SPATIO-TEMPORAL DISTRIBUTION OF LIGHTNING AND ITS RELATED FATALITIES IN BANGLADESH

F. Rahman1, M. A. Mannan2 and M. Moniruzzaman3

ABSTRACT

Bangladesh is extremely susceptible to the lightning hazard. Fatalities, injuries and affected number of peoples due to lightning is significant which is found to increase in recent years. To address this issue, attempts have been made to analyze lightning event day and lightning event frequency for the period of 2001-2016 collected from the Bangladesh Meteorological Department (BMD). Information about fatalities, injuries and affected people related to lightning are from the three dailies of ‘The Daily Ittefaq’, ‘The Daily Jugantor’, ‘The Daily Prothom Alo’ during March to November of 2012 to 2016. Lightning event frequency is the highest in May followed by June and April with the magnitudes of 28.1, 24.1 and 19.1 respectively. The number of fatalities during 2012-2016 is the highest in May and then April and June with the magnitudes of 373, 206 and 144 respectively. Accordingly, the maximum number of injuries are in May and then in April and June with the magnitudes of 196, 152 and 92 respectively. The annual rate of fatalities, injuries and affected peoples due to lightning are 111, 68 and 179. The percentage of fatalities (22.3%) related to lightning is the highest at noon and then in the morning. The percentage of injuries (22.2%) is the maximum during noon and then in the morning. Spatial distribution reveals that fatalities due to lightning is the higher over Sylhet-Mymensingh region with the highest in Sunamganj district and then in Kishoreganj and in Comilla and Netrokona.

Keywords: Fatality, Hazard, Injury, Lightning, and Risk

Introduction

Lightning is found to occur individually as well as with all thunderstorms. The creation of lightning is a complicated process. It is the result of the build-up and discharge of electrical energy. The air in a lightning strike is heated to 50,000 degrees Fahrenheit. Rapid heating of the air produces a shock wave that results in thunder (NOAA, 2001). Lightning is a gigantic electrical spark traveling between cloud to cloud or cloud to earth containing an average charge of 30 to 50 lakh Volts and a current of 30 Kilo amperes with a speed of 220 km per hour. Lightning is due to upward vertical motions accompanied by microphysical processes at elevations with typical ambient temperatures between -5°C and -15°C. A huge amount of charge has to build up before the strength of the electric field overpowers the atmospheres insulating properties. At last, it can be said that the current of electricity forces a path through the air until it encounters something that makes a good connection. The current is driven by a high voltage between the cloud's charge centers or between them and the earth. Tropical regions of the world, including both land and water, are estimated to account for 78% of global lightning mainly in where there are marked elevation changes and land-water boundaries (Albrecht et al., 2016). Asia has the second-most lightning hotspots with its most active regions located in the northwestern ridges of the Himalayas, near Daggar, Pakistan and South America is third in hotspots, followed by North America and Australia (NASA, 2002). About two-thirds of lightning occurs during the afternoon due to the strongest heating of the land surface during this time. At higher latitudes in both hemispheres, about two-thirds of lightning occurs during the three summer months. Holle and López(2003) made an assessment of the worldwide impact of lightning and concluded that 24,000 deaths and 240,000 injuries occur per year. The ratio of injuries to deaths appears to be 10 to 1 based on an intensive search of Colorado medical records. Bangladesh (0.9) and Sri Lanka (2.4) annual fatality rates are higher than in the more developed countries (Gomes et al., 2006). Bangladesh has seen a near-record number of deaths in 2016 from a phenomenon that appears to be worsening with climate change: lightning strikes. So far in 2016, 261 people died from lightning in Bangladesh, putting the South Asian nation on track to beat last year's 265 deaths. Most lightning deaths usually occur during the warm months of March to July. According to the Bangladesh Meteorological Department (BMD), prior to 1981, the country saw lightning strikes on average nine days each May. Since that time, the country has seen strikes

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an average of 12 days each May. The problem has prompted Bangladesh’s government to add lightning strikes to the country’s list of official types of disasters, which includes floods, cyclones and storm surges, earthquakes, drought, and riverbank erosion, among others. National Oceanic and Atmospheric Administration (NOAA) stated about lighting and safety tips for the mariner. From 1990 to 2016 from a variety of sources that contains a total of 5,468 casualties comprised of 3,086 fatalities and 2,382 injuries in Bangladesh (Dewan et al., 2017).

The main aims of this study are: to investigate the spatiotemporal distribution of lighting days during 1981-2016 over Bangladesh; to review the intensity of lighting frequency since 2001-2016 in Bangladesh; to assess the variation of lightning days and frequency of selected weather stations (located over divisional headquarters) in Bangladesh during last 35 years and to explore the lightning induced human fatalities and injuries of last five years of 2012-2016.

Methodology

Lightning-induced fatalities and injuries data and information are collected from three national dailies (The Daily Prothom Alo, The Daily Jugantor, and The Daily Ittefaq) from March to November each year of 2012-2016. Collected data and information are compiled and cross-checked to avoid overlapping and inconsistency for a validation check. To avoid overlapping data are first matched using all of the demographic variables and locations. Then the data are punched against the corresponding day and year in MS Excel. Cases are excluded if any duplication and overlapping are encountered. Analysis has been conducted using SPSS and MS Excel. Both the number of lightning days (1981-2016) and lightning frequency (2001-2016) collected from synoptic weather stations of Bangladesh Meteorological Department (BMD). Spatial distributions are generated using WinSurfer (Version 10) software.

Result and discussions

Monthly distribution of lightning days and frequency of Bangladesh

Monthly distribution of lightning days is depicted in Figure 1. Figure 1 indicates that the number of lightning days is the highest in September and then in August, May, and June. The number of lightning days in September, August, May, June, and April are 4.9, 4.7, 4.7, 4.2 and 3.4 respectively. It is also observed that the number of lightning days in November, December, and January are very low.

Monthly distribution of lightning frequency is displayed in Figure 2. It is found that the numbers of lightning frequency are the highest in May followed by June and April but it is very low and not considerable in November, December, and January. Frequencies of lightning during the successive three months of April, May, and June are the most substantial, which are highly relevant to the death toll and injuries in Bangladesh.

Variation of lightning days and frequency in Bangladesh

Variation of annual lightning days and frequency of eight divisional headquarters stations of BMD during the observed period of 1981-2016 are calculated and analyzed. At Barisal location, lightning days are found higher in 1981-1983, 1996-1999 and 2004-2014. Similarly, at Sylhet location lightning days are found higher in 1981-1987, 1989-2001 and 2006-2016. Again, annual numbers of lightning frequencies are found higher in 2005-2007, 2010-2012 and 2016. Details are given in Table 1 and Figures 3 and 4.

<table>
<thead>
<tr>
<th>Location</th>
<th>Trends (Per year) during 1981-2017</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lightning days</td>
</tr>
</tbody>
</table>

Table 1. Trends of annual lightning days and lighting frequencies
Spatial distribution of lightning days and lightning frequency

Spatial distribution reveals that the highest annual average number of lightning days are higher in Sylhet, Sunamganj regions, then in Faridpur, Dhaka, Tangail, Mymensingh, Pubna, Bogra and Rangpur regions and then other parts. Lightning days are low at Noakhali, Feni and Chittagong regions. The highest annual average lightning frequency is found in Sylhet, Sunamganj, Moulvibazar, Habiganj, Kishorganj, Netrokona and then in Mymensingh, Sherpur, Jamalpur, Tangail, Nilphamari, Rajshahi and then in Panchagar, Khulna, Pirojpur, Nawabganj and then others parts of the country (Figure 4).

Spatial and temporal distribution of lightning-induced fatalities and injuries in Bangladesh

The highest fatalities and injuries are found in May than in April June (Figure 5). Most incidents are found to occur in homestead then cropland and who moves towards outside frequently are highly affected by lightning. The highest death is found among farmers in the observed period. Compiled database predicts that most of the incident occurred during noon and then in the morning. The compiled database which is prepared for the present study concluded by that the percentage of fatalities (22.3%) are related to lightning is the highest during noon and then during the morning; percentage of injuries (22.2%) is the maximum during noon and then in the morning (Figure 6).

<table>
<thead>
<tr>
<th></th>
<th>Dhaka</th>
<th>Rajshahi</th>
<th>Khulna</th>
<th>Rangpur</th>
<th>Barisal</th>
<th>Chattogram</th>
<th>Mymensingh</th>
<th>Sylhet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-1.28</td>
<td>-1.11</td>
<td>-1.64</td>
<td>-0.96</td>
<td>+0.33</td>
<td>-0.53</td>
<td>+0.38</td>
<td>+0.54</td>
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</tbody>
</table>

The study also revealed that pre-monsoon (March to May) season is the most lightning induced fatalities recorded season. Total recorded fatality during pre-monsoon season is 617, which is about 61.6 percent of total fatalities of the observed period.
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Figure 5. Distribution of fatalities and injuries due to lightning in Bangladesh during 2012-2016

Table 2 shows detail information about season wise fatality distribution. Spatial distribution reveals that fatalities due to lightning is the higher over Sylhet-Mymensingh region and lower over Noakhali-Chittagong region with the highest in Sunamganj district and then in Kishoreganj and in Comilla and Netrokona during the observed period. The number of fatalities in Sunamganj, Kishoreganj, Comilla, and Netrokona are 69, 48, 35 and 35 respectively. On the other hand, it is lower in Feni district but nil in Barguna district during the study period (Figure 7).

Table 2. Seasonal variation of the number of fatalities

<table>
<thead>
<tr>
<th>Season</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-monsoon</td>
<td>180</td>
<td>148</td>
<td>67</td>
<td>76</td>
<td>146</td>
<td>617</td>
</tr>
<tr>
<td>Monsoon</td>
<td>42</td>
<td>94</td>
<td>49</td>
<td>49</td>
<td>113</td>
<td>347</td>
</tr>
<tr>
<td>Post-monsoon</td>
<td>10</td>
<td>11</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>38</td>
</tr>
</tbody>
</table>

Figure 6. Temporal duration of Fatalities and Injuries due to lightning in Bangladesh during 2012-2016

The compiled database explore district wise fatality distribution and indicated that the number of fatalities was the highest of 20 in Sunamganj and then 11 in Nilphamari and 10 in Dinajpur, Jamalpur, and Satkhira. A number of fatalities were within the range of 1-9 at other districts. but no fatalities were reported in Feni, Jhenaidaha, Barguna, Joypurhat, Khagrachari, Meherpur, Narail, Natore and Rajbari in 2012. In 2013, district wise fatality distribution indicated that the number of fatalities was the highest of 17 in Comilla and then 16 in Kishoreganj and 14 in Brahmanbaria. A number of fatalities were 1-13 at other districts but no fatalities were reported for Barguna, Bandarban, Bholo, Dhaka, Jhalokathi, Jhinaidaha, Joypurhat, Magura, Narshingdi and Patuakhali. The statistics from the dailies, in 2014, district wise fatality distribution indicates that the
number of fatalities was the highest of 8 in Chapainawabganj and then 5 in Brahman Baria, Habiganj, Kishoreganj, Meherpur, Mymensingh and 6 in Nilphamari. A number of fatalities were of 1-7 at other districts but no fatalities were reported for Barguna, Barisal, Bhola, Comilla, Feni, Gaibandha, Gopalganj, Jessore, Joypurhat, Khagrachari, Kuhlana, Kurigram, Lakshmipur, Narshingdi, Natore, Patuakhali, Rajbari, Sylhet and Thakurgaon. District wise fatality distribution of 2015 indicated that the number of fatalities was the highest of 10 in Sunamganj and then 8 in Comilla, Netrokona, Habiganj and 7 in Rajbari. Number of fatalities were of 1-6 at other districts but no fatalities were reported for Barguna, Bagerhat, Bandarban, Bhola, Cox’s Bazar, Dhaka, Feni, Jamalpur, Jalalpur, Khagrachari, Kurigram, Kushtia, Lalmonirhat, Magar, Meherpur, Naogaon, Nilphamari, Noakhali, Panchagar, Patuakhali, Satkhira, Shariatpur and Sylhet.

In 2016, district wise fatality distribution indicated that the number of fatalities were the highest of 25 in Sunamganj district and then 17 in Kishoreganj and 13 in Pabna. A number of fatalities were 1-12 at other districts but no fatalities were reported in Barguna, Barisal, Bandarban Bhola, Chandpur, Chuadanga, Kushtia, Lalmonirhat, Magura, Meherpur, Rangamati and Shariatpur. Spatial distribution of total fatalities from 2012 to 2016 is depicted in Figure 7.

![Figure 7. Spatial distribution of total lightning fatalities in Bangladesh (2012-2016)](image)

**Conclusion**

From the analysis the following conclusions can be drawn:

i. The highest annual average lightning frequency is found in Sylhet, Sunamganj, Moulvibazar, Habiganj, Kishorganj, Netrokona regions and the highest annual average number of lightning days are found in Sylhet, Sunamganj then Faridpur, Dhaka, Tangail, Mymensingh, Pabna, Bogra and Rangpur regions.

ii. Fatalities due to lightning is the higher over Sylhet- Mymensingh region but lower over Noakhali- Chittagong regions with the highest in Sunamganj district and then in Kishoreganj, Comilla and Netrokona during the observed period.

iii. The trends of lightning days and frequencies are positive in Sylhet region. The temporal distribution shows that the frequency of lightning is higher in May, June and then April.

iv. Lightning frequency is the highest in May than in April and June. The study reveals that the highest numbers of people are affected by lightning in May, then April and June in Bangladesh.

v. Severe lightning is associated with the squall line in Bangladesh.
References


