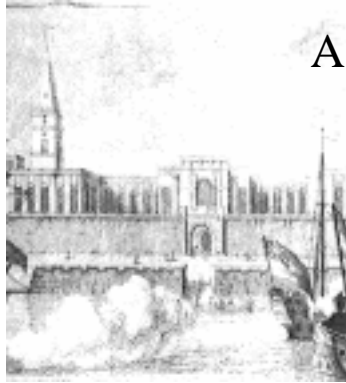
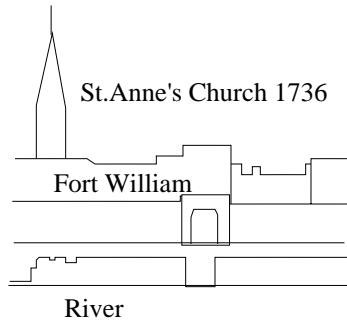


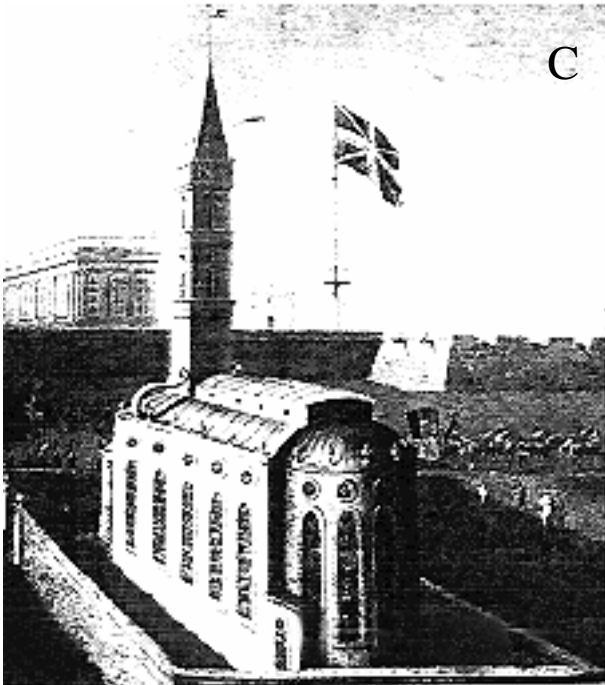
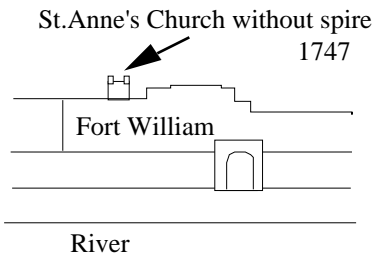
Figure 1. Annual Burials recorded at St. Annes Church, Calcutta, 1727-1747 (from Hyde, 1901).



A



B



C

Extracts from artwork depicting St. Anne's Church 1730-1747.

A. Lambert and Scott (1730),

B. van Ryne (1754),

C. Lambert (attributed, 1730).

A classical concept of a flying buttress supporting the base of the steeple is illustrated in C which is presumed to have been added during repairs following a lightning strike in 1724 (Losty 1990). Details of the church and spire were provided to the artists in London by unknown sources. Toppling and sinking of the spire was cited by Oldham as evidence for severe shaking.

Plate 1. The spire of St. Anne's Church, Calcutta, rising behind of Fort William painted by Lambert and Scott (1736). A view looking to the East by Lambert c. 1730 shows different ornamentation to the tower from that shown in this view.

Plate 2 St. Anne's Church by van Ryne showing the spire missing in 1747. Although there is some disagreement concerning the details of the repairs to the tower in this and other post 1737 illustrations (Lambert, 1730; Anon. 1747, 1754; Losty 1990) the tower and church remain intact until 1756 when they were destroyed during an attack on Calcutta.