

LIGHTNING FATALITIES IN BRAZIL IN THE LAST DECADE

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1. INTRODUCTION

Many studies describing lightning fatalities have been published, mainly in the United States (López and Holle, 1998; Holle and López, 2003; Holle et al., 2005; Holle, 2008). However, there has been almost no systematic information about lightning deaths in a lot of regions of the world.

Holle and López (2003) made an assessment of the worldwide impact of lightning and concluded that 24,000 deaths occur per year. The underlying basis for their study was that a rate of less than 0.3 deaths per million people applies to more developed countries with substantial housing and a decreasing amount of labor-intensive agricultural labor. Other regions were assumed to have an annual lightning fatality rate of 6 deaths per million per year, and this rate was considered applicable to a large portion of the world's population. Holle and López (2003) used data from Amorim et al. (2005) for the Sao Paulo metropolitan area for two months in the summer of 2001 to estimate an annual death rate of 0.8 per million.

In this paper, the results of a very comprehensive study about lightning fatalities in Brazil in the last decade are presented. The study is the first conducted in Brazil and, as far as we know, in the South America. Data collected by different sources including the Federal Civil Defense Agency and the Ministry of Health are sorted by states, types of area (rural, urban, roads and beaches), sex and circumstances. The annual number of fatalities is compared with the annual number of flashes and the population for the different regions of the country. Finally, the results are compared with similar records available for the United States and Australia.

2. DATA

Lightning fatalities were studied from 2000 to 2009 based on data collected by different sources including the Federal Civil Defense Agency and the Ministry of Health. A total of 1321 cases were recorded, that is, an average of 132 cases per year. Considering the average population of Brazil during the period (180 million people) the annual rate of fatalities was 0.7 per million. From this total, 81% was males and 19% females, with small variations at different regions (the percentage of males varies from 88% in the center region to 74% in the northeast region). The southeastern region was the region with the largest number of fatalities (29%), followed by the center (19%), north and northeastern (18%) and south region (17%). Considering the population of different regions, the annual death rate changes from 0.4 to 1.8 deaths per million.

When the data are sorted by ages, the maximum number of fatalities occurs in the group aged 20-39 with 43%, followed by the group aged 0-19 with 27%.

Most fatalities occurred in the rural area (61%), followed by the urban area (26%), beaches (8%) and roads (5%). In addition, 85% of the fatalities occurred in open areas while 15% occurred inside houses. The most common circumstances related to the fatalities was rural activities (19%), followed by persons near transportations or inside houses (14%), under a tree (12%) and playing soccer (10%).

Other statistics include: 45% of the fatalities occurred in the summer; the state with the maximum number of fatalities was Sao Paulo (230 cases or 17%), followed by Rio Grande do Sul (106 cases), Minas Gerais (99 cases), Mato Grosso do Sul (89 cases) and Goias (80 cases).

In terms of cities, the maximum number of fatalities was recorded in Manaus (16 cases) followed by São Paulo (14 cases). This last number indicates that the annual death rate in

the city of Sao Paulo is 0.14 per million people, and not 0.8 as estimated by Holle and Lópes (2003). It is interesting to note, however, that accidentally the value estimated by Holle and Lópes (2003) is exactly the same value for the whole country (0.8) making their estimations still valid.

The highest annual death rates in Brazil are in the State of Tocantins (4.6), followed by Mato Grosso do Sul (4.3). On the other hand, the lowest annual death rates occur in Paraíba, Sergipe and Amapa (0.1).

3. DISCUSSION AND CONCLUSIONS

Figure 1 shows the annual number of fatalities and the relative annual incidence of flashes in Brazil obtained by the Lightning Imaging Sensor (LIS) weighted by the population of each state. The comparison of the curves shows significant differences, suggesting that other factors should be taking into account in the analysis of the variations of the annual number of fatalities. Clearly, one of these factors should be the different rates of urban and rural population at different regions of the country.

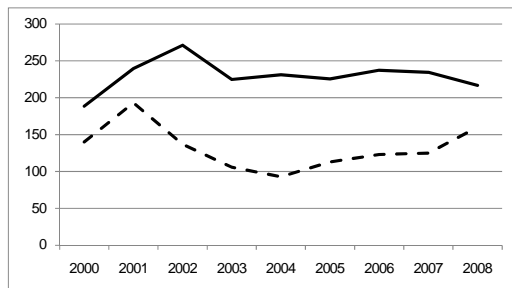


Figure 1. Annual number of fatalities (dashed line) and relative annual incidence of flashes (solid line) in Brazil. See text for details.

In the United States the overall death rate from 2000-2006 is 0.2 per million people (Holle, 2008). From the total of fatalities, the percentage of males is 82% and the females 18%, almost the same values found in Brazil. The percentage of fatalities for different groups, compared to Brazil, indicates similar values (Table 1).

Table 1. The percentage of fatalities for different groups of age in the United States and Brazil.

Age	Brazil (%)	US (%)
0-19	27	19
20-39	43	40
40-59	23	31
>60	7	10

The state with the largest number of fatalities is Florida with an average of 12.6 deaths per year in the period from 1990 to 2003 (Storm Data, NOAA). In the state of Sao Paulo the number of fatalities was 23 deaths per year. Considering the average population of both states during the period, the annual death rate is 0.8 per million people in Florida and 0.6 in Sao Paulo.

The circumstances related to the fatalities are different in Brazil and in the United States. Recreational or sports-related activities, such as fishing, camping and golfing, are the main circumstance involved in lightning-related deaths in the USA, while in Brazil most fatalities occur with people working in the rural areas in agriculture. The percentages of fatalities for other circumstances, such as ball field, on the telephone or under a tree are summarized in Table 2.

Table 2. Percentage of lightning fatalities for different circumstances in the United States and Brazil.

Circumstance	Brazil (%)	US (%)
Telephone	2	0.2
Under a Tree	12	19
Ball Field	10	3

In Australia, the overall death rate from 1910-1989 is 0.8 per million population, almost the same value of Brazil (Coates et al., 1993). The group that has been most at risk in Australia is that of males aged 15-19, differently of Brazil and in the United States is males aged 30-39. The male to female ratio of victims is 5.3 in 1980-1989, a value higher

than the values observed in Brazil (4.2) and in the United States (4.4). About 86% of fatalities have occurred outdoors and 14% have occurred indoors, again almost the same value of Brazil.

Finally, the number of lightning fatalities per million people in Brazil is 0.7, a value a little bit higher than the average value observed in developed countries (0.3). In part, the difference can be explained by a larger percentage of the population involved in rural activities (about 35% in Brazil) than in these countries. However, other aspects may be involved. In order to decrease this difference in the future we suggest the following actions:

- Improve meteorological forecasts and warnings,
- Improve the awareness of the lightning threat through education.

4. REFERENCES

- Amorim, W.C.M, and C.A. Morales, Storm tracking and thunderstorm now casting for Sao Paulo State, Brazil. 32nd Conf. on Radar Meteorology, Albuquerque, NM, 5 pp. 2005.
- Coates, L., R. Blong, and F. Siciliano, Lightning Fatalities in Australia, 1824-1991, *Natural Hazards* 8: 217-233, 1993.
- Holle, R.L., Lightning-caused deaths and injuries in the vicinity of vehicles. 3rd Conf. on Meteorological Applications of Lightning Data, New Orleans, LA, Amer. Meteor. Soc., 10 pp., 2008.
- Holle, R.L. and R.E. López, A comparison of current lightning death rates in the U.S. with other locations and times. Intl. Conf. on Lightning and Static Electricity, Blackpool, England, Royal Aeronautical Soc., paper 103-34 KMS, 7 pp., 2003.
- Holle, R.L., R.E. López, and B.C. Navarro, Deaths, injuries, and damages from lightning in the United States in the 1890s in comparison with the 1990s. *J. Applied Meteorology*, 44, 1563-1573, 2005.
- López, R.E., and R.L. Holle, Changes in the number of lightning deaths in the United States during the twentieth century. *J. Climate*, 11, 2070-2077, 1998.