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Shifting Ground: A Historical Study of the Impact of Major Earthquakes of the 19th Century on Assam's Geology

Roja Ahmed

Department of History, North-eastern Hill University, Shillong, Meghalaya (India) E-mail: <ahmedroza9999@gmail.com>

Abstract

The present study examines the profound impact of major earthquakes on the geological landscape of Assam. The region has been historically susceptible to seismic activity, and the article delves into the aftermath of some of the significant earthquakes of the past like the Cachar Earthquake of 1869 and the Shillong Earthquake of 1897. Through a review of archival records, the study makes an attempt to explore how earthquakes have shaped the topography, landforms and geological features of Assam over centuries. It tries to trace the correlation between seismic events and changes in the landscape of the region. Assam's geology has played a significant role in the occurrence of notable earthquakes in the region. The geological setting of Assam is intertwined with tectonic collision zone. The study has tried to present an overview of Assam's geology and some significant earthquakes of the past. Major earthquakes have influenced the hydrological dynamics of Assam and therefore, this change has also been looked into.

Keywords

Assam, Earthquake, Geology, Topography, Rivers.

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Editorial Office : D-59, Shastri Nagar, Meerut - 250 004 (INDIA)
Ph. : 0121-2763765, +91-9997771669, +91-9219658788

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1. Introduction

Throughout human history, civilizations have grappled with the enduring impact of natural disasters, including earthquakes, which have left indelible marks on societies and reshaped the course of human development. The annals of history bear witness to the profound and often catastrophic influence of these seismic events, underscoring the entwined relationship between human civilization and the powerful 'forces of nature'.

When considering the multifaceted impact of earthquakes on human history, it is paramount to recognize the pivotal role of geological events in shaping the trajectory of human societies. The seismic upheavals wrought by earthquakes have catalyzed profound changes, from altering landscapes and coastlines to triggering social, economic and political transformations.

From ancient settlements such as Pompeii devastated by the eruption of Mount Vesuvius to modern urban centers ravaged by recent earthquakes, the tangible scars of seismic devastation endure as poignant testaments to the power of natural disasters.

In contemporary society, the study and understanding of earthquakes continue to play an instrumental role in informing disaster mitigation and response strategies. Thomas Oldham, the director of the Geological Survey of India has left a catalog of earthquakes of early India. His son, Richard D. Oldham has also given account of some of the major earthquakes in India. The present study has tried to delve into the geological aspects of the significant earthquakes of the 19th century Assam which left a profound impact on the region's landscape.

2. Assam's Geology

Assam, located in the northeastern part of India, falls under seismic zone V, as per the seismic zoning map of India.[1] Seismic zone

V is the highest level of seismic risk in India and is characterized by the highest probability of experiencing earthquakes of moderate to very high intensity. Earthquakes have had a notable geological impact in Assam, shaping the terrain, topography, and natural processes of the area.

Tectonic Activity : Assam is situated at the eastern edge of the Indian tectonic plate, where it converges with the Eurasian Plate.[2] This convergence has resulted in the uplift of the Himalayas and the ongoing collision between the Indian and Eurasian Plates. As a result, Assam experiences significant tectonic activity, and the release of accumulated stress through seismic events such as earthquakes has led to geological deformation and uplift in the region.

The impact of major earthquakes of the past in Assam has had a profound and enduring influence on the region's landscape and geology, shaping its geological features and environmental narratives. These seismic events have left indelible marks on Assam, with far-reaching consequences that extend well beyond the immediate periods of the earthquakes themselves.

Geological Deformation : Major earthquakes of the past have engendered significant geological deformation, leading to the formation of new landforms, uplifts, and subsidence. Seismic activity had induced complex faulting and folding processes, contributing to the region's diverse topography and creating landscapes shaped by tectonic movements.

Significant Earthquakes : Assam has experienced some significant earthquakes in its past, causing widespread damage and loss of lives. A major earthquake to have occurred in the region's history was the Cachar Earthquake of 1869. With an estimated magnitude of 7.4 that occurred in the Kopili fault, the earthquake rocked the region causing massive damages in Imphal (present day Manipur) and Silchar besides affecting Guwahati, Nowgong, Lakhimpur, Dibrugarh, Nagaland and Sylhet. It also rocked places in West Bengal and Bihar.[3] One of the most devastating earthquakes in the region's history occurred in 1897, known as the Shillong Earthquake of 1897. This earthquake, estimated to have a magnitude of 8.1, resulted in extensive destruction, primarily affecting the districts of Sylhet, Khasi Hills, undivided Goalpara, Kamrup and Nowgong.

3. River Dynamics

Major earthquake like the earthquake of 1897 has influenced the hydrological dynamics of Assam's rivers, with direct consequences for the region's geological features. Seismic events triggered changes in river courses, leading to avulsions, raising of river beds and the reconfiguration of fluvial landforms, shaping the courses and characteristics of the region's waterways. Detailed inspections after the Earthquake of 1897 revealed that the Brahmaputra River and its channels had become shallower following the earthquake. Following the earthquake, the river bed had been raised by more than a foot in some areas and sand bars were formed lower down which kept the level of water higher than usual. In parts of the Kamrup district, the earthquake was immediately followed by a sudden rise of water from the rivers and beels which had been partly filled up with sand by the earthquake. The damage done by the floods which followed the earthquake was much greater than that caused directly by the earthquake. The numerous rivers which fall into the Brahmaputra also rose in flood at the same time. Pandit Matadin Sukul's inspection shows that between Sontoli in Kamrup and a little below Hatimura, Nowgong, the river was broken into two channels, which again joined lower down. There was hardly 5 feet of water in either. Following the earthquake commanders of cargo steamers viz. 'Shillong Down' and 'Varuna Down' found shallow waters in the channel leading out into the main stream above Mangaldai.[4] Cargo steamer 'Dilwara' also found shallow water while sailing between Tezpur and Guwahati on 1st December, 1897.

In the town of Goalpara, the land lying close to the bank slid forward towards the rivers, creating series of cracks running parallel to the bank, the upper most cracks extended up to the slope of the Goalpara Hill. A portion of the hill had also slipped in during the earthquake of 1897. In Dhubri town, following subsequent floods, the river shifted its channel to almost the middle of its bed and formed a big char opposite to the town. Steamers coming to Dhubri from Goalpara town found the channel getting shallower. In West Guwahati, much sand was thrown up in the Brahmaputra during the earthquake and the banks slipped in with trees, obstructing channels. The Khanajan bridge with masonry abutments and piers had also collapsed which almost blocked the channel. Back waters were thus set in, and crops higher up were damaged by the spill waters of the

river.[5] During the earthquake, the Kalbhog channel was entirely blocked from the place of its bifurcation to near Salisala Village in Chayani mauza, Kamrup. The length of the closed portion was about 4 miles. The bed turned dry and almost leveled with the bank. This channel was previously used for irrigation and drinking purpose in Rani and Chayani mauzas, Kamrup. In Barpeta, the bed of the Hirajan and the Marachaolkhoa rivers were raised by 7 feet while the Saru Manas was raised by 3 feet following the earthquake. The strand road in front of the courthouse and other government buildings had sunken from 3 to 5 and a half feet. The examination of the interior of the Barpeta town showed that many of the low places were filled in with sand geysers and silt deposit, and the artificial grounds or mounds on which the houses were built had sunk along with the embanked roads. Owing to the sinkage of river banks and raising of their beds, subsequent floods followed which caused much damage to the town. The rivers which caused most floods in the Barpeta subdivision were Noanadi, Pagladia, Tihu, Caldia, Pohumara and Saru Manas. During the earthquake landslips occurred in the Bhutan Hills and sand geysers were formed in a number of places. The subsequent rains brought down loose soil from the hills and distributed it all over the town. Beels were also silted up and their beds raised. At the Trunk road crossing, the Pagladia river got dried up by sand springs during the earthquake and remained so for a day, when waters from the hills rushed in and scoured its bed. Two of its tributaries, viz. Alpa and the Singra were silted up and ran in different channels.

In Goalpara, during the earthquake, bars of sand were formed at places and the channel of the Manas river became very shallow. The sliding of banks into the river bed was also observed in many places. Some of the other rivers of the South bank which were affected during the earthquake were Deosila, Bherbheria, Dudhnai, Krishnai, Jinari, Gara, Jinjiram and Kalu.

During the earthquake, the banks sank and slipped into the bed and blocked the channel at many places, with the result that the subsequent floods overtopped the banks and caused considerable damage to crops. Apart from voyage, these channels were regularly used for timber floating from various neighboring hills which was halted after the blockage owing to the earthquake. The Krishnai River, one of the largest rivers of Goalpara subdivision was blocked at various channels. Backwaters were formed which caused great damage by submerging extensive tracts. *Sali* paddy and a large

portion of the *sal* forest lying West of Jiar rora was submerged whereby around 50,000 *sal* trees were destroyed. The back waters also caused damage to the Trunk road near Krishnai by washing away three bridges and widening their openings. Foothills were flooded as well.

The forcing up of the river beds was not uniform, and in some places was more extensive than in others. This led to the formation of barriers 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.

4. Landslides and Erosion

Major earthquakes have heightened the susceptibility of the region to geological hazards such as landslides, slope instability, and erosion. Seismic events triggered mass movements leading to the reconfiguration of hill slopes and sediment transport, thereby influencing erosion patterns and geomorphological evolution of the landscape. The Cachar Earthquake of 1869 caused big landslips in the Naga Hills of colonial Assam. An extract from the Deputy Commissioner of Naga Hills' diary showing an account of the earthquake as experienced by him at the village of Keromah, Naga Hills goes as :

> As the first great wave passed, I noticed on my right a great cloud of dust go up from a landslip under the village of Biffomah to the north of me, and almost directly afterwards another rose from a low hill to the south-west of Biffomah, followed directly by a third from a huge landslip under Geroophemah, which also bears south-west from Biffomah… Directly the shock was over I found that the earth had opened in several places, the fissures were of considerable length and sufficiently wide to admit of the insertion of two fingers abreast, one of the graves at the edge of the khud had cracked right across, the end of another had been shaken down… on my return to Samoogoodting I noticed on the road that the rivers were discolored and swollen… that there had been a fresh fall of rocks and earth from old landslips, and that new landslips had occurred in places.[6]

Regarding landslips in Bhutan Hills surrounding Assam due to the earthquake of 1897, the Sub-divisional Officer of Mangaldai wrote:

> The principal damage has been done in the outlying ranges of the Bhutan Hills. Many roads have been carried away by the

landslips caused by the earthquake, but very little loss of life was incurred.[7]

5. Earth Fissures, Sand Vents and Allied Phenomena

During major earthquakes in colonial Assam, seismic events triggered the formation of earth fissures and sand vents due to intense ground shaking, liquefaction, and the release of pore water and sediments. The geological impact of these earthquakes led to the development of distinctive surface features, providing evidence of the seismic disturbances and their effects on the landscape.

Seismic forces acting on the ground during major earthquakes in colonial Assam led to the development of earth fissures, also known as ground ruptures or earthquake ruptures. These fissures were manifested as fractures or cracks in the earth's surface, resulting from horizontal and vertical displacement of the ground along tectonic fault lines. Fissures in the ground, the formation of vents from which sand, water and mud pouring out have been numerous and widespread during the earthquake of 1897. The pushing forward of the abutments of the bridges was universal throughout the fissured tracts and the narrowing of the river channels seems to have been still more conspicuous in places where there were no massively built bridges to assist in supporting the banks. In all cases of earthquakes it was due to the throwing off of the unsupported river banks and accompanied by the formation of fissures.[8]

Another very striking result of the displacement of the alluvium, whether by throwing off at the free surfaces of river channels or tanks or otherwise, was the bending of rails. There are a series of photographs showing the effects of the earthquake on the Assam Bengal and Eastern Bengal Railways and on the Tezpore Balipara tramway.[9] The lateral and vertical movement of the ground during the seismic event caused the rail tracks to contort and deform, disrupting the alignment and structural integrity of the railway lines.

At Nowgong, the ejection of sand had such force that covers of wells, imbedded in mortar were hurled aside. The other was at Goalpara where a well was altogether filled with sand and a portion of the wooden cover was hurled 30 feet distant where it lay half buried.[10]

6. Conclusion

Through this historical study of the impact of major earthquakes on Assam's geology, the work has tried to gain valuable insights into

the dynamic and altered landscape of the region. The study has tried to include how the seismic events of the past have left an indelible mark on the geological features of Assam, shaping its topography and landforms. From the Cachar Earthquake of 1869 up to the Earthquake of 1897, the geological heritage of Assam bears witness to the forces of nature that have restructured the earth's crust over time. In course of the present work it has been understood how raising of river beds and shifting of river channels owing to the earthquakes have caused high floods in the region bringing agony to the marginalized section, notably the peasant class. The work however, owing to its limitations has not included the impact of floods as a result of earthquakes on society and has been confined to the geological and hydrological aspects.

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