The 7 May 2022 Barpeta tornado of Assam, India

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On 7 May 2022 an unexpected low-intensity tornado hit the Barpeta district, Assam, North East India, in the morning. Details of the tornado as gathered from on-the-spot enquiries and eyewitnesses are presented here. The tornado did not cause much harm as it passed through areas that were not densely populated. A probable hypothesis for such an unusual natural hazard in Assam, where tornadoes are infrequent, is discussed.

In a rare event, a tornado outbreak occurred in the Rowmari village, Chenga area, Barpeta district, Assam, North East India, on 7 May 2022, at 10.20 am (Figure 1). No casualties or significant damages were reported during the event as the tornado developed in a sparsely populated *char* area. However, four houses and three other establishments were damaged in the village affecting nearly 56 people in the area, according to Assam State Disaster Management Authority (ASDMA), Guwahati (Figure 2).

A tornado is a violently spinning column of air developed within a convective cloud[1]. One end of a tornado is always attached to a supercell thunderstorm and the other end to the ground or water body below, depending upon its place of origin. Tornadoes are reported from all the continents except Antarctica. They are most common in the mid-latitude regions (between 20° and 60°N and S), where the cold polar air meets the warm tropical air[2].

In Assam, severe weather outbreaks like tornadoes are relatively infrequent. However, the state is usually hit by tropical cyclones known as Nor'westers or Kalbaishakhi (locally known as Bordoisila) every year during the onset of spring[3]. In general, four specific atmospheric parameters are necessary along with the topography for the development of a tornado. These include shear (S), lift (L), instability (I) and moisture (M)[4] (acronym S.L.I.M.). Vertical speed shear (change in wind speed with altitude) and vertical directional shear (change in wind direction with altitude) are the key shearing components. The vertical speed shear can tilt the updraft of a storm and enhance its strength. It can also create horizontal rolling in the atmosphere. Lift initiates the thunderstorm and the sources of lift include dry lines, cold fronts, warm fronts, sea breeze and changes in terrain elevation. Instability is caused by the temperature gradient with altitude, i.e. warm and humid air near the ground and progressively cooler air at higher altitudes. Oceans are the source of moisture, which is another essential parameter for the formation of a tornado[4].

It is to be noted that the highest number of tornado occurrences in the world has been in the USA, Canada, England, New Zealand, Bangladesh and Argentina. Among them, the Great Plains of the Central United States are more prone to tornadoes due to the prevailing ideal environment for forming severe thunderstorms. In this area, known as Tornado Alley, storms are caused when the dry cold air moving south from Canada meets the warm moist air travelling north from the Gulf of Mexico. Our neighbouring country Bangladesh too is highly prone to tornadic events. Here, the warm, humid air flows from the Bay of Bengal and travels northwards to meet the southeasterly winds emerging from the Himalayan mountains. This leads to the convergence of two different winds resulting in the formation of tornadoes[5].

The history of tornadoes in Assam dates back to 19 April 1963. On that day, a powerful tornado swept across the Kooch Behar district of West Bengal and continued its travel up to Goalpara district of Assam, causing severe damage to life and property[6,7]. This historical tornado traversed a total path of 36 km towards the SE with a land interaction funnel diameter of 100–130 m (ref. 6). The 7 May 2022 Barpeta tornado may be an EF-0 or EF-1 (EF, enhanced Fujita scale[8])-type low-intensity tornado according to India Meteorological Department[9]. According to Parihi Bhuyan, headman of the Chenimari village, there was formation of a long limb of air with a diameter of about 15–18 ft that existed for 10–15 min in the Balartari region at around 9:30 am. Suddenly the limb started moving with increased diameter from north to

Figure 1. An image of the 7 May 2022 tornado that occurred in the Rowmari village of Chenga Revenue Circle, Barpeta district, Assam, North East India. The tornado is seen moving adjacent to the banks of the mighty Brahmaputra River. (Source: ASDMA, Guwahati.)

Figure 2. Photographs showing moderate destruction of human establishments. (Source: ASDMA.)

south and vanished in the east (at Roumari). During the passage, it traversed a distance of nearly 3 km, including land and water surfaces. According to eyewitness accounts, big ripples formed in the Brahmaputra river, creating panic among the locals. Though it lasted only a few minutes (approx. 20–30 min), several pertinent questions arose. Will this type of tornado or those of higher intensities hit Assam again? If so, what should be our future course of action? Does climate change have a role in the formation of this unusual tornado?

In the Indian subcontinent, Bangladesh and the plains of West Bengal present the most favourable topography and conditions for the formation of tornadoes, especially during pre-monsoon months, because of the existence of both hot and cool air fronts[10,11]. The hot air flowing from the Bay of Bengal easily travels across the coastal plains without any obstacles due to favourable topography. However, in the case of Assam, the Shillong plateau serves as a barrier, resisting the oceanic air circulation, due to which it loses strength before reaching the plains of Assam. This may be the reason for the rare occurrence of tornadoes in Assam compared to coastal areas of Bangladesh or West Bengal.

Figure 3 shows the temporal variation of temperature, relative humidity and precipitation (MERRA2 Native Resolution Daily Data) during April and May 2022 for Barpeta district, Assam. The figure shows a pattern of declining relative humidity and a subtle temperature increase in the previous two days before the event, i.e. from 5 May 2022. Fall in relative humidity and simultaneous temperature rise indicate the presence of sufficient amounts of water vapour (moisture) and cold air in the atmosphere. Figure 4 shows S.L.I.M. for the formation of the Barpeta tornado. In this case, cool air from the Himalayas could account for the necessary vertical and horizontal shearing (S). Whereas the cold front from the west could have initiated the lift (L) and temperature gradient, i.e. warm air near the surface and cold air at higher altitudes, might have generated the instability (I). Moisture (M) is ideally supplied by the Brahmaputra river. The interplay of all these air fronts may have initiated a favourable condition for the formation of the 7 May 2022 Barpeta tornado.

Assam has been experiencing the impacts of global climate change during the past decade. According to a report prepared by the Assam State Action Plan on Climate Change 2015, the mean temperature in the State for the period 1951–2010 has increased by +0.01°C/yr, while there has also been an increase in the seasonal temperature across seasons, with pronounced warming in post-monsoon and winter temperatures. The annual rainfall has also decreased by –2.96 mm/yr during the same period. However, this tornado may not be an adequate diagnostic event for inferring the climate change phenomenon. Even while some studies have shown that climate change may increase the odds of tornadoes and other violent thunderstorms, no actual observations have been made yet. The role of climate change that may affect different parameters responsible for tornado formation is still an open question and a subject of ongoing studies. Research shows that

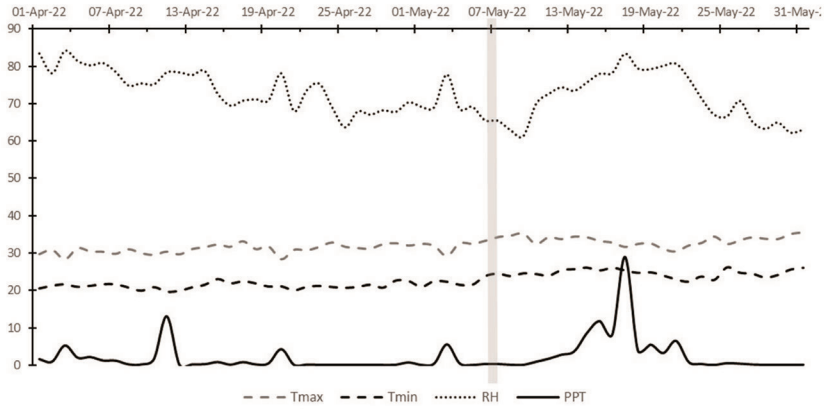

Figure 3. Temporal variation of precipitation (PPT; mm/day), minimum (T_{min}) and maximum (T_{max}) temperatures (°C) and relative humidity (RH; %) during April and May 2022 for Barpeta district, Assam. Grey vertical line indicates the tornado event date, i.e. 7 May 2022 (MERRA2 Native Resolution Daily Data).

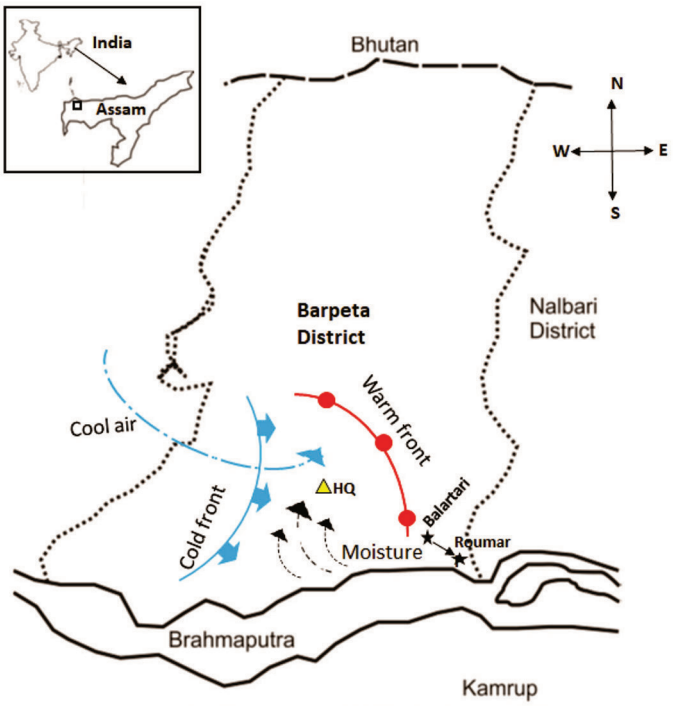

Figure 4. A sketch of the Barpeta district, Assam, with the district headquarter (HQ) shown by a triangle. The tornado moved from Balartari to Roumari (indicated by black stars), towards the SE direction (as shown by the straight black arrow). The probable factors responsible for the 2022 Barpeta tornado are also shown, details of which are discussed in the text. (Inset: Map of India and Assam.) The Barpeta district is marked as a small box in the map of Assam (maps are not to scale).

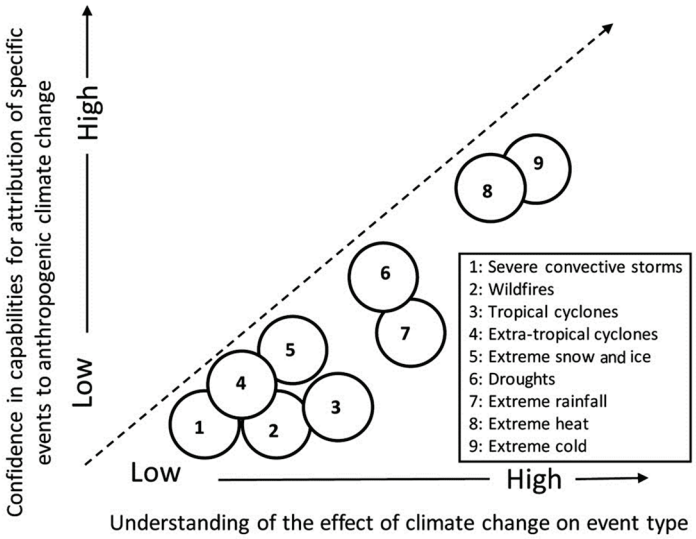

Figure 5. Correlation among different extreme events with climate change (modified after refs 12, 13).

climate change affects different extreme weather events in different ways[12,13]. Figure 5 deciphers the impacts of climate change on certain extreme events based on how well the effects of climate change are understood and on the extent to which any individual event can be attributed to climate change according to a 2016 report by the National Academy of Sciences, USA[13]. Some phenomena, such as increases in severe heat events, decreases in extreme cold events and increases in extreme precipitation, can be attributed to a changing climate. No comprehensive link could be established to correlate severe convective storms (that produce tornadoes) with climate change[12,13]. The 2018 Fourth National Climate Assessment has also revealed similar observations[14]. However, one cannot completely rule out the possibility of a climatic link for the occurrence of tornadic events.

Documenting natural hazards of any form, size and intensity is necessary for policy development and decision-making to protect lives and livelihoods and to strengthen standards in loss accounting and related disaster databases. To our knowledge, the last recorded tornadic activity in Assam was in 1963, but of a greater scale than the 2022 Barpeta event, and importantly, it originated in West Bengal and moved to Goalpara. The Barpeta tornado could probably be the first documented tornado to originate from Assam. Recording of such events could provide valuable information in reviewing hazard exposure and vulnerability assessment in the future.

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