34th International Conference on Lightning Protection
02-07 September 2018
Rzeszow, Poland

Lightning Fatalities in Africa from 2010-2017

Ronald L. Holle
Executive Committee
African Centres for Lightning and Electromagnetics Network
Oro Valley, Arizona, United States

Mary Ann Cooper, M.D.
Managing Director
African Centres for Lightning and Electromagnetics Network
River Forest, Illinois, United States

***Abstract*—Lightning is a major hazard to people in Africa but there is only a small amount of direct information about its impacts. Since about 2010, there has been an improvement in news reporting by use of the internet. The result is wider dissemination of lightning incidents that had been occurring but were not reaching newsgathering media. In the absence of organized lightning casualty data collection in most of Africa, this study will address the use of available internet-based reports. A sample review of lightning fatalities for Zimbabwe is summarized from English-language searches in order to obtain an overview of scenarios involved in lightning casualties. Future data collection will be stratified, when possible, by nation in Africa, month, activity, location, and age, number and gender of individuals.**

Keywords-Africa, lightning, lightning fatalities, monthly, agriculture, hut, school

I. INTRODUCTION

The combination of frequent lightning occurrence and a lightning-vulnerable population makes it apparent that large numbers of lightning casualties are taking place in Africa. Yet there is minimal organized information on the topic from many locations in Africa. A summary of existing global lightning fatality studies [1, 2] has been updated to include several new countries, as shown in Fig. 1.

Table I lists the few national studies of lightning deaths that have been published for multiple years since 1979 for Africa. These are for Burundi [3], much of Malawi [4], South Africa [5], Swaziland [6], Uganda [7], and Zimbabwe [8, 9]. It is apparent in Fig. 1 that the fatality rate is typically large or very large in Africa compared with developed nations of the world. Australia and countries in Europe, North America, and several other regions have rates below 0.5 deaths per million people per year. Reasons for the differences are explored in detail in [10]. This study will begin to address some gaps in this knowledge despite the lack of national-scale studies in Africa at this time.

II. DATA SOURCES

For such studies, data can be collected with some success by online search engines. These daily or hourly updates provide all links to reports related to the word "Lightning". However, this identification restricts the links to those in English so that reports from other languages are not included. A search on this word includes human casualties and damages from lightning, but also has many other non-casualty entries that comprise over 95% of the links. These discarded links include sports teams, commercial products, colloquialisms and other situations where "Lightning" appears in a news story. Only by visually scanning each entry in the online search engine can the event be determined if it involved people and occurred in Africa. In most cases, the reports do not identify the country, so it is necessary to search for the location where the newspaper or online news reporting agency is located.

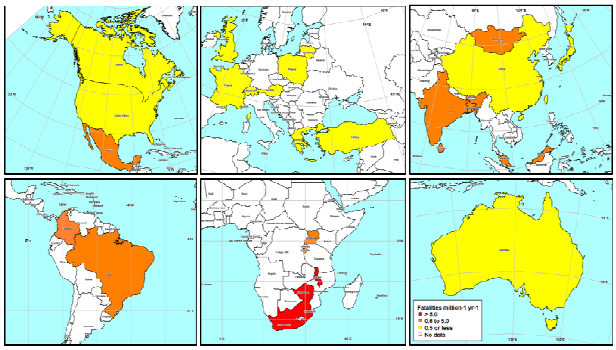

Figure 1. National lightning fatality rates per million people per year by continent. Red shading indicates rates > 5.0 fatalities per million per year, orange is 0.6 to 5.0, and yellow is 0.5 or less. White indicates no national summaries have been published for periods ending in 1979 or later [updated from 1, 2].

TABLE I. PUBLISHED ANNUAL LIGHTNING FATALITY RATES PER MILLION PEOPLE AND ANNUAL NUMBER OF FATALITIES BY COUNTRY IN AFRICA ENDING IN 1979 OR LATER. DATA COLLECTION TYPES: A=MEDICAL RECORDS; B=PERSONAL DATA COLLECTION FROM VARIETY OF SOURCES; C=PRINT MEDIA, AND D=MIXTURE OF SOURCES [UPDATED FROM 1, 2].

Country	Annual fatality rate (deaths/million)	Fatalities per year	Data type
Burundi	2.5	26	B
Malawi	5.5	45	C
South Africa	6.3	264	A
Swaziland	15.5	15	D
Uganda	0.9	30	D
Zimbabwe	14 to 21	100 to 150	D

Many of the African reports are from remote areas where it is not possible to independently check or verify them, since no national data gathering of lightning fatalities is attempted by any government agency in many developing nations. The following is an estimate of the quality of the data obtained from online search engines:

- The location is likely to be accurate, beginning with the country, then the local province or district, and often the exact village or town.
- The year and month are quite certain.
- Numbers of deaths and injuries are usually accurate.
- Ages and gender are often reported and likely to be accurate when they are reported.
- Location and activity are generally well known such as in an agricultural field, under a tree, or in a hut or school.
- The day of the month and day of the week can be ambiguous due to delays in the incidents reaching the newsgathering agencies, and sometimes the time zones are not well identified. Sometimes the day of the week is specifically identified.

III. African Population and Lightning

A. *Population*

The population of Africa has increased by 19.7% from 1.049 billion in 2010 to 1.256 billion in 2017. Recent estimates are that 60% of the population of sub-Saharan Africa is under 25 years old.

B. *Lightning ocurrence*

The global occurrence of lightning in Fig. 2 indicates that lightning is very frequent in Africa south of the Sahara, but it varies widely across the continent. By month, Fig. 3 shows minimal variability through the year for all of Africa. For that reason, Fig. 4 was prepared to indicate that lightning north of the equator is primarily in the Northern Hemisphere warm season from May through September. Conversely, areas south of the equator have lightning in the Southern Hemisphere warm season from November through March. The result is that for some regions near the equator, there are two lightning seasons during the course of the year.

IV. Zimbabwe

A. *Events, fatalities and injuries*

Zimbabwe was chosen as a first test of this approach since it is a small lesser-developed nation that has regular English-language reporting. Virtually nothing is known about lightning casualties in Zimbabwe except for two estimates of 100 to 150 deaths per year [8, 9]. The web search engine can therefore be of value in addressing general results for this developing country from 2010 to 2017, as shown in Table II.

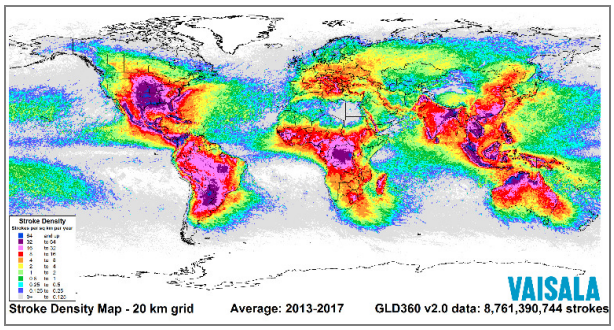

Figure 2. Lightning stroke density per square km per year from the Global Lightning Dataset GLD360 network for the globe from 2013 through 2017. The density map depicts 8,761,390,744 strokes. Scale is at lower left; grid size is 20 by 20 km [11].

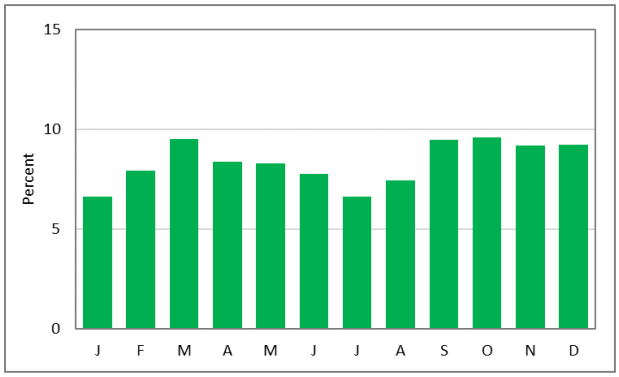

Figure 3. Lightning stroke percentages by month over all of Africa [11].

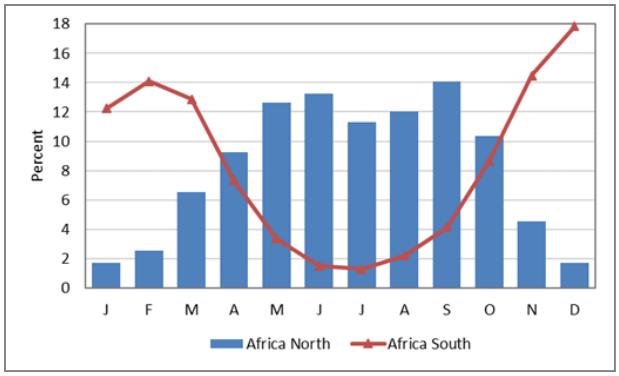

Figure 4. Lightning stroke percentages by month in Africa north and south of the equator [11].

TABLE II. SUMMARY OF LIGHTNING CASUALTIES IN ZIMBABWE FROM 2010 TO 2017.

Number of events	57
Number of deaths	101
Number of injuries	186
Male	51
Female	63

This sample for Zimbabwe from the internet search engine results in an average of 12.6 deaths per year during this period, which is about 10% of the estimates of 100 to 150 deaths per year in [8, 9]. The conclusion is that the internet search is indicating a small portion of the total. Therefore, fatality rates weighted by population cannot be determined from such data.

This dataset for Zimbabwe showing a majority of female victims is unusual, since previous studies tend to find more males [10]. For example, in Bangladesh it was found that 86% of those who died due to lightning on 12 to 13 May 2016 were males [12]. Similar research in Colombia [13] found that most of those who died due to lightning were young males. Furthermore, in Swaziland, 68% of those killed were males [6]. In developed countries, the male death percentage is 65% in the United Kingdom [14], and more males than females are killed in the United States [15] and Australia [16].

B. Month

The month of Zimbabwe events involving one or more deaths and/or injuries is shown in Fig. 5. The period from November through February accounts for two-thirds of the events. This cluster is similar to the Southern Hemisphere curve for lightning occurrence in Fig. 4, and lends confidence to this aspect of the data collection method.

C. Location/activity

The situation in which people were killed or injured by lightning is shown in Fig. 6. This Zimbabwe dataset indicates agriculture to be the most common activity [17]. Locating under a tree to avoid rain is also common [18], followed by being in a hut and on a school property [19]. These are useful indications of the lightning exposure in Zimbabwe, despite the limitations of the dataset.

D. Age

The age distribution in Fig. 7 shows a very wide range with no specific grouping. Ages were not specified and therefore not included in Fig. 7 for incidents where 1) many students were killed and injured at schools and 2) a large group of soldiers was injured.

E. Summary of Zimbabwe lightning casualties

The preceding information provides the first overview of lightning deaths and injuries in Zimbabwe, as follows:

- The events are concentrated in the warm season months of November through February, consistent with the annual cycle of lightning occurrence that is provided by data from a lightning detection network.
- Agriculture is the most frequent activity of those killed or injured by lightning, followed by being under a tree, in huts and on school property.
- More victims are female than male.
- The age distribution is more varied than in other locations of the world.

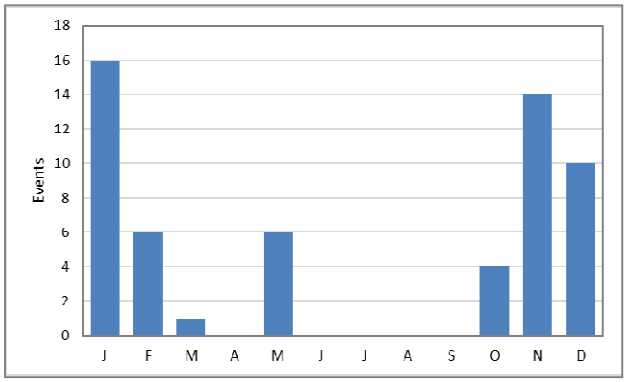

Figure 5. Lightning casualty events by month in Zimbabwe from 2010 to 2017.

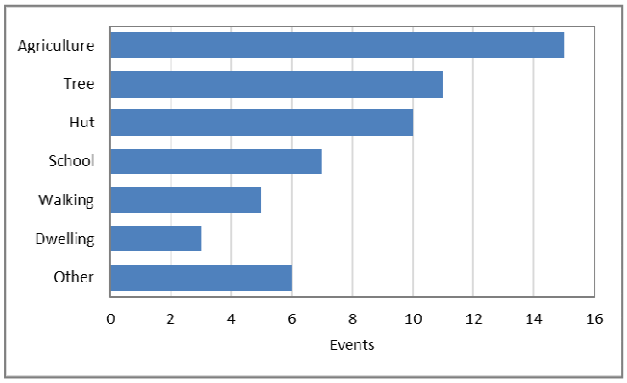

Figure 6. Lightning casualty events according to location and activity in Zimbabwe from 2010 to 2017.

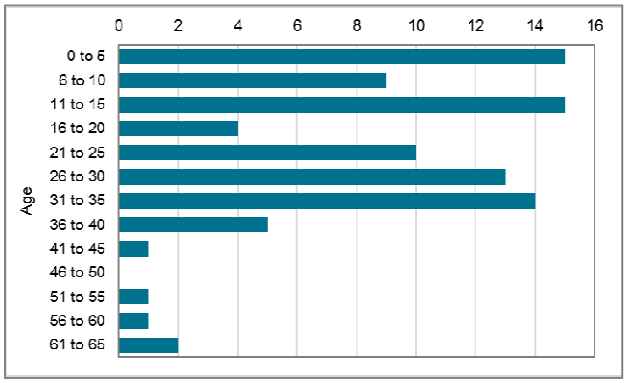

Figure 7. Lightning casualty events according to age in Zimbabwe from 2010 to 2017.

V. ADDITIONAL COUNTRIES

The Zimbabwe data based on web search-engine entries have been able to provide a plausible general view of lightning casualties in that country. Based on the success of this effort, it is planned to expand the approach to additional nations. Those with sufficient data at present are the following:

- **Kenya and Zambia:** No previous analyses have been made to date of lightning casualties in these countries, so the search-engine approach can be expected to provide similar general information as in Section IV for Zimbabwe.
- **Burundi, South Africa, Swaziland, and Uganda:** Existing studies are mentioned in the Introduction, but it may be possible to expand or verify those results with the search-engine dataset.
- **Malawi:** A summary of recent lightning fatalities and injuries has been completed for 16 of the 28 districts in [4].
- **Rest of Africa**: None of the other countries in Africa has had any prior lightning fatality studies published for any length of time. The search-engine approach has yielded relatively few reports from these nations compared with those listed above. The reasons are 1) news reports are not widely available in English, and/or 2) remoteness makes any reports unlikely to reach newsgathering agencies. Nevertheless, useful data that may be obtained are deaths versus injuries, gender and age, and location/activity. In addition, it appears possible to group monthly event counts from the nations north of the equator from those south of the equator to compare with detected lightning.

VI. CONCLUSIONS

The improvement of internet search-engine data for locating lightning casualties since about 2010 has made it possible to gather such information from countries in Africa where none currently exists. A sample of data from Zimbabwe has proven to provide useful information that can be used to address mitigation of the effects of lightning on people. This approach can be expanded to other parts of Africa, although the dataset is very limited in many regions due to language and remoteness barriers.

REFERENCES

[1] Holle, R. L, "A summary of recent national-scale lightning fatality studies," Wea., Climate and Society, vol. 8, 2016, pp. 35-42.

[2] Holle R. L., "The number of documented global lightning fatalities," paper presented at the 33rd International Conference on Lightning Protection, Estoril, Portugal, 2016, 4 pp.

[3] Nibigira, E., and C. Gomes, " Lightning environment in Burundi," paper presented at the 32nd International Conference on Lightning Protection, Shanghai, 2014, 4 pp.

[4] Kalindekafe, L., V. Katonda, T. K. Nthara, C. Chinsenga, P. Gomani, M. Mkandawire, and R. L. Holle, "Lightning fatalities in Malawi: A retrospective study from 2010 to 2017," paper presented at the 34th International Conference on Lightning Protection, Rzeszow, Poland, 2018, 7 pp.

[5] Blumenthal, R., "Lightning fatalities on the South African Highveld: A retrospective descriptive study for the period 1997-2000," Amer. J. Forensic Med Pathology, vol. 26, 2005, pp. 66-59.

[6] Dlamini, W. M., "Lightning fatalities in Swaziland: 2000–2007," Natural Hazards, vol. 50, 2009, pp. 179–191.

[7] Mary, A. K., C. Gomes, A. Gomes, and W. F. W. Ahmad, "Lightning accidents in Uganda," paper presented at the 32nd International Conference on Lightning Protection, Shanghai, 2014, 10 pp.

[8] Chitauro, J. J., "Welcoming speech. Discussion Section," paper presented at the First All-Africa International Symposium on Lightning, Harare, Zimbabwe, 1990, 4 pp.

[9] Van Olst, M. D. A., "Minimising lightning fatalities: Lightning earth currents in Zimbabwe," paper presented at the First All-Africa International Symposium on Lightning, Harare, Zimbabwe, 1990, 8 pp.

[10] Cooper, M. A., and R. L. Holle, "Reducing lightning injuries worldwide," Springer Natural Hazards, New York, 2018, 233 pp.

[11] Holle, R. L., R. K. Said, and W. A. Brooks, "Monthly GLD360 lightning percentages by continent," paper presented at the 7th International Lightning Meteorology Conference, Fort Lauderdale, FL, Vaisala, 2018, 4 pp.

[12] Holle, R. L., and A. K. M. S. Islam, "Lightning fatalities in Bangladesh in May 2016," paper presented at the 8th Conference on the Meteorological Applications of Lightning Data, Amer. Meteor. Soc., Seattle, WA, 2017, 4 pp.

[13] Navarrete-Aldana, N., M. A. Cooper, and R. L. Holle, "Lightning fatalities in Colombia from 2000 to 2009," Natural Hazards, vol. 74, 2014, pp. 1349-1362.

[14] Elsom, D. M., "Factors contributing to a long-term decrease in national lightning fatality rates: case study of the United Kingdom with wider implications," Intl. J. Disaster Risk Reduction., vol. 31, 2018, pp. 341-353.

[15] 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. Appl. Meteor., vol. 44, 2005, pp. 1563-1573.

[16] Coates L, R. Blong, and F. Siciliano, "Lightning fatalities in Australia, 1824–1991," Natural Hazards, vol. 8, 1993, pp. 217-233.

[17] Holle, R. L., "Lightning-caused deaths and injuries related to agriculture," paper presented at the 33rd International Conference on Lightning Protection, Estoril, Portugal, 2016, 6 pp.

[18] Holle, R. L., "Lightning-caused deaths and injuries in the vicinity of trees," paper presented at the International Conference on Lightning Protection, Vienna, Austria, 2012, 8 pp.

[19] Holle, R. L., and M. A. Cooper, "Lightning-caused deaths and injuries at schools," paper presented at the 33rd International Conference on Lightning Protection, Estoril, Portugal, 2016, 5 pp.