Nataraj's Dance
Earthquakes and Environmental History of the Brahmaputra River Valley

WORKING DRAFT ONLY: Please do not cite or circulate it.

Yale Agrarian Studies Colloquium
13 April 2012

Arupjyoti Saikia
arupjyotisaikia@gmail.com
Program in Agrarian Studies, Yale University

(This working draft is part of an on-going book project tentatively titled *'An Unquiet River: an environmental history of the Brahmaputra and land beyond'*. This draft, then, is needed to be read in the larger perspective of the whole book and the chapter in itself fails to give a full picture. Please do read it as draft idea.)

Map of India and course of Brahmaputra

The Brahmaputra and the Valley

Nataraj's Dance

Earthquakes and Environmental History of the Brahmaputra River Valley

> Assam is literally known as the home of earthquakes … This region is the most unstable in India; it lies along the main boundary fault line along the foot of the Himalayas and the eastern Assam ranges, and has been the scene of nearly a dozen major earthquakes during the last century.[1]

Early in the 20th century, the *Imperial Gazetteer of India* could not refrain from commenting on the state of affairs about the physical condition of Assam by claiming that this Indian province had 'always been subject to earthquakes'. The *Imperial Gazetteer* reminded its readers that in 1607 hills were said to have been 'rent asunder and swallowed up' or in 1837 'a village standing on a knoll near Goalpara completely disappeared, a pool of water appearing in its place'. The authors of the *Imperial Gazetteer* witnessed the Great Earthquake of 1897 and heard 'stories' about the devastation caused by it. They, amazed and anguished, wrote:

> All previous seismic disturbances were, however, completely eclipsed by the earthquake of June 12, 1897, which was the most severe and disastrous of which there is any record (sic) in Assam. The station of Shillong was levelled with the ground; and women and children were for several days exposed to drenching rain, with no better shelter than could be obtained from a few tents, tumbledown stables, and sheds.[2]

Later most seismologists came to agree that this earthquake holds a 'prominent place among the great earthquakes of the world'. This prominence, something unusual for an earthquake, has been explained not only because of its large magnitude, but also because of the large area over which it caused damage to property, liquefaction- a phenomenon in which the strength and stiffness of a soil is reduced-, and landslide.[3] The *Imperial Gazetteer's* condemnation for Assam as being the prisoner of tectonic unpredictability came true again in August 1950 when another major earthquake, the sound of which, as

[1] Government of India, Bulletins of the Geological Survey of India: Engineering geology and groundwater, No. 1-5, (Delhi: Government Press 1950), p.3.
[2] Government of India, *The Imperial Gazetteer of India*, (Oxford: Clarendon Press, 1908), Vol. 6, p. 22.
[3] N. Ambraseys and R. Bilham, 'MSK Isoseismal Intensities Evaluated for the 1897 Great Assam Earthquake', *Bulletin Seismic Society*, Am. 93, no. 2 (2003), pp. 655–73.

described by the American ornithologist S. Dillon Ripley, 'muffled, subterranean, grinding-teeth noise'[4] put everything into disorder in the Brahmaputra River Valley (hereafter Valley). The Valley was in trouble again. Like the earthquake of 1897, the Valley's physical features were further reconfigured within a short period of time. Indian geologists quickly admitted that 'Assam, geologically most unstable'.[5] The impacts of this reconfiguration of physical space continued to unfold in the later years.

The bourgeoning literature on environmental history since few decades has already emphasised on disasters as central to environment.[6] Impressed upon by other social sciences the environmental historians have increasingly began to pay close attention to the 'catastrophe' and 'disaster' -representing the sudden, sublime, and seemingly singular event. Famines, droughts, or climate change, which unfold over a relatively long period of time -years, decades, or even centuries -are still favourite with the environmental historians. Environmental histories are inclined to take an inadequate assessment of natural processes. For instance, historical appreciation of the subtle chain of events—like, the gradual rise or fall in temperature or long-term environmental impacts of earthquakes— are more puzzling historical subject than the sudden and often one-off natural disaster. A review of the historical literature on natural disasters suggests how the environmental historians have so little attention to explain how earthquakes fundamentally reshaped the physical space, and how this altered physical space reshaped the humans' relation with environment.[7] Despite Braudel's appeal for longue durée historians understand the impact of earthquakes as being of a short-term nature. Their interest in studying earthquakes is limited to understanding and evaluating the damages caused to property, loss of human lives or livestock, and so on. Historians also examine the post-earthquake rebuilding process from various perspectives like the reinforcement of ideas of a nation or of national trauma. This is particularly true of the South Asian environmental history literature. However, what is being ignored is the long-term impact left behind by these earthquakes like changes in the courses of rivers, drainage systems,

[4] S. Dillon Ripley, *The land and wildlife of tropical Asia*, (New York: Time-Life Books, 1970), p. 34.
[5] D.N. Wadia, Geological Advisor, Government of India, 1950, Quoted in *The Times of India*, 30 Aug 1950.
[6] A comprehensive bibliography of the history of the natural disasters is available at http://www.h-net.org/~environ/bibs/disasters.html (access: 10 March 2012).
[7] A comprehensive bibliography of the history of the natural disasters is available at http://www.h-net.org/~environ/bibs/disasters.html (access: 10 March 2012).

or siltation level of the river beds or levels of the flood plains or changes brought into the peasant economy.[8]

Geologists studying the Valley agree that earthquakes, essentially, redesigned the landscape of the region adding another small step towards the stabilization of the unsteady natural history of the region. The previous two chapters have already recounted this process of making and remaking of the physical history of the Valley and human efforts to cope with these uncertainties. These uncertainties, however, never disappeared. Two major earthquakes, in 1897 and 1950, restaged what had happened earlier, literally mutilated the physical history of the Valley. This chapter recounts what had happened.

The Valley and Earthquakes

The Valley and its surrounding region has always been host to a number of major- and average-intensity earthquakes. The pre-19th-century Assamese descriptions of earthquakes were sensitive to role of the earthquake in the region. They may be reticent but never failed to appreciate the intensity and damages caused by the earthquakes to the physical space. Likewise Assamese historical records, the Indian pre-print historical records did not ignore physical scare left behind by the earthquakes.[9] An Assamese pre-print chronicle –called *buranji*-, thus, describes how in 1548 AD 'a violent earthquake took place, pebbles, sand and ashes came out bursting the surface of earth'.[10] Or how, in 1596, water, sand, ashes and pebbles 'burst out from the interior of the earth all over the country' and 'hot water, sand and ashes were thrown up from below'.[11] More earthquakes with varying degrees of danger were reported before a Mughal official reported at length on human dimension of the earthquake in 1663. Shihabuddin Talish, the Mughal official

[8]Only recently, some attempts have been made to assess the environmental impacts of earthquakes. 'Environmental Challenges after China's Sichuan Earthquake'. Available at http://earthtrends.wri.org/updates/node/316 (last date of access: 28 March 2012)

[9] For an excellent discussion on the pre-19th century earthquakes in India and their historical records see, R.N., Iyengar, D. Sharma and J.M. Siddiqui, 'Earthquake History of India in Medieval Times', *Indian Journal of History of Science*, 34(3), (1999), pp. 181-237. The authors have discussed on 8 earthquakes which were measured between III and X in MMI scale. For a discussion on earthquake scale, see fn. 18.

[10] Golap Chandra Barua, translated and edited. *Ahom Buranji*, (Calcutta: Baptist Mission Press, 1930) pp. 81-82, para.61.

[11] Quoted in Edward Gait. *A History of Assam*, (Calcutta: Thacker and Sprink, 1906), p. 96.

from Delhi who was on visit to Assam, accompanying the Mughal army, reported how 'On this *Manzel*, on the last day the sky was thick with dark clouds with terrifying thunderclaps coming from the direction from hill. At the same time a strong earthquake rocked the entire area, which shook all, wether (sic) they were sitting or standing, reclining or sleeping. The situation like this continued for half an hour creating great havoc and anxiety among the people'[12] Scientists agree that several major earthquakes during the 17th and 18th century altered the Valley's river system and brought significant changes into the floodplain pattern. Equally affected was the Brahmaputra's lower reaches. For instance, the earthquake of 1762, which hit the coasts of Arrakan, Pegu and Bengal, equally reconfigured parts of the Valley and the courses of the Brahmaputra. Major earthquakes that had occurred along the Himalaya since 1800 differed in dimensions, destroying vast regions along the front of the Himalayas.[13] These tectonic activities continue to tremendously impact the Brahmaputra and its floodplain. However, the influence of the tectonic activity never became central concern of governance till the end of the 19th century.

The colonial government, after the region's complete occupation, remained helpless during the 1869 earthquake in the far southern part of Assam.[14] But this earthquake provided the GSI an opportunity to explain seismic reasons behind the frequent occurrence of earthquakes. They were now convinced that the region had no volcano.[15] However, unsure of when a next earthquake would take place and still unfamiliar with what to do in the event of an earthquake, the Assam government could only open a register of earthquakes in 1874. A columnar seismometer was also placed to monitor earthquakes.[16]

---

[12] Shihab-ud-Talish, *Fathiiyaa-i-'Ibriyya*, (1670) trans. *Tarikh-i-Asham,* Mazhar Ashif, (Gauhati: DHAS, 2009), pp. 140.

[13] Roger Bilham, Vinod K. Gaur, and Peter Molnar, 'Himalayan Seismic Hazard', *Science*, Vol. 293, no. 5534 (24 Aug 2001), pp. 1442–44.

[14] 'Earthquake in Cachar Hills' *Proceedings of the Royal Geographical Society*, Vol. 13, No. 1-5(1869) p. 370; *Science: An Illustrated Journal,* Vol.1, (February-June, 1883), p. 67; *Illustrated London News*, 30 January 1869.

[15] Henry. Luttman-Johnson, 'The Earthquake in Assam', *The Journal of the Society of the Arts,* Vol. 46, (1898), pp. 473-493.

[16] This seismometer consisted of a series of round columns or cylinders of wood, or other material, which was placed on a level plane and surrounded by a soft material to prevent their rolling when they fell.

Fortunately, while other natural disasters like floods contiued to disturb the Valley an earthquake did not come till 1897. The 1897 earthquake came as a major shock to the government. In terms of human loss, Shillong, the capital city of Assam was the worst sufferer.[17] All brick and stone buildings collasped within a range of 30000 square miles. The *Imperial Gazetteer* summarised the loss: 'Nearly all masonry buildings in Gauhati and Sylhet were completely wrecked, and much damage was done in Goalpara, Nowgong, and Darrang. Two Europeans and 1,540 natives lost their lives, the majority of the latter being killed by landslips in the hills and by the falling in of river banks in Sylhet. Roads and bridges were destroyed, and the drainage of the country was seriously affected by the silting-up of streams and watercourses.'[18] Faced with such a significant loss of human lives and proterty the Indian government was forced to appreciate and handle the aftermaths of the earthquakes. R.D. Oldham, the head of the *Geological Survey of India* (GSI) describes:

> At about quarter past five in the afternoon of the 12th June 1897, there burst on the western portion of Assam an earthquake which, for violence and extent, has not been surpassed by any of which we have historic record. Lasting about two and a half minutes, it had not ceased at Shillong before an area of 150,000 square miles had been laid in ruins, all means of communication interrupted, the hills rent and cast down in landslips, and the plains fissured and riddled with vents, from which sand and water poured out in most astounding quantities; and ten minutes had not elapsed from the time when Shillong was laid in ruins before about one and three quarter millions of square miles had felt a shock which was everywhere recognized as one quite out of the common.[19]

Despite the Valley and region's apparent remoteness from the metropolis, the news of the earthquake of 1897, reached out to a larger audience far too quickly with more authoritative and factual information about the destruction caused to the physical space.[20]

---

[17] Estimates of number of people who died in 1897 varied. Henry Cotton, the chief commissioner of Assam put the figure at 1542, but at the same time admitted that 'a figure no doubt below the truth, as it was impossible at a season of floods and downpours of rain to collect complete returns', Henry Cotton, *India and Home Memories,* (London: T. Fisher Unwin, 1910), p. 236.

[18] Government of India, *Imperial Gazetteer of India,* Vol.6, p.23.

[19] Richard Dixon Oldham, 'Report on the Great Earthquake of 12 June 1897', in *Memoir of the Geological Society of India,* Vol. 29, (Calcutta: Government Press, 1899) p.1. (hereafter *Report*)

[20] Newspapers from several cities widely reported about this event. One of the reasons behind this report was the devastation caused to the Shillong, the capital city of Assam and home to a majority of British officials. For a compiled collection of these reports, see, S. N. Banerji, *The earthquake in Bengal and Assam: reprinted from the "Englishman."* (Calcutta: Englishman Press, 1897). Not only newspaper but scientific journals also posted reported on the event. See, J.D. LaTouche, 'The Last Earthquake in India',

For the British geologists the region was not necessarily unknown. At least since the second decade of the 19th century there was an increasing flow of geologists to the region in search of mineral resources and by the time the earthquake took place a fair amount of geological understanding of the Valley and its surrounding areas was in place. Oldham could only admit that the earthquake was felt across over an area exceeding that of the 1755 Lisbon earthquake.[21] The appreciation of the impact of the 1897 earthquake was a gigantic task for the GSI. This was a time when the science of seismology was passing from a pre-instrumental period to seismograph but a standard universal scale of earthquake measurement was still missing.[22] Oldham could only alarmingly describe how 'the surface of the ground vibrated visibly in every direction as if it was made of soft jelly'.[23] The colonial government not only lacked resources and experiences to deal with such a devastating earthquake but the idea of state intervention to rescue affected population from disaster was yet to be part of the narrative of governance.[24]

The 1897 earthquake, however, provided a great opportunity for the Oldham-led GSI to redefine its task mandate to collect information about Indian minerals.[25] Oldham

---

Nature, Vol. 56 (1897), pp. 444 –45, T.D.H. LaTouche, 'The Calcutta Earthquake', *Nature*, Vol. 56 (1896), pp. 273 –74.

[21] Oldham, *Report*. Appendix H.

[22] The nine seismometric cylinders, which were installed in Shillong, were leveled to the ground during the 1897 earthquake and making any possible measurement ineffective. Cotton, *India and Home Memories*, p. 232.

[23] Based on descriptions, which was fairly well-recorded, given the effort of Oldham and his colleagues to map the intensity of the damages the intensity was later evaluated at 8.7 M (approximately) in Richter scale. C. Richter., *Elementary Seismology*, (San Francisco: W.H. Freeman and Company, 1958), p. 709. Much later, the intensity of this earthquake was estimated at greater than 8 Richter scale but less than 8.1 M. N., Ambraseys and R. Bilham, 'Reevaluated intensities for the Great Assam earthquake of 12 June 1897, Shillong, India', *Bulletin of the Seismological Society of America.* Vol. 93 (2), 2003, pp. 655–673.
The Richter Magnitude Scale assigns a single number to quantify the energy contained in an earthquake which is a base-10 logarithmic scale. This is obtained by calculating the logarithm of the amplitude of waves. The later is measured by a seismograph. Scientists agree that such a measurement can only approximately suggests whether the earthquake is large, small, or medium-sized. In the second half of the 20th century, the destructiveness of an earthquake came to be understood as a complex matter, related to the geology, population density, and cultural features of a specific area. Damage caused by the earthquakes was understood by their intensity with the beginning of the Modified Mercalli Scale (MM). The Modified Mercalli Scale is divided into 12 degrees, each identified by a Roman numeral. Intensity, measured on a numerical scale, is the degree of damage or observable effects caused by an earthquake at a particular location. An earthquake of a particular magnitude will produce different intensities at different places.

[24] T. Roy, 'State, Society and Market in the Aftermath of Natural Disasters in Colonial India: A Preliminary Exploration', *Indian Economic Social History Review*, Vol. 45, no. 2 (June 2008), pp. 261–94.

[25] For a history of Geological Survey of India (GSI), see, D. Arnold. *Science, Technology and Medicine in Colonial India*, (Cambridge: Cambridge University Press, 2000).

sent out several of his officers to tour extensively in the earthquake-ravaged hills and Valley. They were joined by British and Indian officials from revenue and other branches of administration to contribute to their narrative. Later, Oldham could publish an account based on the information obtained in this way and 'supplemented by a tour through the epicentral tract, which was made by him "during the cold weather of 1897–98"'. The earthquake of 1897 succeeded by another three great earthquakes during the years 1905, 1934, and 1950, clearly indicated the vulnerability of the Shillong plateau to large earthquakes.[26] Another earthquake in 1930 severely destroyed the western part of the Valley but little was recorded about the associated changes in the physical landscape.[27]

Due to its large magnitude and intensity, and large area over which it caused damage, liquefaction, and landslides, the 1897 earthquake continued to draw attention of the seismologists. Also, the 1897 earthquake forced the scientists to look for historical occurrence of earthquakes in the region. Henry Luttman Johnson, with one-and-half-decade of administrative experience in Assam, wondered how despite Assam not being a land of volcano—though there are hot springs and one mud volcano—earthquakes were not anything new to Assam, or indeed in the east side of India.[28] Oldham compiled a list of Indian earthquakes, many of his contemporary geologists, however, agreed that it was a very incomplete list, observed without the aid of instruments of which 110 earthquakes recorded as having occurred in eastern Bengal, Assam, and Burma, up to 1869. In Assam alone, in the 20 years ending 1869, there were some fifteen. Before the imperial observation, there was no systematic record of such events. Luttman Johnson himself came across an old diary where he found information on 11 earthquakes occurred at Dibrughar, between January 1839 and September 1843 and 'all of these came from the south-west, indicating an origin in the central hill trail'[29]. The earthquake helped understand that rather than the volcano, it was the tectonic movement which was responsible for Assam's tryst with earthquakes.

---

[26] B.S Sukhija, M.N Rao, D.V Reddy, P Nagabhushanam, S Hussain, R.K Chadha, and H.K Gupta, 'Paleoliquefaction Evidence and Periodicity of Large Prehistoric Earthquakes in Shillong Plateau, India', *Earth and Planetary Science Letters*, Vol. 167, nos 3–4, (15 April 1999), pp. 269–82.

[27] E.R. Gee, 'The Dhubri Earthquake of the 3rd July 1930', *Memoirs of the Geological Survey of India*, Vol. 64–65 (1934), pp.1-101.

[28] Henry. Luttman-Johnson, 'The Earthquake in Assam', *The Journal of the Society of the Arts*, Vol. 46, (1898), pp. 473-493.

[29] Ibid.

The next major earthquake came on 15 August 1950.[30] By this time, however, earthquakes were better measured.[31] It was felt across a macro-seismic area of 1,794,000 square kilometres. Of these, approximately 15,200 square miles in eastern Assam was completely affected with 1.5 million people affected in these areas.[32] The number of deaths was estimated at more than 1,500 but acknowledging that these figures could be gross statement, Bishnuram Medhi, the Assam chief minister, told his legislators helplessly:

> … even after the six weeks of the occurrence of the disaster, it was difficult to estimate the causalities and damage caused to private property. The exact number of causalities would perhaps never be known as no traces of many villages had been left in the Subansiri Valley of the North Lakhimpur sub-division as also the Abor and Mishimi Hills of the North East Frontier Agency. [33]

Assam's tectonic instability began to draw attention again in the aftermath of 1950. Darashaw Nosherwan Wadia (1883–1969), the grand man of Indian geologists, and geological advisor to the new independent Indian government, fiercely resisted any such idea.[34] Reiterating what both Oldham and Luttman argued half a century earlier that the region did not have any volcano; Wadia claimed that Assam was geologically and seismologically, the most unstable region in India which 'lay along the prominent fault line along the foot of the Himalayas and northern Assam ranges'.[35] Wadia put the onus on the young 1,500-mile long and 250-mile wide Himalayas and suggested that the mountain range put a heavy strain on rocks 'which occasionally slipped off under strain'.

---

[30] This is measured at 8.5 M. Refer to http://earthquake.usgs.gov/earthquakes/world/events/1950_08_15.php. Earthquake scientists calculate that earthquakes, seemingly with a small difference in earthquake scale, can actually left behind huge dramatic differences in impacts. For instance, an earthquake measuring 8.5 M releases energy of 85 megaton of TMT where another measuring 8.7 can release energy equivalent to 170 TMT.

[31] For an excellent introduction to the history of earthquake measurement, see S.E. Hough, *Richter's Scale: Measure of an Earthquake, Measure of a Man* (Princeton: Princeton University Press, 2007).

[32] V.K. Krishna Menon, 'Earthquake in Assam', *The Times*, 13 September 1950. The total affected area was calculated at 49,700 square kilometers.

[33] 'Assam's Chief Minister Unfolds Grim Picture of Earthquake Havoc', *The Times of India*, 1 October 1950.

[34] 'Assam Geologically Most Unstable: Scientific Reasons for Quakes', *The Times of India*, 30 August 1950.

[35] Ibid.

Both 1897 and 1950 impacted the physical landscape of the Valley in similar ways. These changes permanently impaired key geographical features and endowments of the Valley. Still more, both these two earthquakes helped record the physical changes, especially the issues related with floodplain, unlike many such events across the world. Except damages caused to Shillong and parts of Calcutta, the impacts of the 1897 earthquake were mostly confined to a landscape which was less exposed to urban vulnerability. How these earthquakes changed the rural and agrarian landscape of the Valley is narrated below.

Changing Topography: The Hills

By the early years of the twentieth century, it was recognized that the 1897 earthquake had led to alterations in the height and relative position of the hills along the Valley. *The Times of India* reported how portions of the hills had slipped to the Valleys.[36] This was in addition to the usual phenomena of earth-fissures, sand-eruptions, small faults, and the destruction of buildings. The violence of the movements is shown by the fracture of upright stones, indicating in the case of short stones which were broken and overturned, a modified form of projection, while in other there was distinct rotation by the action of a vorticose motion in the ground. In the alluvial areas, the effects were especially conspicuous, vibrations being noticed in the distant and detached alluvial area of Ahmadabad, though the earthquake was not noticed over the rocky ground to the east for about a hundred miles. Recent researches show that during the 1897 earthquake the northern edge of the Shillong plateau rose violently by at least 11 metres and it took another century to explain the reason behind this pop-up. This pop up was due to the rupture of a buried reverse fault approximately 110 kilometres in length and dipping steeply away from the Himalaya.[37]

The effect of earthquake on the topography of hills became fairly conspicuous in the 1950s. An airman who went into a reconnaissance mission reported that ‘whole chain

[36]*The Times of India*, 30 March 1898.

[37] R. Bilham and P. England, ‘Plateau “pop-up” in the Great 1897 Assam Earthquake’, *Nature*, Vol. 410, no. 6830 (2001), p. 806.

of mountains seems to have vanished'.[38] For many, it was surprise at how mountains had succumbed to the shocks and tremors. A combination of factors including steepness of the slopes, burning of the pine forest, leaching of the granite, and climatic weathering helped this fall. Francis Kingdon-Ward, the British botanist—a plant hunter as he would like to call himself—who became a prisoner of the 1950 earthquake and not far from the epic centre, noticed that the Valley's upstream primarily consisted of or was covered with a blanket of loose boulders, sand, and gravel.[39] What came under serious destruction were passages and tracks which facilitated as major routes of communication across the mountains.

If the hills came under tremendous pressure, the 1950s earthquake equally caused massive landslides. The landslides affected three-fourth of the hills covering a tract—200 kilometre long and 60 kilometre wide—which was approximately one-third of the total geographical area of the region.[40] L.P. Mathur, a geologist with the Indian government calculated that this landslide, which had a depth of 10 to 100 metre, took away an enormous amount of soil roughly equivalent to 10,000 million cubic metres which was three times higher than the normal sediment carried by the river system. On the other hand, the landslides in the mountains and extensive liquefaction in the alluvial plains was estimated at about 30 times the average yearly amount of detritus carried by the Brahmaputra.

Kingdon-Ward argued that severity of damage to the forest coverage was much higher than the normal expectation. This was due to the very pattern of the landscape which helped in aggravating the situation. The condition of the landscape was 'anything but favourable'. The screes (accumulation of broken rock fragments at the base of crags) were exceedingly steep. They remained fully exposed, and were still moving. There was no soil and no humus. Where stability had been reached at the foot of a slope, enormous

[38] 'Mountain chains said to have vanished: Airmen's report of damage by Assam earthquake', *The Times of India*, 29 August 1950.
[39] Frank Kingdon-Ward, *Himalayan Enchantment: An Anthology* (London: Serindia Publications, 1990). The earthquake was measured 8.5 M in the Richter scale. See f. n. 20.

[40] L.P Mathur, 'The Assam Earthquake of 15 August 1950', *Indian Minerals*, Vol. 4, no. 4 (October 1950), pp. 167–80). Also see, Gee, 'The Dhubri Earthquake of the 3rd July 1930'.

angular boulders were piled on top of each other in utter confusion; and there was (and is) ever the chance of more joining them from above. So far as one could see at the time, the severity of the destruction depended less on the type of forest than on the angle of slope and nature of the rock.[41]

Floodplains and Fields

The 1897 earthquake produced fissures and sand vents throughout the western and central part of the Valley and partially on the eastern side. Earth fissures occurred across the alluvial plains. This led to innumerable jets of water and sand, like fountains, spouting up from 1–3 metres in the air. Touring officials extensively reported such fissures all along the river Brahmaputra in the western and central part of the Valley. M.A. Grey, the Deputy Commissioner of Darrang during his extensive tour of the eastern part of the district, noticed 'fissures everywhere in low-lying lands'.[42] He noticed how large quantities of water and sand were ejected from the surface near a river Bharalu. In most part of the low-lying tract in the eastern part of the district was a mass of small springs. These springs poured out sand and water 3–4 feet in height. The sand thrown up smelt sulphurised. The deposits of sand fully damaged cultivated fields. The *chapori* -the low-lying riverine tracts close to the river -tracts in western part of the Valley were completely riddled with fissures, some of them more than 200 yards long. Grey admitted that 'the deposits of sand were much greater on the chapori than elsewhere, and covered the land in some places to a depth of four feet'. These changes not only occurred to river Brahmaputra. Grey reported that 'the beds of some of the rivers were also thrown up several feet by the earthquake'. T.D. La Touche, Superintendent of the *GSI* reported how from Goalando to Mangaldai, a distance of some 260 miles, banks were fissured on either side. Fissures extended along the tributaries and minor rivers. P.R.T. Gurdon, a senior official with the Assam administration reported fissures across 'nearly all' rice-fields in

[41] Ward, *Himalayan Enchantment*, pp.298–99.

[42] Letter from M. A. Grey, Deputy Commissioner, Darang, to the Secretary to the Chief Commissioner of Assam, No. 9J9-C, Tezpur, the 26 August 1897 in Oldham, *Report*.

Kamrup.[43] Gurdon's fissures 'rose to a height of several feet, and on falling formed sand crater' but he did not find any sulphurous smell like others. He also reported of 'earth-waves' in paddy fields. 'The waves could be seen following one another at intervals, the *ahu* –summer rice- falling and rising as the waves progressed'[44]. Different and extensive kinds of fissures were reported from different localities which tore up the ground violently to smaller kinds. An official reported from Barpeta how:

> … in several places rice-fields and public roads have been badly injured by them, some roads have been rent lengthwise, while on some deep gaps have occurred crosswise, letting in strong currents of water from the submerged fields. In several places again the earth has subsided more or less alongside the rents, and this has been specially marked on the banks of rivers and streams…'[45]

Further in the western part of the district, another official reported further deterioration in the situation

> The earth opened in fissures in every direction, and as far as it has since been ascertained by local enquiry, everywhere within this subdivision, the openings being wider and greater in length in places higher up than in places lower down near to the Brahmaputra; while on the other hand geysers rose, throwing up sand and water from different heights ranging from 2 feet to 12 feet. Bits of coal, old logs, and other vegetable substance came out of the springs with the sand and water. The springs were more numerous in low lying places than in high tracts towards the north near the Bhutan hills…'[46]

The situation was not far better in the far east of the Valley. At Lakhimpur, fissures and outpouring of sand and water were very reported throughout the west of the river Subansiri.[47] Such activities were reported along the banks of rivers, low lying or swampy tracts. Fissures were of varying length; from a few inches in breadth to two feet in depth, and often exceeded 100 metres in length. Tracts affected by fissures also reported

[43] Letter from F.R.S. Collier, Officiating Commissioner of the Chittagong Division, to the Chief Secretary to the Government of Bengal, No. 1074 G., dated Chittagong, 1 October 1897, in Oldham, *Report*, pp. 332-333.

[44] Oldham, *Report*, p. 27.

[45] Babu Abhay Sankar Guha, Sub Deputy Collector, 'Memorandum, 19 September 1897, Barpeta' in R.D. Oldham, *Report*, p.336.

[46] Letter from Madhub Chandra Bardalai, Sub-divisional Officer, Barpeta to the Deputy Commissioner, Kamrup Barpeta, 23 September 1897 in Oldham, *Report*, p. 335.

[47] Letter from H.A.C. Colquhoun, Sub-divisional Officer, North Lakhimpur, to the Deputy Commissioner of Lakhimpur. North Lakhimpur, 30 October 1897 in Oldham, *Report*, p.340.

sinking.[48] Extensive fissures were reported from the southern bank of the Brahmaputra. Most places were major paddy-producing areas.[49] These fissures were neither universal. Not only the hills escaped fissuring or the formation of sand vents but large tracts of older alluvium could not be affected by these fissures. This older alluvium mostly rising from the newer alluvium was distributed all across the Valley. Resembling a red-colour-elevated tract, this alluvium was characterized by compactness and absence of beds of loose waterlogged sand.[50] Even in the newer alluvium, such beds of sand are not everywhere near enough to the surface to allow fissures.

Not only extensive fissures broke up alluvium near the river banks, there was also extensive shifting of the alluvium throughout western areas of the Valley. Such shifting was also noticed in parts of north and east Bengal. Oldham explained that the deltaic river banks were higher than the land behind them and the pressure on the subjacent yielding layers were greater than elsewhere and shifting of the river banks took place by yielding to compression. However, this shifting had a critical impact on the rice fields. These rice fields were created over a long period by carefully levelling them so as to allow them to be flooded to a shallow and uniform depth. The earthquake had thrown these rice fields like a piece of crumbled paper with moderate creases. Peasants in many places changed their fields after the earthquake. This was due to the fact that the earthquake simply washed away their fields due to the changing channels of the rivers and sand spring. Away from the rivers, raising swamps resulted in making urban areas of the central part of the Valley water-logged during the monsoon.

These changes into the Valley's floodplain were not unique for the 1897 earthquake. The paleoseismological study of the areas affected by the 1897 earthquake indicate traces of previous such phenomenon at several sites in the alluvial deposits along

[48] This is especially noticeable along the left bank of the Dikrang for four miles above Narainpur.

[49] At Rangamati mauza, a fissure, 3-miles long and from 1–3 feet broad, was formed from the old Garhali to the new road near the Dhansiri river. Almost from all *chapori* fissures were reported. An official reported how in a chapori near Tinsukia a fissure appeared, vomiting sand and water.

[50] Oldham referred to Madhupur jungle, lying between Dacca and Mymensingh as the best example of such older alluvium.

the Brahmaputra.[51] Reaffirming uncertainties these changes into the physical space was to come back again. The Brahmaputra flood plain provides ideal conditions for liquefaction. The floodplains of river Brahmaputra and its tributaries experienced extensive liquefaction confined to the areas proximal to the river courses.[52] Studies have also shown that liquefaction remained a major feature of the previous earthquakes which occurred in this region.[53] The 1950 earthquake brought further damage to the fields and this time it was both floodplains and high Valleys. Repeating 1897 fissures and sand vents, running parallel to river banks and other small channels, occurred in the alluvial plain in different parts of the eastern Valley.[54] Large tracts of cultivable land were converted into grasslands covered with 3–5 metre-high wild grass.[55]

Such a physical overhauling meant massive damage to the man-made structures. Officially damage to property was estimated at ₹ 3.7 million which was about half of the entire state revenue receipt for the year.[56] Displacement of the alluvium also bended railway tracks. For instance, in the Tezpur–Balipara tramway line 'the rails were thrown about, and twisted into all manner of curious shapes, almost baffles description'.[57] The sight was a most 'extraordinary and interesting one'. Roads were rendered impassable, and houses became uninhabitable. Also, affected was the route of navigation in the Brahmaputra.[58] The main channels of Brahmaputra, for instance in Hatimura in Nagaon,

[51] *B. S., Sukhija,* et. al 'Paleoliquefaction evidence and periodicity of large prehistoric earthquakes in Shillong Plateau, India." *Earth and Planetary Science Letters* 167, no. 3-4 (1999) pp. 269-282.

[52] M.C Poddar, 'Preliminary Report of the Assam Earthquake, 15th August, 1950', *Bulletins of the Geological Survey of India*, Series B, No. 2, 1952.

[53] D.V. Reddy, et al., 'The Great 1950 Assam Earthquake Revisited: Field Evidences of Liquefaction and Search for Paleoseismic Events,' *Tectonophysics*, Vol. 474, no. 3 and 4 (2009), pp. 463–72.

[54] The worst affected areas were Margherita, Ledo, Sadiya, Jorhat and North Lakhimpur.

[55] N.R. Ramesh and N.S. Gadagkar, 'Effect of 1950 Earthquake on Geomorphology and Ecology in a Part of the Brahmaputra Valley Near Teju, Arunachal Pradesh', *Journal of the Geological Society of India*, Vol. 35, no.1 (1990), pp. 87–90.

[56] Government of India, *Imperial Gazetteer of India*, vol.6, p. 88. This necessitated a small financial support from the central government to which senior official complained. Cotton wrote that 'But I venture now to say that we received no adequate assistance from the Government of India'. Cotton, *India and Home Memories*, p.237.

[57] M.A. Grey, Deputy Commissioner, Darang from, to the Secretary to the Chief Commissioner of Assam, Letter No. 9J9-C, in R.D. Oldham, *Report*.

[58] Poddar, 'Preliminary Report of the Assam Earthquake'.

became shallow, restricting the movement of mails and cargos.[59] This was going to have deep impact on the larger navigation regime of the Valley. River navigation played a critical role in trade between the Valley and Bengal. Tea, jute, and mustard were primarily exported through the river routes. As the river bed of the Brahmaputra had risen up within a period few decades, not only river navigation had to be curtailed significantly in the eastern part of the Valley but it lost its relevance.[60]

Changing Rivers and Floods

If floodplains, domesticated over the centuries suddenly faced new challenges due to the earthquake of 1897 and 1950, like earlier ones, they were further exposed to new and long-term consequences. The channels of the Brahmaputra underwent several, major short-term and long-term transformation. This included either shifting of the river courses or rise in the river beds. In fact, Himalayan seismicity continues to have deep effect on the fluvial processes in the entire Ganga–Brahmaputra plains. The outline of the Brahmaputra river course is strongly controlled by the geotectonic set-up and tectonic activity. Neither of these processes has disappeared. The tectonic activity not only affects a river's braiding pattern but also reconnects streams that had previously branched out and also leads to rapid abandonment of channels.[61] In recent time, in 1762, the uplift and tilting of an earthquake significantly resulted in major westward shift of the Brahmaputra in present Bangladesh.[62] The 1897 earthquake, not only altered river courses, but Indian geologists, for instance Wadia, emphasised that due to the 1897 earthquake 'beds or rivers, tanks, or even wells were ridged up or filled, by the outpouring sand, thus,

[59] 'The effects of the Assam earthquake', *The Times of India*, 30 March 1898.

[60] Prior to the 1950 earthquake, the cargos used to travel up to Dibrugarh. The earthquake forced the introduction of feeder services between Dibrugarh and Disangmukh which was downstream of the former at a distance of 46 miles. National Council of Applied Economic Research (NCAER). *Techno-economic Survey of Assam* (New Delhi: NCAER, 1962), p. 127.

[61] S. Ouchi, 'Response of Alluvial Rivers to Slow Active Tectonic Movement', *Geological Society of America Bulletin*, Vol. 96, no. 4 (April 1985), pp. 504–15. Also see D.I. Gregory, and S.A. Schumm, 'The Effect of Active Tectonics on Alluvial River Morphology' in K.S. Richards, ed., *River Channels: Environment and Process* (London: Blackwell, 1987), pp. 41–68.

[62] James M. Coleman, 'Brahmaputra River: Channel Processes and Sedimentation', *Sedimentary Geology*, Vol. 3, no. 2 and 3 (1969), pp. 129–239.

generally disturbing the drainage system of the land and causing extensive flooding'.[63] Not only the main channels but all forms of water bodies and drainage system were disturbed. Land close to water bodies came to be filled with sand. Near Goalpara, the river channel shifted to the north bank unlike its normal southward journey. This led to shifting of the river port two miles away.[64] As the previous channels become a dead one, large tracts were covered with sand, up to 6 feet at some places, making crucial places defunct. Popular reaction was that the southern hills had come closer to the Brahmaputra. There were also reports of silting up with sand of the wells used by the villagers for drinking water leading to a water crisis.[65]

Rising of the river beds was reported from western and central part of the Valley. Madhav Chandra Bardalai, an official from Kamrup reported how 'the river beds were raised high as to make them nearly of the same level with the banks'. The obvious result was that 'the volumes of water imbedded hitherto in the rivers, added to the subterranean water thrown out of the springs, overflowed all the places, high and low'.[66] As subsequent high floods inundated these localities, Bardalai observed:

> [T]here could not be much doubt that the river channels have been raised, and that the lands near the river banks have generally subsided to a depth varying from 3 to 7 feet or more, while the tracts of the subdivision towards the north nearer the Bhutan hills remain higher as before.[67]

What led to the rise of river beds? All explained that redistribution of comparatively superficial material forced the river channels to rise. This also led to the corresponding sinking of the land adjoining the river banks.[68] The effect of these changes was threefold. First, the sinking of the high land bordering the river channels caused it to sink below

---

[63] D.N. Wadia *Geology of India,* (Delhi: Tata McGraw-Hill, 1975) quoted in Neil A Wells and John A Dorr, 'Shifting of the Koshi River, northern India', *Geology*, Vol. 15, no. 3 (1987), p. 204-207.

[64] 'The Effects of the Assam Earthquake', *The Times of India*, 30 March 1898.

[65] Ibid.

[66] Madhav Chandra Bardalai, *op. cit.*

[67] Ibid.

[68] Oldham explained that the impact of movement by which the deformation took place should have been higher. However, alluvium, because of the ability to offer resistance against deformation, acted as buffer and the impact was ordinarily transmitted to the shortest distance. Oldham explained that for this reason alone, the subsidence of the banks would probably be greater than that of the alluvium further back. R.D. Oldham *Report.*

flood level and, apart from anything else, these lands, which were ordinarily left dry, were submerged in 1897. Second, the sinking of this barrier along the river channel allowed its waters to spread more freely over the low land away from the river. Third, the raising of the beds of the drainage channels blocked the usual means of escape of the greater part of the flood waters, and necessitated their spreading over the land. All these causes combined, caused the disappearance of the relatively greater elevation of the river banks. Oldham thought the earthquake reduced inequalities of level by causing a depression of the high ground and an elevation of the low. Years later, it was noticed that the raising swamps did not disappear nor did the government restore the broken dikes. The drainage of the country continued to be seriously affected by the silting-up of streams and watercourses.

The earthquake also helped in the sudden rise—varying from 2–10 feet—of water levels in the rivers over a large area. This massive rise of water level however disappeared soon.[69] This rise of the rivers was due to the large volumes of water poured out from the sand vents. Large volumes of water from below affected the amount of water in the drainage channels leading to a rise in the smaller drainage channels. The raising of the river beds was probably continuous to a greater or lesser extent all along the channels. It appeared that the water was lifted bodily to a certain extent by the earthquake. The forcing up of the river beds was by no means uniform, and in some places it was more extensive than in others; in this way, barriers were formed across the stream, and on the upstream side the water was ponded up to the height of the maximum rise of the next barrier downstream. The combined impact of all these was clear. Thus, a greater rise of water level occurred than would have been the case if the raising of the river beds had been uniform. The barriers, being composed of loose sand, were more easily scoured away. Also, the material of which they were composed distributed along the stream bed in such manner as to leave the water lower than the level to which it had risen immediately after the earthquake, though a little higher than it was before. It was only where the blocking of the river channels took this form—and where there was a

[69] A river gauge, stationed at Gauhati, showed a height of 167.41 feet above sea level at 7 a.m. on the morning of the 12 June. It showed a rise of 7.59 feet at 6 p.m., about three quarters of an hour after the earthquake.

strong current, with its consequent power of scouring—that the channels reopened. Where the current was slack, the beds were not scoured out and remained choked when the floods of August and September subsided. Where the channel was continuously and completely choked, the streams had in many cases deserted their old channels and formed new ones.

Numerous river channels in the lowland tracts between the foot of the Garo hills and the Brahmaputra had been filled up over a large area. These channels, normally with shallow stream in the dry weather and having varying depth ranging from 15–20 feet, used to carry off the surplus waters when the Brahmaputra was in flood. This saved the basins from flooding during the rainy reason. Oldham noticed that the earthquake forced up the bottoms of all these channels till they levelled with the banks on either side. In the succeeding winter season after the earthquake, the drainage system of this tract collapsed. The rivers now in shallow sandy channels, instead of deeply depressed channels, had flowed nearly level with the general surface of the land. The blocked drainage channels prevented them from serving their natural task of maintaining flood water at low ebb. Large volumes of water which would otherwise have escaped were forced to spread over the surface of the land. This, Oldham argued, gave rise to the high floods of 1897. Outpouring of sand and the forcing up of the bottoms from below filled up river channels across the Valley. The impact was equally shared by tanks and wells over a large area.[70] Next to wells, narrow watercourses were most affected, while in large tanks and natural pools, the raising of the bottom had been less than in water channels of equal depth but smaller width in the neighbourhood.

What was crucial behind the rise of bed was the lateral shifting of the river channels. Oldham denied that this shifting was to the movement of the alluvium towards a river course. He noticed how the alluvium movement was parallel to the only river course. Oldham's idea was that this shift could be attributed to the presence of a yielding

[70] In defense of this idea, Oldham argued that many bridges crossing small streams or canals have been, in innumerable instances, forced up in the centre and the roadway, which was once horizontal or nearly so, rose after the earthquake in a more or less steep slope from either side.

bed underground. The superficial layers of the upper surface of these beds were able to move.[71]

Additionally, for Oldham, one of the best illustrations of how the earthquake disturbed the river system was that of the river Kulsi in the south bank of the Brahmaputra. Oldham described that the direct effect of the flood 'was to sweep everything before it; trees were uprooted and soil and subsoil washed away from the underlying rocks, but in the side channels the rush of the water was upstream'.[72] Trees had been bent over, and vegetation flattened down in an upstream direction, while every obstruction had an accumulation of driftwood and weeds on the downstream side, or just the reverse of what would have been the case had the flood been an ordinary one coming down this channel. The flood had hurried up this channel of the length of two miles with sufficient force to left noticeable traces of its effect. Most tributaries encountered barriers in its mouth like the one noticed by Oldham at the junction of the tributary with the Kulsi, which was some 30 feet high and 300 feet across, and composed of a matted mass of tree trunks that had been swept down from the hills and stranded there. The indirect effect of the flood had been to raise the bed of the river Kulsi. This could be seen in the main stream, which had formerly a series of deep pools. It was a well-known fishing river, but after the earthquake it flowed over a broad and shallow, sandy bed. In the side streams, it was even more conspicuous, for the raising of the bed of the main stream had ponded up the water in them, and led to the submergence of a large area of ground. In the Dharan, the streams had been flooded for a distance of five miles and more from the junction, and all the cultivation of Ukiam village submerged. Close to the junction, Oldham found a depth of 20 feet of water in the Dharan, but this was local and due to the scour of an eddy from the Kulsi; further back, the depth of water was about 12 feet, showing that the bed of the Kulsi had here been raised not less than 10 feet above its former level. In the Lokia Jan and another small tributary, flooding had also taken place, but to a less degree. In the Sri Nadi, which joins the Kulsi just above the Dharan, there had been similar flooding, but the depth of water was only about 5 feet, and only extended a short distance, to a

[71] H. Luttman-Johnson, 'The Earthquake in Assam', *Journal of the Society of Arts*, Vol. XLVI (1898), pp. 473–93.
[72] Oldham, *Report*, p. 122.

sandy delta composed of material brought down by the Sri Nadi, which had nearly joined on to the deposits in main stream. The Sri Nadi differs from the other tributaries already referred to, not only because of its greater size but due to the draining of the higher hills by a steep sided, narrow gorge, on the sides of which were many landslips. Evidently, the stuff washed down from these and from the Valley of the main stream and other tributaries, joining it below the landslips at Sinya. It had already raised the level of the bed by over 5 feet, before the great flood came down; the remaining rise of 5 feet was due to the flood and debris brought down during the rest of the rainy season.

The rising river beds led to unprecedented floods in the winter of 1897 and later.

> All down the course of the Brahmaputra the floods of 1897 were more extensive and rose higher than they had been known to do before, but nowhere were they so long continued and so disastrous as in the Barpeta … Not only were the floods severe during the wet weather, but even after the dry weather had set in, and the rivers fallen to their lowest level, large tracts of country, usually dry, remained under water.[73]

This extraordinary flood was attributed to subsidence of the land, elevations of depression, and changes in the river beds. The regions in which the floods were worst those where the filling up of river channels, and the shaking down of the high river banks, was most marked. The general effect of the earthquake was to make rivers, which were formerly insignificant, into large ones. As is clear now, this happened as the river beds were filled up with sand (that caused the floods), resulting in the flowing of river over the surrounding country, destroying the crops, and leaving deposits of sands.[74] Widespread fear was that the earthquake would effectively prevent any cultivation of the tract affected for considerable time to come.

Critical damage was done to embankments in central and western part of the Valley. Though the colonial government did not invest for protection of the floodplain in the 19th century, there were raised roads along the banks of several of the rivers, serving

[73] Oldham, *Report*, p. 161.
[74] 'The effects of earthquake in Assam', *The Times of India*, 30 March 1898.

the purpose of flood embankments. The earthquakes either completely destroyed or breached these dikes in most rivers of the central part.[75]

If the 1897 earthquakes drastically redefined the rivers and their channels, the 1950 earthquake further altered the landscape. The earthquake caused massive floods which brought down sand, mud, trees, and other debris. Significant changes, largely due to enormous slides, in topography were reported by pilots flying over the far eastern part of the Valley. The 1950 earthquake suddenly released approximately 47 billion cubic meters of sediment to the Brahmaputra and Assam.[76] This sediment, mostly mud deposit, in place of the usual sand, helped the rise of river bed again; at Dibrugarh, the river bed rose by 3 metres. This enormous increase of silt was also carried and less quickly dropped, when the flood subsided in November. This was particularly noticeable in the Lohit Valley, above and below, Sadiya. This also resulted in the destruction of the vegetation. Kingdon-Ward noticed that this destruction took place for miles along the left bank of the Lohit.. While a fine faction of this sediment passed to the Bay of Bengal, the coarser section moved slowly and took decades to reach downstream. The 1950 earthquake seriously disturbed the water-level regime of the Brahmaputra for a long period. These disturbances had an impact in the flood level of Bangladesh too. Measurement at Bahadurgarh in Bangladesh show that the 'dominant low water level in the Brahmaputra of 11.9 m in the early fifties had gradually gone up to 13.4m, a rise of 1.5 m in the sixties'. However, since then, a lowering trend can be observed.[77]

Kingdon-Ward, who happened to be travelling in the upper hills of the region during the 1950 earthquake, provided an excellent glimpse of the landscape transformation during the earthquake.[78] For Kingdon-Ward, the impacts could be

[75] Government of India, *Imperial Gazetteer of India,* vol.6, p. 226. The most important roads were those running along the right bank of the Kalang from Kaliabar to Raha, those along the left bank of the Rupahi, and those along the right banks of the Kapili and Jamuna from Raha to Dabaka.

[76] Gregory H. Sambrook Smith, *Braided Rivers: Process, Deposits, Ecology and Management* (London: Blackwell, 2006), p. 292; D.C. Goswami, 'Brahmaputra River, Assam, India: physiography, basin denudation, channel aggradation', *Water Resources Research,* Vol. 21, (1985), pp. 959-978.

[77] B. G. Verghese, *Waters of hope: integrated water resource development and regional cooperation within the Himalayan-Ganga-Brahmaputra-Barak basin (*Delhi: Oxford 1990), p. 125.

[78] F. Kingdon-Ward, 'Aftermath of the Great Assam Earthquake of 1950', *The Geographical Journal*, Vol. 121, no. 3 (September 1955), pp. 290–303.

distinctly categorized into temporary and permanent nature. He eloquently wrote how 'the immediate result of the earthquake was to pour millions of tons of rock and sand into all the main rivers and their tributaries, within the space of a few weeks or even days thereby displacing millions of cubic feet of water'. Felling rocks also left behind 'terrible scars which have been torn in the mountain sides directly enclosing these rivers and their main tributaries'. Kingdon-Ward cited how the Dibang River and its tributaries were almost completely denuded of forests, making the landscape unstable. The rocks brought with them the forests. The rocks and forests immediately impeded and blocked the rivers. The water current had to make its way against these obstacles. River currents failed to take this debris to a long distance, making the rivers shallower. This meant that the tributaries of the Brahmaputra's chief tributaries were completely blocked for some time. Kingdon-Ward noticed this happened to Tidding, Yepak, and Sap Chu—all tributaries of the Lohit. These rivers got blocked, according to him, for at least 24 hours. Kingdon-Ward speculated that this blockade could have been for a longer period also. The blockades were created by rock dams and eventually the dams gave way, 'with indescribable results'. Kingdon-Ward also reported that many other tributaries—both on the Dibang and on the Lohit—were blocked for a longer or shorter period. The impact of these blockades was less, compared to the complete hold-up of the Tidding river for two days, and the appalling devastation which followed. The earthquake also removed extensive forest cover. Kingdon-Ward described:

> … as the earthquake struck across every zone from 15,000 feet to the bottom of the deepest valley, all types of forest[s] suffered, but some much more than others. Every vegetation type will have to be renewed in its own zone before comparative stability can be reached; there is at least enough forest left to supply all the seeds necessary to replant the devastated areas. Obviously, however, it is going to take a long time, since forest cannot regenerate immediately on raw open slopes; there must be several preliminary stages first.[79]

The enormous debris which fell into the rivers filled their gorges and blocked their courses.[80] Most of these blocks burst within a few days. The Subansiri dam broke

[79] Kingdon-Ward, 'The Aftermath of the Great Assam Earthquake of 1950', p. 298.

[80] L.P. Mathur, 'Assam Earthquake of 15th August 1950: A Short Note on Factual Observations' in M.B. Ramachandra Rao, compiled, *A Compilation of Papers on the Assam Earthquake of August 15, 1950* (Delhi: Government Press, 1953).

eight days later, creating a wave 7 metre high which inundated downstream villages killing more than 500 people. The dam break resulted in sudden and extensive floods.[81] The flood brought down huge quantities of sand, silt, and logs of timber. As the blocks had burst successively, many rivers like the Subansiri and Dibang faced repeated flooding. All these were much higher than the usual capacity of the rivers.[82] Beds of many small rivers and *nala*s were blocked, making the flow of these rivers sluggish or non-existent. This seriously upset the drainage of the countryside. Large tracts of cultivable tracts but previously never inundated became flooded and waterlogged. In October 1950, the river Dibang became so silted up that its tributaries could not release water into the main channels. The unreleased water was diverted to high land. As floods receded in the winter, rivers in the eastern part of the Valley looked like 'wide tracts of desert-like country with dead trees standing here and there'. There were dead trees everywhere with silt, debris, and driftwood. Some rivers like the Subansiri and its tributaries Dirgha, Kadam, and Kakoi, quickly changed their channels giving birth to new channels destroying villages, agricultural fields or tea-plantations.[83] Long-term changes in the river system came to be noticed later. One of the most fundamental transformations was noticed in the case of the Subansiri. The landslide in upstream increased sediment load in the river and sudden increase in water discharge altered the hitherto nearly stable hydrologic regimen of the river. Coupled with several other factors, this meandering river had transformed into to a braided one making it highly unstable.[84]

In 1951, the flood came back ferociously despite a normal monsoon and efforts by technocrats to protect river banks.[85] E.P. Gee blamed the previous year's earthquake for this flood. Gee argued that the rapid run-off from the landslides in the hills resulted in equally rapid rises and falls in the flood levels. The silted-up river beds in the plains

[81] The Subansiri dam collapsed on 19 August inundating 300 square miles and affecting more 50,000 people. This flood killed 500 people and there is every reason to doubt this estimate. See M.C. Poddar, 'The Assam Earthquake of 15th August 1950', *Indian Miner*, Vol. 4 (1950), pp. 167–76.
[82] Poddar, 'The Assam Earthquake of 15th August 1950'.
[83] Poddar, 'The Assam Earthquake of 15th August 1950'.
[84] U. Goswami, J.N. Sarma, and A.D. Patgiri, 'River Channel Changes of the Subansiri in Assam, India', *Geomorphology*, Vol. 30, no. 3 (1999), pp. 227–44.
[85] G. Parthasarathi, ed., *Jawaharlal Nehru: Letters to Chief Ministers: 1947–1964*, Vol 2 (Delhi: Oxford University Press, 1985), p. 439.

could not contain the flood water. Many places were flooded for the first time in popular memory.[86] Compared to the pre-1950 level, later studies showed that post 1950, the lowest flood level in the Brahmaputra continued to be higher.[87] That the river system underwent more critical changes was further proved in later researches.[88] Deposition of a gravel and sand and landslides led to rise in the ground level of several tributaries. Most river beds registered aggradation. Some rivers disappeared or were severely damaged at certain sections.

Earthquakes and Non-Human Organisms

There is very little record of the immediate and long-term impact of the 1897 earthquake on non-human organisms. As the rivers changed courses, the floodplains obviously underwent critical transformations. This would indeed put pressure on a range of floodplain inhabitants. Earthquakes played a critical role in the formation of wetlands. Existing wetlands acquired new shape and form as rivers changed their courses and also, sediments left behind it formed levees. The illustrative example is that of Chandubi lake in south bank of the Brahmaputra in western part of the Valley. Popular belief claims that the lake was a result of fissure caused by the 1897 earthquake; later investigation points towards combination of changing river courses and increased sedimentation. The wetland was surrounded by extensive forest coverage and was home to a range of species. This tectonic lake, spreading over little more than 2,500 acre, came to be connected with the Brahmaputra through a feeding canal. Due to tectonic activities, its total area continues to

[86] Gee, 'The Dhubri Earthquake of the 3rd July 1930' p. 104.

[87] D.C. Goswami, 'Fluvial Regime and Flood Hydrology of the Brahmaputra River, Assam', in V.S. Kale, *Flood Studies in India* (Geological Society of India, 1998).

[88] Studies were carried out by comparing the topo-sheet of pre- and post-1950 period, aerial photographs of 1963, and visual analysis of 1974 Landsat satellite images to arrive some important conclusions. N.R. Ramesh and N.S. Gadagkar, 'Effect of 1950 Earthquake on Geomorphology and Ecology in a Part of the Brahmaputra Valley near Teju, Arunachal Pradesh', *Journal of the Geological Society of India*, Vol. 35, no. 1 (1990), pp. 87–90.

shrink over the century.[89] The lake became a crucial site for various non-human organisms.[90] The 1897 earthquake also converted a large floodplain into swampy area in the western part of the Valley which was a crucial habitat for both herbivores and carnivores.[91]

The 1950 earthquake seriously helped to appreciate the impact on the fauna and other non-human organism. By this time, a number of wildlife enthusiasts had made a survey of the fauna of the Valley. There was a critical shift from game and hunting to fauna conservation.[92] Three game reserves had already marked their way into an effective mechanism of fauna preservation. It was obvious that such new concern for the fauna also helped in retaining some understanding of the impact of the earthquake on the fauna. Amongst many others, the person who elaborately recorded obituary for the fauna was E.P. Gee, a tea-planter and avid wildlife observer in Assam. Gee was already a known name in the field of fauna conservation. He had already published and explained the Valley's fauna and topography. It was natural for Gee, while making tour of the earthquake affected Valley, to take stock of the silent devastation caused to them. He described how 'trees and other vegetation of all types from various altitudes were torn down and swept away by the rivers. Many of these trees were of coniferous species'.[93] The earthquake depleted the habitat area available for fauna; both herbivores and carnivores. Both domestic and wild animals lost their lives in landslides, flood, and erosion of the river banks. The number of cattle had been variously estimated from 50,000 cattle to 100,000.[94] Most died due to flood while many would die later of hunger.

---

[89] B. Duarah and Sarat Phukan, 'Understanding the Tectonic Behaviour of the Shillong Plateau, India Using Remote Sensing Data', *Journal of the Geological Society of India*, Vol. 77, no. 2 (2011), pp. 105–12.

[90] Amongst others, the Ghariyal (*Gavialis gengeticus*) became key member of this new habitat. B.P. Saikia, et al., 'Present Distribution Status and Conservation Threats of Indian Gharial in Assam, India', *International Journal of Biodiversity and Conservation*, Vol. 2, no. 12 (December 2010), pp. 382–87.

[91] A.J.W. Milroy, 'The North Kamrup Game Sanctuary, Assam', *The Indian Forester* (September 1916), p. 452.

[92] A. Saikia, *Forests and Ecological History of Assam* (Delhi: OUP: 2011), chapter 7.

[93] E.P. Gee, 'The Assam earthquake of 1950' in M.B. Ramachandra Rao, compiled. *A Compilation of Papers on the Assam Earthquake of August 15, 1950* (Delhi: Government Press, 1953), p.8. In papers, Gee noted that a 'major portion of the driftwood could not be salvaged in the plains and has passed beyond the Indo-Pakistan border on its way to the sea'.

[94] *The Manchester Guardian*, 23 August 1950; *The New York Times*, 24 August 1950.

But, Gee had no doubt that the 'loss among the mammals must have been very great. At a conservative estimate some forty to fifty per cent of the wild animals of the area must have been killed'.[95] It was not sure as to what would be the impact of such a large-scale disappearance of the fauna of a landscape within a short-time span.

> The Mishmi Hills … were so violently devastated … that whole hillsides for miles along the narrow steep Valley have been denuded of soil and vegetation. Centuries will be needed in some areas to restore even as an appropriate habitat for the fauna … the fate of the many of these little known bird and animal species will probably unknown for an indefinite period of time to come.[96]

Gee admitted how difficult it was to estimate the depletion of birds. He thought that as most of them were roosting 'the earthquake must have paralyzed some of them with fear and swept them with the forest to their doom'.[97] If birds faced massive extinction in the central part of the Valley, Kingdon-Ward found they were safe in the far-eastern part of the Valley as these tracts mostly acted as facilitator for the migratory birds.[98]

The greatest causality of the earthquake was fish. Fishes probably never escaped the ferocity of earthquakes. A 17th century Assamese chronicle described how fish struggled to survive after an earthquake in 1697.[99] In 1897, Oldham noted how 'fishes were differently situated'. They were attacked on all sides and over the whole surface of their body by a blow of greater violence than this. Oldham noticed how they were killed in 'myriads, as by the explosion of a dynamite cartridge'.[100] Villagers in the Garo Hills, where rivers had been unaffected by landslips, reported to Oldham the number of fish caught in their traps were 'phenomenally small'. For days after the earthquake, 'the Sameswari River was choked with thousands of dead fish floating down from the upper reaches'. While we know little about how many species of fishes had vanished or to what

---

[95] E.P. Gee, 'The Assam earthquake of 1950'.
[96] S. Dillon Ripley, 'A New Race of Black-throated Babbler', *Pastilla: Yale Peabody Museum of Natural History*, no. 14 (15 December 1952). Ripley was part of the Smithsonian-Yale expedition of 1946–47 to Assam. The expedition concluded that fauna there in many respects were unique.
[97] E.P. Gee, 'The Assam earthquake of 1950' p.9.
[98] Kingdon-Ward, 'The Assam Earthquake of 1950', pp. 175.
[99] The earth was asunder at Sadiya, and magur and kawai fish appeared in the breaches. S.K. Bhuyan, ed., *Tunghungia Buranji* (Gauhati: DHAS, 1933), pp. 29–30.
[100] Oldham, *Report*, p. 80.

extent the fishes succeeded to recover from this trauma but we know surely that they met with the same fate in 1950.[101] Kingdon-Ward describes the tragic fate of the fishes:

> With aquatic life it was another matter. The Lohit and its tributaries ran so thick with mud that the astonished fish found their world turning solid, and were liquidated accordingly. It was, of course, difficult to extract them from the waves, but we acquired one or two, and excellent eating they were. It seems highly probable that every living thing, plant or animal, must have perished slowly or suddenly, stifled by the mud which for months clogged the waters.[102]

Most rivers in eastern part of the Valley carried water thick with mud. Four days after the earthquake, *The Times of India* reported how 'for two days now, fishes have been swimming in multitudes near the banks of this mighty river as if to escape suffocation in the contaminated water'.[103] Another account described the situation where 'an unaccountable sulphurous stench was reported of the Brahmaputra and large shoals of dead fish were said to be floating'.[104] Later, an official report claimed the 1950 earthquake led to the death of millions of fishes.[105] Some fishermen also died but for other reasons. As the river Subansiri dried up, the fishermen thought of catching fish but they met with a tragic fate when burst dam brought in heavy floods.[106]

That the earthquake caused devastation to fish had drawn widespread attention. Angling by now had emerged as another important recreation for Anglo-Indian officials and planters. Officials were astonished at the loss of angling provisions in the Subansiri.[107] Fearing chemical contamination, the Assam administration imposed partial prohibition of catching of fish in the river.[108] Years later an official survey confirmed the

---

[101] Poddar, 'The Assam Earthquake of 15 August 1950'.
[102] Kingdon-Ward, 'The Assam Earthquake of 1950', p. 175.
[103] 'Assam Racked by Earthquakes Still: Rivulets Dry Up—Islets Enveloped By Water', *The Times of India*, 20 August 1950. There were also reports of disappearance of fishermen from the rivers.
[104] 'River Dihang Overruns Town of Upper Assam: Evacuation of Inhabitants Imminent', *The Times of India*, 21 August 1950.
[105] S.K. Dutta, 'Silting of Assam River Beds: Yearly Flood Havoc', *The Times of India*, 28 June 1976.
[106] Francis St. Quintin Wyld, *Thirty Years in Assam: Being Extracts from the Diary of a Chaplain* (Calcutta: self, 1957).
[107] Gee was informed this by R.G. Menzies, who was the political officer of the Subansiri. Menzies, however, claimed that he could obtain 'normal good sport in the rivers Ranganandi and Dikrang'. It was presumed that this was due to non-blocking of the rivers by landslides which kept the rivers from all ill effects.
[108] 'Geologists to Undertake Aerial Survey of Assam: Investigation of Earthquakes Effects, *The Times of India*, 22 August 1950.

reduction in fishing areas of the Valley due to the earthquake.[109] Apart from the fishes and river dolphins[110] we have little information about the fate of other aquatic life.

What explains such mass annihilation of the fishes? The failure of artificial dam after the earthquake caused floods. The flood carried liquid mud mixed with decaying vegetation. 'Countless thousands' of fish in most of the north bank in the east of the Valley had been entirely destroyed.[111] There was widespread belief that nothing was left alive of the aquatic lives in these rivers. Scientists explain how fissures would bring immediate danger to the lives of fish. The rivers and flood carried more than normal sediment. These sediments had also contained mud, and they seriously hampered the flow of oxygen proving dangerous to the fish and other inhabitants of the rivers. If these were the immediate fate of the non-humans, the long term impact of the 1950 earthquake was equally critical. Wildlife scientists have noticed how wildlife habitat underwent critical transformation after the earthquake. Earthquake induced siltation and consequent change in the flooding pattern, slowly changed the vegetation pattern in several location. A change in the vegetation pattern meant change or shrinkage of habitat for specific wildlife species. An illustrative example of such a change was the Dibru-Saikhowa national park in the eastern part of the Valley where the evergreen trees came to be replaced by deciduous forest cover and this severely reduced habitat for Hoolock Gibbon.[112]

Crops and Mortality

How did the peasants and their fields do amidst these chaos and disruption in the river system? Earthquakes meant a sudden increase in the total area classified as fallow land of the Valley. Officials reporting on 1897 widely agree that 'damage done to' unlike loss of humans 'cultivation was considerable, owing to the choking up of the drainage channels

[109] M.P Motwani, *A Preliminary Report on the Fisheries Resources of the Brahmaputra River System in Assam State* (Central Inland Fisheries Research Station, 1959).

[110] R. S. L. Mohan, S. C. Dey, S. P. Bairagi and S. Roy. 'On a survey of the Ganges River Dolphin, Platanista gangetica of the Brahmaputra river, Assam'. *Journal of Bombay Natural History Society*, Vol. 94, No. 3 (1997), pp. 483 - 495.

[111] Gee especially mentioned the Subansiri, Lohit, and Dihing. Amongst the species, Gee mentioned, the mahseer (Barbus tor), bokar or Catli (Barbus hexagonolepis).

[112] A. U. Choudhury, 'The Hoolock Gibbon (hoolock hoolock) in Tinsukia and Dibrugarh districts of Assam, India', *Asian Primates Journal* Vol. 1 no. 2 (2009), pp. 24-31. A.U. Choudhury, 'Mammals, birds and reptiles of Dibru-Saikhowa Sanctuary, Assam, India', *Oryx*, Vol. 32, No. 3, (1998), pp.192-200.

and the disturbance of the levels of the country'.[113] The immediate damage to the crops and general agriculture was colossal. Oldham noted his experience:

> Several villages were, and still are, partly submerged, and some thousands of bighas of cultivated land have been made useless. Of the crops, jute has suffered most; in some fields plants as high as a man have [sic] been completely buried in sand. The ashu crop has suffered a great deal less, and, where not destroyed, promises to be up to the average. Several bhils have silted up, and the newly-formed land is now being ploughed for salt; as the soil is excellent, good results are expected.[114]

Another official described further how the paddy fields underwent major surgeries:

> In some of the corn-fields, these gaps took the form of little rivulets, which ran sometimes to a considerable length, while in others, sands were deposited to such a height that the jute and the early rice crops, which stood over them, were buried together with the hopes of the cultivators, which were fastened upon them.[115]

In the west, the Krishnai, a small tributary of Brahmaputra submerged extensive tracts of crop land and led to the destruction of 50,000 Sal trees.[116] Substantial damage was caused by the fact that fields were covered with sand fills making them uncultivable for several months or in places for years. The earthquake of 1897, as mentioned ealier, in some way affected the drainage channels and levels of the country, and since that date the floods, especially in the western part of the Valley, had been of greater duration and intensity. Large tracts, which used formerly to bear rich crops of mustard, now remain under water too long. This prohibited the peasants from sowing mustard. *The Times of India* predicted that as river banks had entirely subsided, extensive bunds would be required before the peasants could be induced to cultivate the land which in some cases had been abandoned and fresh sites for villages chosen.[117] However, the government failed to invest, leading massive fall in acreage in the following years.

---

[113] B.C. Allen, *Assam District Gazetteer*, Vol. 4 (Allahabad: The Pioneer Press, 1905), p. 15.
[114] Oldham, *Report*, p. 14.
[115] Letter from Babu Hiranmoy Mukherjee, Muktachar to Chief Secretary, Bengal, in Oldham, *Report*, p. 21.
[116] 'The Effects of the Assam Earthquake', *The Times of India*, 30 May 1898.
[117] 'The Effects of the Assam Earthquake', *The Times of India*, 30 March 1898.

Also, subsequent flood caused critical damage to peasants' crops. Both summer and winter crops suffered crucially during the 1897 earthquake in the western part of the Valley. Available statistics for 1895 and 1903 indicate 43 per cent increase in the total fallow area in Assam.[118] In 1904, the Assam Land Revenue Administration Report mentioned how in the western part of the Valley, peasant settlement declined after the 1897 earthquake.[119] Official accounts blamed changes in the natural drainage pattern as reasons behind this fall in acreage.[120] Similarly, an increase of 21 per cent in fallow land was recorded between 1949–50 and 1950–51. This increase was a departure from the normal pattern of declining rate in the fallow area.[121] In 1950, Kingdon-Ward noticed that in most places, main irrigation channel were blocked. This, he feared, would eventually lead to the drying up of the paddy fields.[122]

Floods in the previously not inundated area now forced peasants to move out to safer places. In many places, new village settlement came up. This happened both during the 1897 and 1950 earthquakes.[123] This short-distance migration was facilitated by a practical compulsion as well as the nature of land tenure. The government was still experimenting with temporary and permanent land settlement. Peasants' search for new land was nothing new in the region. They moved out to new higher fields. There was also expectedly a fall in the area under crop. This happened mostly in the riverine tracts as sand deposition in the fields forced the peasants to avoid such places. Resignation of land also meant a drop in the land revenue. Between 1897–98, in the two districts of Nowgoan and Kamrup, there was a 32 per cent drop in the area under winter crop. In Kamrup, the

[118] This figure is calculated from the *Statistical Abstract relating to British India* 1885–86 to 1894–95 and 1894–95 to 1903–04 (London: Her Majesty's Stationary Office, 1896).

[119] *Annual Report of the Assam Land Revenue Administration Report*, 1903–04, p. 4, para.16.

[120] Government of India, *Imperial Gazetteer of India*, vol.6, p. 59.

[121] This figure is quoted from P. C. Goswami, *The Economic Development of Assam*, (Bombay: Asia Publishing House, 1963), Table 17, p. 245.

[122] Kingdon-Ward, *Himalayan Enchantment*, p. 238.

[123] D.H. Lees, an official with the Assam Land Record Department, found out that peasants quickly moved out from their villages in Goalpara. Letter from D.H. Lees, Assistant Commissioner, Land Record Department to Director, Land Records Department, Assam, Gauhati, 25 April 1898, Assam Secretariat Proceeding, Revenue A, May 1898. In 1950, a village Mahmora shifted to Jonai in Lakhimpur to eventually settle in the new place permanently. S.M. Dubey, *North East India: A Sociological Study* (Delhi: Concept, 1974), p. 174.

total area under cultivation fell by approximately 50 per cent.[124] Sown area also declined after the 1950 earthquake.[125] Lands variously classified in official records either 'barren and uncultivable waste' or 'cultivable waste' or 'fallow land' showed tremendous variations immediately after 1950. Also acreage under rice, mustard, tea, and sugar-cane declined significantly. However, this decline was temporary and peasants would go back to their normal practices soon. The 1951 flood, now being directly blamed for the previous year's earthquake caused massive damage to jute and tea. It has been variously claimed that 60 million worth rupees of jute and one-eighth of the tea crop was swept away by the flood.[126] At the same time crop failure, destruction of available stored crops and failure to receive any relief from the government meant an increase in food crisis. Official reports mentioned of increase in incidences of theft from the granaries of the rich peasants; most such incidents were reported from southern hills.[127]

If there was a tangible fluctuation in the area under crop and acreage, at least for the 1897 and 1950 earthquake, officials also blamed the 1897 earthquake for leaving behind a critical impact on the birth rate. The Indian census of 1901 quoted several officials—responsible for monitoring the health and population statistics of the southern hill ranges of the Valley—about the relationship between earthquake and fertility rate. A health official confirmed his view that 'another feature' after the earthquake was a marked decrease in the number of births. Couple of years of bad weather and sharp decline in the crop production was blamed for rapid fall in the fertility rate in the Khasi and Jaintia hills. Edward Gait, the Indian census official, and also a historian on Assam, did not deny this unusual fall in the fertility rate.[128] The Census officials further confirmed this view.[129] This increasing mortality due to the earthquake was fairly acceptable to the colonial officials. The official gazetteer agreed that 'the decrease of nearly 15 percent in the last intercensal period was due to exceptional unhealthiness and

[124] Extract from the Proceeding of the Chief Commissioner of Assam, 3 June 1898, Assam Secretariat Proceedings, Revenue A, May 1898.
[125] Goswami, *The Economic Development of Assam*, Table 20, p. 248.
[126] 'Assam Floods Hit Jute Crop', *The Times of India*, 14 August 1951.
[127] Henry Cotton, *India and Home Memories*, p. 232.
[128] Edward Albert Gait, *Census of India, 1901*, Vol. 4, Part 1, chapter 2, pp. 24–25.
[129] 'The decrease in fertility observed by Dr Roberts is clearly brought out by Table VII, from which it appears that while in 1891 there were 117 children under 5 for every 100 married women between 15 and 40, in 1901 there were only 108…'. Ibid.

to the damage done by the earthquake of 1897'.[130] Many blamed *incessant rain, anxiety, want and bad food, dysentery and fever* for this state of affairs. Health officials noted the spread of black fever epidemic into the previously untouched areas and increase in the mortality rate. One health official expressed anguish at the mortality rate. He admitted:

> Up to the time of the earthquake the whole of the district was fairly healthy and prosperous, but after the earthquake a most malignant kind of fever was very prevalent, and hundreds of people died of it. This lasted for about two years. I have been in the district for close upon thirty years, but I never saw such mortality as during the years 1898 and 1899. [131]

Despite fear that large-scale tea-gardens in the Valley had suffered due to damage done to the upper soil and largely shared by the government in the long run; the tea gardens did not suffer massively as they were better situated and away from the rivers.[132] If tea gardens due to their privileged natural location did not suffer massively, most urban restoration attempt was rendered challenging, as after the earthquake these towns were found to be below flood-level. Only in few cases, supported by their environmental advantages, urban restoration was found to be successful. Some northern bank urban areas like the trading town of Barpeta could be restored by improving drainage, in which the people had to work without payment.[133]

Earthquake, Landscape, and Nation Building

> Look at the map of India you will find Assam on the north-eastern corner bordering Tibet and China and Burma and Pakistan.
>
> Jawaharlal Nehru, Indian Prime Minister
>
> 9 September 1950, All India Radio Broadcast

---

[130] Government of India, *Imperial Gazetteer of India*, vol. 7, p. 84.

[131] Gait, *Census of India, 1901*, Vol. 4, Part 1, chapter 2, pp. 24–25.

[132] 'Assam Tea Gardens Face Ruin: Quake Shocks Affect Top-Soil, Physical Features of Upper Assam Altered,' *The Times of India*, 26 August 1950. However, tea statistics for the period 1950–54 indicate only 71,000 acres which was approximately a 5 per cent decrease in the total area under tea cultivation. Goswami, *The Economic Development of Assam*, Table 31, p. 262. Nehru shared this agony of the tea-planters and wrote to Assam chief minister about this. G. Parthasarathi, *Jawaharlal Nehru: Letters to Chief Ministers*, vol. 2, 1950–52, (Delhi: Oxford University Press, 1989,), p. 231.

[133] Government of India, *Imperial Gazetteer of India*, vol.6, p. 22.

The 1950 earthquake also provided a crucial opportunity for the Indian nation state to reinforce its relationship with the Valley's far eastern landscape known as the North East Frontier Tracts till 1951. Since then, this administrative zone came to be known as North East Frontier Agency (NEFA). Till India's Independence in 1947, this terrain was loosely governed by the colonial government. Independent India also followed a similar policy while a future framework of these terrains was still debated. The earthquake provided a surprising prospect to extend the help of support and friendly gesture to a 'wild' territory, till then, governed insecurely. The experience of encountering the earthquake in the 1950 was strikingly different from the 1897 experience. On the part of the government, it could offer only little help. The government tried to restore public works, but, it agreed that 'even with this sum, it was impossible to restore them to their former condition'. Neither there was any careful estimate of damage done to private property.[134]

By the next major earthquake, India had gained Independence but also put the earthquake-affected tracts into new worries. The colonial government considered that these areas could not be easily brought under governance and allowed qualified local autonomy through promulgation of laws. A number of obstacles stood in the way of the colonial government to assert its full control. Amongst them, linguistic barrier, traditional legal practices, and less navigable terrain continued to haunt the government. The colonial government, unlike its fairly complete control over Indo-Aryan and Dravidian languages, had limited command on the Tibeto-Burman languages which was variously used in this area. Customary laws of resource use, labour, and governance stood in opposition to colonial laws. A hostile mountainous landscape and a dotted line of intricate and fiery river systems gave birth to a landscape which refused to extend an easy welcome to the actors of modern nation state. Despite this, several British explorers tried to travel through hills and mountains to reach out to southern China and eastern Burma. Often unsuccessful, these searches and journeys convinced the colonial administrators that these areas acted as a link between Tibet and northern Burma. Also, the hills and terrains were home to a different economy altogether which required a different political treatment. The colonial government began to administer these tracts through an

[134] Government of India, *Imperial Gazetteer of India*, vol.6, p. 23.

administrative arrangement of *Inner Line* which excluded these areas from the larger colonial framework of governance.

At India's Independence, this system was still at work and came to be administered by the Indian Ministry of External Affairs. The experience of the Second World War had already transformed the area into India's strategic borderland. This new-found strategic importance was angrily resisted by the Chinese government. Later, in 1962, the Indo-China war broke out and China laid strong claim over these territories. This was not a thing to be welcomed by the new Indian government. Previously several military *punitive* campaigns against the local inhabitants often resulted in disastrous results to the colonial government. All these ensured that the foothills of Himalaya and upper reaches of Brahmaputra had a limited space within the imagination of modern Indian geographies. The earthquake had severely injured an impenetrable natural frontier lying between India and China. This was a sentiment shared by the Indian national media. As mentioned earlier, *The Times of India* expressed remorse and claimed that consequent to the earthquake 'mountain chains said to have disappeared'.

The earthquake-induced relief and rehabilitation programme suddenly offered space for these Himalayan foothill areas to gain attention in the Indian imaginary. The tragedy and devastation associated with the 1934 Bihar earthquake was still fresh before the nation.[135] Nehru admitted that the earthquake 'has been a very big and serious affair'.[136] It was also an extraordinary opportunity to prove the worth of the new nation state. The nation state and its various instruments also got worried by the fact that the tribal people—estimated to be around half a million—now needed the guidance and benevolence of the Indian state.[137] Nehru appealed to the nation to face the 'disaster bravely'.[138] Thousands of tea-garden workers were mobilized to put rehabilitation and reconstruction work at pace. Shortage of food, mostly due to hoarding by traders, was widely reported and admitted by the government. The earthquake only reaffirmed

[135] P. Chatterjee, 'The Nation in Heterogeneous Time', *Indian Economic and Social History Review*, Vol. 38 (December 2001), pp. 399–418.
[136] Parthasarathi, *Jawaharlal Nehru*, p. 196.
[137] Donald Thomas, 'Fate of Tribal People in Quake-rocked Assam: Immense Devastation in North-East India', *The Times of India*, 3 September 1950.
[138] 'Face Disaster Bravely: Rush Food To Assam', *The Times of India*, 10 September 1950.

stereotypes about Assam, as a place irreducibly subject to the whims of nature which was so meticulously circulated over long period. The Valley and its rulers again proved to be unqualified to take care of it.[139] The earthquake facilitated conditions for an encounter between the Indian government through intermediaries in the Valley and the people living in the interior to begin a nation-building process in this strategic borderland.

These urge for both nation building and proving the worth of newly attained freedom relief and rehabilitation came in war footing. Support came in from across the nation and international groups, recovering from shocks and traumas of the Second World War.[140] Prime Minister Nehru made an aerial visit of the affected places and addressed a public meeting at the bank of Brahmaputra on 5 September.[141] Agreeing that this earthquake brought varieties of permanent physical changes into the landscape of the Valley, Nehru, however, admitted, 'Assam is a province which was badly neglected in the past and yet is most important today for a variety of reasons. It deserves every kind of assistance….'[142] Beyond and through these relief and rehabilitation programmes, the Indian government also critically reoriented the area's homogenization process to reaffirm its relationship with the 'mainland' geography. Nehru had equally made sure that the earthquake had 'done good in the sense that it has roused up the people of Assam and made them realize that it is up to them to pull their province up'.[143] The process began with the formation of NEFA in 1914 as a state apparatus to administer the region. After Independence, the subject got crucial attention when the new Constitution of India

[139] Bérénice Guyot-Réchard, 'Waging "Nature's perpetual war": The Great Assam Earthquake of 1950 and the Vagaries of Nation-building' (unpublished paper presented at the Social Sciences Seminar, Indian Institute of Technology, Guwahati, India, August 2011).

[140] In Bombay, traders gathered to send relief funds. *The Times of India* reported how within 'ten minutes' of an appeal by the Mayor of the Bombay city, resulted in the collection 30,000 rupees. 'Assam Earthquake Relief', *The Times of India*, 31 August 1950. The Bombay-based cinema halls contributed one-fourth of their day's earning on 23 October which was a public holiday. 'Funds for Assam relief: Film Show Proceeds To Be Donated', *The Times of India*, 14 October 1950. The London-based India Relief committee, of which V.K. Krishna Menon was the joint president, and like their somewhat successful work during the Bengal Famine of 1943, mobilized international fund. Menon received a grant of £500 from Lady Mountbatten of Burma. V. K. Krishna Menon,, 'Earthquake in Assam', *The Times*, 13 September 1950.

[141] 'Help to rebuild Assam assured: Pandit Nehru's aerial tour of affected area, traditional reception by villagers', *The Times of India*, 6 September 1950.

[142] Parthasarathi, *Jawaharlal Nehru*, 1 October 1950, p. 212.

[143] I*bid*, p. 213.

provided for political space to allow further negotiation with these areas. The Indian government was worried for its weak prospect of becoming a welfare state for the populations in these areas. The government put itself in a long-term project towards making this exclusive geographical space as core to the Indian geography and national cultural imagery as the rest. Through relief operations the inhabitants came under the direct contact with modern state agencies. Also, it was also an excellent opportunity to prove the worthiness of Indian bureaucracy after Independence. The Indian government declined offers of assistance in relief operations from ex-colonial officers. The government distributed relief materials through the Indian Air Force's 'mercy mission'.[144] Amongst many commodities distributed, iron agricultural implements also found place. Relief camps were established and religious structures were restored. The boldest example was in Tawang, a crucial centre of Indian Buddhist practices.[145] The government repaired the Buddhist monasteries reaffirming the secular nation state's faith in a multicultural religious world. This also afforded the Indian administration to make entry for Indian Monmpa priests than the Tibetan ones. New administrative towns, similar to Indian townships, were established. A medical department with several health units was founded also in 1951.

A modern nation state also meant symmetry in the country's agrarian practice. The livelihood practices of the people in these areas also required significant transformation. To achieve this, 'model villages' were established in Pasighat. These villages aimed at transforming the hunter–gatherer populations to settled agrarian practices.[146] The first move was to establish an Agricultural Research Institute, a symbol of modern Indian agriculture.[147] This would train the populations to practice wet rice cultivation. The populations fiercely resisted these attempts. They would frequently go back, to the much concern of the officials, to hills in search of food. Discouraged by the humid and hot climate and epidemics, many finally returned to the hills. The relief

[144] 'Airlift of Food Supplies to Quake-devastated Assam: mercy mission', *The Times of India*, 23 August 1950.
[145] N. Rustomji, *Enchanted Frontiers: Sikkim, Bhutan, and India's Northeastern Borderlands* (New Delhi: Oxford University Press, 1971), pp. 317–19.
[146] Guyot-Réchard, 'Waging "Nature's perpetual war"'.
[147] Government of India, *The March of India*, Vol. 8, Publications Division, Ministry of Information and Broadcasting, 1955, pp. 163–66.

programme and remaking of the urban setting provided other Indians to move in various capacities. The administrative policy of sheltering the area from outside influence and penetration was temporarily discontinued. This enabled various people to occupy government jobs or Marwari traders—the principal trading community in modern India—moved into the hills. Couple of years later, Indian anthropologists would find meaningful but slow transformation in these areas of both people and landscape.[148]

Similarly, the Assam government was able to temporarily re-affirm investments into its relationship with the frontier. In spite of the major political defeat of losing Agency powers over the frontier, the Assam Government was determined to retain influence over the area. Throughout the 1950s, an increasing tug-of-war would take place between centre and state. Interestingly, this was framed around the same unique slogan of 'unity in diversity,' but wielded against one another. The Assam Chief Minister, Bishnuram Medhi, visited the affected hill areas and met the affected populations. As 1951 waned, the NEFA administration gradually closed the door that was momentarily kept ajar. Both social organisations and the Assam government lost physical access to the Frontier, and the latter further witnessed the increasing reluctance of the Governor and his Adviser's Secretariat to keep them informed of administrative policy in the frontier. The door would remain close till the late 1950s.

Earthquake and Contested Histories

Great and moderate earthquakes will continue to shake northern India in the coming millennium[149].

'Villagers desert homes: quake fears'[150]

The Times of India

[148] Pradish Das Gupta, 'Forgery Comes Naturally to Assam Tribe' *The Times of India*, 30 November 1952.
[149] R. Bilham, F. Blume, and R. Bendick, 'Geodetic Constraints on the Translation and Deformation of India: Implications for Future Great Himalayan Earthquakes', *Current Science*, Vol. 74, no. 3, (1998), pp. 213-229.
[150] *The Times of India*, 18 May 1987.

After 1950, earthquake again troubled Assam in 1954. For centuries, the Valley remains a prisoner of tectonic instability. It might take another millions of years to arrive at a stable situation. Earthquakes of smaller and average intensity continue to frequent regularly. This led Hunter, the imperial government's statistician, to note that after the earthquake of 1897, Assam and its surrounding region had been disturbed by small shocks, more than 5,000 being recorded in 1897.[151] The people and the nation state responded variously to these anxieties. Anxieties had gripped the larger mental map of the region. The science of earthquake prediction has not been able to make any major breakthrough. This did not restrain seismologists to predict earthquake in the region. Villagers, apprehending earthquakes after occurrence of an earthquake of an average intensity, frequently deserted their homes to avoid damages. Seismologists agree that tectonic movements have helped in the accumulation of strains to inflict earthquakes in future.[152]

Earthquakes had continued to occur across the Indian sub-continent. This apparent uncertainty combined with a speculative science and past experiences about the natural alteration of physical landscape, however, has not deterred Indian policy-makers to tame this uncertain seismic trap. Large numbers of river dams which have been earmarked in the Brahmaputra river system, as discussed elsewhere in this book, however, does not restrain the late 20th century and early 21st century Indian policy-makers to ignore the geological and ecological uncertainties conditioned by the histories of earthquakes. Ambitious hydro-power projects demand exploring an uncertain geological terrain of the Valley. The government assumes that risk behind these projects is worth-taking, given the economic gains to be made out of it even while scientists have warned the policy-makers not to dismiss these tectonic uncertainties.[153] This apparent unwillingness of the policy-makers to ignore past devastation caused by the earthquakes stems from the very fact that rivers and its geological surrounding are increasingly seen as two discrete entities, and not to be influenced by each other. At the same time

[151] Government of India, *Imperial Gazetteer of India*, Vol.1, p.98.

[152] R. Bilham, V.K. Gaur, and P. Molnar, 'Himalayan Seismic Hazard', *Science*, Vol. 293 (2001), pp. 1442–44.

[153] A scientific committee reported in 2010 that '…from geological, tectonic and seismological points of view the Expert Group suggests not to consider the Himalayan foothills, south of MBT for any mega hydropower project'. In J. Kalita et al, *Report on Downstream Impact study of the Subansiri Lower hydroelectric power project at Gerukamukh of the NHPC*, (Guwahati, 2010).

earthquakes unfold massive human losses and natural devastations. Earthquakes bring empathy and help mobilize the nation.

The rural peasantry and labouring class, mostly drawn from the tea gardens, were mobilized all along after the earthquakes to restore the fields and river channels. A local official suggested that local bodies should take lead in mobilizing peasantry and rural labour in opening up the rivulets or canals, re-digging the tanks, removing the deposits of sands from the corn-fields, filling up the gaps and hollows and repairing the roads.[154] The official, however, showed imagination when he equally claimed that such decisions should be left to these local bodies to consider whether the new canals opened up by the earthquake should be closed or continued to any natural stream which may be close by though he would prefer the latter course, as they would, if continued, water a large tract of the country and supply drinking water to men and cattle.

If the state tried to impose discipline in the aftermath of the earthquake, for the large majority of the people who survived the tragedy of the devastation, they blamed their fate and sought religious explanations and often such explanations became part of the official narrative. Thus, Oldham, took note of how some Hindus reacted to him during 1897 earthquake:

> If you get famine, drought and plague in one and the same year, you get the earthquake that year. This calculation has indeed been verified…We Hindus fully believe in this that the sin of mankind has been causing all these woeful changes, and that unless there is an advance made towards beatitude there will be no end of these.[155]

If fate was responsible, suggestion of religious remedies to overcome natural challenges was also put forward. A local official thought that:

> … to guard against the recurrence of such unnatural changes in future, I should only repeat what I have said in some of my previous reports to Government, viz., firstly, that Government should see that every man in every community should follow the dictum of the religion which has been accepted by that community and act accordingly.[156]

We do not know whether the government relented to his suggestion but sudden changes brought into the physical space left deep scars in the mental map of the rural peasantry. Yet, they knew that the earthquakes and subsequent changes are beyond their control. For

[154] 'Letter from Babu Hiranmoy Mukherjee' in Oldham, *Report*, p. 24.
[155] 'Letter from Babu Hiranmoy Mukherjee' in Oldham, *Report*, p. 21.
[156] Ibid.

some of them these natural disasters are results of god's curse on them but they are equally hopeful of new life afterwards. They find solace in religious discourse around the life of Shiva, or *Nataraja,* the Hindu god, well known for his dances. They believe that Shiva's cycle of destructive dance yields to restorative phase of creativity.[157]

The Valley's populations over the years have adjusted to the earthquake-defined landscape. The anxieties and confusion caused by earthquakes are only part of their folklore.[158] The human experience in the Valley from the earthquake was short-lived; the number of human death was lesser and also, peasant agriculture had recovered moderately. The human loss, during both the earthquakes, remained minimal for two reasons. The sparsely located rural population used mostly used light material for their housing and both the events took place when the people were not asleep. Most damages, from the perspective of human loss took place in urban areas. It so happened that the 1897 earthquake led to immediate reconfiguration of urban housing design. But away from this moderate picture of recovery earthquakes induced physical transformations created new worries in the form flood to which the Valley remains a permanent prisoner, as discussed elsewhere in the book.

[157] For an insightful reading of the meaning of Shiva's dance, see A.K. Coomaraswamy, *The Dance of Śiva: Fourteen Indian Essays* (New York: Sunwise Turn, 1924), pp. 56–66.

[158] Ballads were composed on 1897 earthquake to be known as *Bhumikampor Git*- the songs of earthquake. P.D. Goswami., *Ballad and Tales of Assam: a study of the folklore of Assam,* (Guwahati: Gauhati University, 1960), p.53, 271; P.D. Goswami, *Folk-Literature of Assam: an introductory survey* (Guwahati: Gauhati University, 1954), p. 32.