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OCCURRENCE OF CATTLE DEATHS CAUSED BY LIGHTNING STRIKES IN BRAZIL: A STUDY FROM 2010-2019

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Abstract - This study aims to analyze the occurrence of cattle deaths caused by lightning strikes in Brazil between 2010 and 2019. It examines 169 death events, which led to a total of 3,122 animal deaths. The study analyzed the geographical and monthly patterns of the incidents and compared the average number of cattle deaths to human deaths caused by lightning in the same period. The financial loss incurred by Brazil due to these incidents was estimated. The study found that the average annual number of cattle deaths due to lightning strikes in Brazil is 3.5 times greater than that of humans. Most of the incidents occurred in the south, southeast, and central regions of the country between November and March. Rio Grande do Sul had the highest number of events, but the lowest average number of cattle deaths per event. The highest number of cattle deaths in a single event was 103. The estimated annual financial loss incurred by Brazil due to these incidents is at least \$200,000. The results highlight the significant impact of lightning strikes on the agricultural sector in Brazil. The findings can be used by relevant authorities to develop measures and strategies to mitigate the impact of lightning strikes on cattle and prevent financial losses.

1 - INTRODUCTION

From 2000 to 2019, 2194 humans were killed by lightning in Brazil, according to the Atmospheric Electricity Group (ELAT) of the Brazilian Institute of Space Research (INPE) [1]. The chance of being killed by lightning is about 0.6 in 1 million [2]. A recent book summarizes lightning injuries suffered by humans globally [3]. In contrast to the human, although there have been reports of deaths of cattle for a long time [4], there is no significant information on farm animal fatalities has been presented, mainly due to poor documentation. However, considering that animals remain in open areas during thunderstorms for more extended periods than humans, their chances of being hit by lightning are more significant. Additionally, a farm animal is less likely to survive being struck by lightning for several reasons, such as remaining exposed to lightning for more extended periods and a higher chance that the current will go through the heart if the animal is in the normal position.

Animal injuries and consequent permanent disabilities or death due to lightning strikes related

effects are relatively common in many parts of the world with high lightning incidence, such as Brazil. While a comprehensive review on lightning injury mechanisms for animals has been published by Gomes [5], very few studies have examined the number of deaths of cattle caused by lightning. Uman [6] reported that lightning caused the deaths of 362 cattle in the United States in 1968. In other work, Vanneste et al. [7] reported 388 cattle fatalities related to lightning in Belgium over a 15-year period. Recently, Matos et al. [8] reported 733 cattle deaths in the Amazon region of Brazil from 2012 to 2019. On a global scale, only rough estimates have been given; these estimates suggest that thousands of animals are killed by lightning every year worldwide [5]. Although Gomes [5] has pointed out that the loss of animals can have a much higher economic impact than property damage, there is scarce information regarding the economic impact of animal deaths caused by lightning.

In this article, we present a descriptive study on cattle deaths caused by lightning in Brazil from 2010 to 2019, indicating where and during what part of the year such deaths are most frequent. The study also compares cattle deaths to human deaths caused by lightning in Brazil during the same period and, finally, estimates the annual financial loss incurred by Brazil from these events.

2 - DATA

Due to the lack of official information, this study is based on media reports, primarily published from 2010 to 2019 in the main newspapers of each state of the country. All information regarding the deaths of cattle used in this article were found on free access pages on the internet using the Google search engine and checked with the primary source (farmers). Considering the limitations of internet, the results of study may underestimate the actual number of events. Despite this limitation, this study is the most comprehensive of its type conducted in Brazil, with sufficient data to identify where and during what time of the year the deaths occur. Information regarding human deaths was obtained from Ministry of Integration and Regional Development and

Ministry of Health. The information of human and cattle densities was obtained from the Brazilian Institute of Geography and Statistics (IBGE) - www.ibge.gov.br.

3 – RESULTS

From media reports from 2010 to 2019 it was found 169 events encompassing 3,122 cattle deaths by lightning (approximately 18.5 per event on average). Considering that the number of human deaths by lightning in this period was 898, we found that the number of cattle killed by lightning is at least 3.5 times higher than the number of human. Assuming an average cost per cattle death of USD 460.00 [8], we estimated that the country incurs an annual total cost of at least USD 200,000.00.

The highest number of cattle deaths in one event was 103 in Cacoal, Rondônia, on March 16, 2018 (Figure 1). The cattle were under a tree, which is the most common circumstance of death. As far as we know, this is the highest number of cattle deaths in one event already reported worldwide. In the media we found 68 cattle deaths after a lightning strike in New South Wales, Australia (<https://www.northernstar.com.au/news/apn-flash-of-lightning-kills-68-dairy/17327>) in 2005 and 52 cattle deaths after a lightning strike in Uruguay in 2008 (<https://en.mercopress.com/2008/10/24/lightning-kills-52-cattle-during-storm-in-uruguayan-farm>). The largest known number of animals reported as being killed by a lightning event was 320 sheep in Scotland in 1748 [9]. In comparison, the largest number of human reported being killed directly by a lightning strike was 21 in Rhodesia (now named Zimbabwe) in 1975 [10].



Figure 1 - Cattle killed by lightning under a tree in Rondônia on March 16, 2018.

Figure 2 shows the monthly distribution of the number of events from 2010 to 2019 in Brazil of cattle killed by lightning. The distribution is similar to the monthly distribution of lightning in the country with its maximum in the spring and summer.

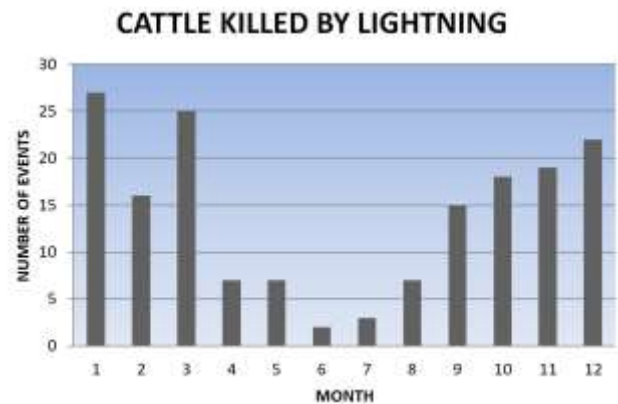


Figure 1 - Monthly number of events from 2010 to 2019 in Brazil of cattle deaths by lightning.

Table 1 presents the percentage of events of cattle and human deaths in different regions of Brazil, along with the densities of these populations. The regions with the highest densities exhibit the greatest percentages of deaths. For instance, the South region is the region with the largest percentage of events of cattle deaths and the region of the largest cattle density, while the Southeast region is the region with the largest percentage of human deaths and the region of the largest human density, what would be expected in a first glance.

However, the variations in the percentage of cattle deaths in the different regions reflect the density variations in the regions more closely than human deaths did. This disparity may be due to the more uniform exposure of cattle to lightning in different regions than humans.

A striking example of this discrepancy is the contrast between human deaths in the southeastern and north regions. In the north, the percentage of human deaths (22%) is slightly lower than in the southeast (26%), even though the population is considerably lower (5% compared to 95%). Two factors may contribute to this difference: first, a larger fraction of the northern population participates in outdoor activities, and second, a smaller fraction of the northern population has access to safety information.

Table 1 - Percentages of events of cattle and human deaths in different regions of Brazil, along with cattle and human densities.

Region	Events of cattle deaths (%)	Cattle density (cattle/km ²)	Human deaths (%)	Human density (human/km ²)
South	28	41	15	52
Southeast	24	21	26	95
Center	26	38	18	10
Northeast	11	14	19	37
North	11	9	22	5

Table 2 shows the ten states in Brazil with more events of cattle deaths by lightning, including the average number of cattle deaths per event and cattle density. It is worth noting that Rio Grande do Sul is the state with the highest number of events of cattle deaths, while it has the lowest average number of cattle deaths per event. The large number of events in Rio Grande do Sul may be related to the high cattle density.

Table 2 - The ten states in Brazil with more events of cattle deaths by lightning, the average number of cattle deaths per event, and cattle density.

STATE	EVENTS OF CATTLE DEATH	AVERAGE NUMBER OF CATTLE DEATHS PER EVENT	CATTLE DENSITY (cattle/km ²)
Rio Grande do Sul	20	9.2	40.0
Mato Grosso	17	25.7	26.9
São Paulo	16	22.6	33.5
Santa Catarina	15	12.2	38.5
Minas Gerais	15	12.7	33.4
Mato Grosso do Sul	14	25.6	54.6
Goiás	11	16.5	50.8
Paraná	9	11.6	42.2
Rondônia	8	30.0	41.4
Tocantins	7	35.6	23.5

4 – CONCLUSIONS

A study on the number of cattle killed by lightning in Brazil from 2010 to 2019 is presented and compared with human deaths by lightning in Brazil in the same period. The study is based on 169 media reports, encompassing 3,122 cattle deaths (18.5 deaths per event on average). The average annual number of cattle deaths by lightning is approximately 3.5 times greater than the average number of human killed by lightning in the same period (898).

The geographical and monthly distributions of deaths are presented and discussed, indicating that most events occurred between November and March in the south, southeast and center regions of the country.

The highest number of cattle deaths in a lightning event was 103 in the state of Rondônia in 2018. As far as we know, this is the highest number already reported worldwide.

In addition, the state of the Rio Grande do Sul had the highest number of events of cattle deaths and the lowest average number of cattle deaths per event.

Finally, it was estimated that the country incurs an annual total cost of at least USD 200,000.00.

5 - REFERENCES

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