Challenges to Lightning Safety Advocacy Programs

ACLENet's Experience and Advice

Mary Ann Cooper, MD
Managing Director, ACLENet
River Forest, USA and UGANDA
macooper@uic.edu

Richard Tushemereirwe
Executive Committee, ACLENet
Los Angeles, CA, USA
mailto:richadt2002@yahoo.com

Ronald L Holle
Executive Committee, ACLENet
Oro Valley, AZ, USA
rholle@earthlink.net

Barnabas Akantambira
Country Coordinator
ACLENet, UGANDA
ak.barna@yahoo.com

Dickens Mugabe
Director of Communications and Program Development
ACLENet, UGANDA
dickensmugabe1@gmail.com

Isaac Tumuhimbise
Chief Installer
ACLENet, UGANDA
tumuhimbiseisaac2016@gmail.com

***Abstract*—As one of the first national lightning safety advocacy programs outside the United States, the African Centres for Lightning and Electromagnetics Network (ACLENet) has faced many challenges, most of which other advocacy programs are also likely to face in the future. This paper addresses the real-world challenges that lightning safety advocacy programs encounter and gives references for background studies, reports and analyses of advocacy program projects, demographic surveys, and advocacy education resources, all of which may be useful for other advocacy programs in planning projects and messages.**

Keywords—lightning safety, lightning protection, lightning in Africa, lightning injury prevention, national lightning safety week

I. The Goals of Lightning Safety Advocacy

The goal of lightning safety advocates is to save lives and decrease injuries caused by lightning. A secondary goal, sometimes used for energizing governments and soliciting funding from industry, is decreasing property damage and down time from lightning.

Lightning safety advocacy efforts have been occurring with increasing frequency over the last five decades, usually promoted by concerned individuals or small groups, almost always self-funded by the advocates, and often dependent primarily on the energy of an individual leader or small group of dedicated people. Key to these efforts is the formulation of the lightning safety message to be communicated. While lightning safety guidelines have been proposed in the past, most had little influence until the multidisciplinary Lightning Safety Group formulated the Lightning Safety Guidelines in the late 1990's [1-5]. Shortly afterwards, the United States (US) National Weather Service (NWS) formed the National Lightning Safety Awareness team [6, 7].

II. Evidence that Lighning Safety Programs can be Effective

Since the formation of the US National Lightning Safety Awareness team, members have worked extensively with many groups. Over the past twenty-two years, lightning safety guidelines have been reviewed, adopted, and implemented by both professional and amateur sports organizations, state athletic agencies that regulate school sports programs, national and state parks, and sports venues across the nation, to name only a few.

Lightning safety recommendations have become a regular spring and summer feature in newspapers, sports magazines, and television broadcasts. Professional broadcast meteorologists have been taught to discuss safety measures individuals and groups should take when thunderstorms threaten, and they regularly add 'and dangerous lightning may occur' to their thunderstorm forecasts. While the U.S. population may not be able to rigidly repeat 'When Thunder Roars, Go Indoors', the vast majority now know that thunder means danger and that they should seek shelter. These societal changes have been reported in several papers [6-10].

Due to extensive work with the media, who have been instrumental in public education efforts over more than twenty years, the annual death toll for the United States has steadily decreased from 55 to only 11 deaths in 2021 for a population of over 330,000,000 [11][Fig 1]. Other factors that

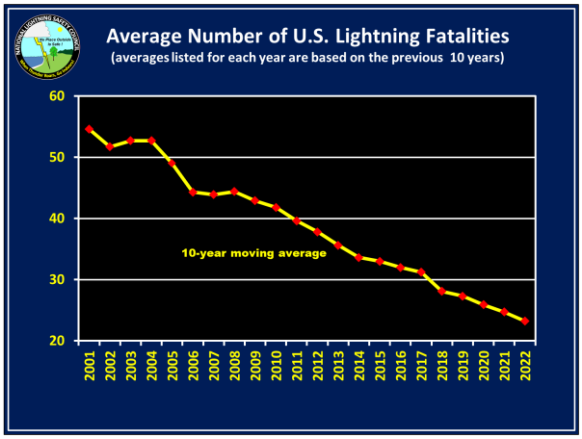

Fig 1. Ten-year moving average of lightning deaths in the United States of America since the Lightning Safety Awareness Team was formed in 2001. Figure courtesy of the National Lightning Safety Council.

contributed to the success of lightning safety public education efforts in decreasing deaths in the US include the ready availability of lightning safe areas people can seek when thunderstorms are present, excellent weather forecasting, mobile phone weather apps, and safety drills in schools and with youth groups. In developing countries, lightning safe areas are often not available. US safety messaging require review before implementation in other countries.

Although National Lightning Safety Week (2001-2016) was among the most successful programs run by the US NWS, the NWS disbanded the national 'safety week' programs in 2016, replacing them with a local approach to be managed by each forecast office. Many members of the lightning awareness team banded together to form the National Lightning Safety Council, which has become nationally recognized as a source for lightning safety information and maintains the most up-to-date and complete record of US lightning deaths every year [11].

Both the National Lightning Safety Council and the NOAA Lightning Safety websites have extensive data on lightning victims, safety recommendations, and a wealth of free educational resource materials that can be downloaded and modified by any lightning safety advocate [12, 13].

Other countries have reported on similar work and results [14].

IV. Other Lightning Safety Advocacy Programs

Internationally, many lightning safety, research, and education programs and centers have been proposed or started over the last two decades. To name a few with apologies to those not included: SALPAET (South Asian Lightning Protection Awareness and Entrepreneurship Training Program), LIGHTS (Lightning Interest Group for Health and Technology), LARC (Lightning and Atmospheric Research Center), CELP (Centre of Excellence in Lightning Protection), SALNet (South Asia Lightning Network), PREVLER (Programa de Registro y Evaluacion de Lesiones por Electricidad y Rayos), CERT (Centro Especializado en Rayos y Tormentas), and ACLENet (African Centres for Lightning and Electromagnetics Network). Some have been successful, others become inactive, been renamed, or merged into other formats, and some nearly faded from memory. Like many programs founded by an individual or small group, the success of the program will depend on the energy and success of those individuals in attracting funding, gaining wider institutional or government support, recruiting partners, training successors, catalyzing public activism, and finding donors and a particular mentor or public spokesperson.

Some academic leaders maintain that a lightning center or safety program should generate income. However, this can be difficult to achieve unless the members have skills such as lightning protection (LP) design to market or are affiliated with research or training programs at a university that they use to attract grants and contracts which may peripherally include operating funds for lightning safety advocacy. Lightning safety advocacy programs, particularly those that are not university or government based, can fail for lack of funds, lack of time or exhaustion of the leaders, inability to recruit associates who are able or willing to give the time and energy and have the expertise to generate contracts, solicit donations, write grants, and other income generating activities on a consistent basis.

Some lightning safety programs have actually benefited from the Covid pandemic. As in-person conferences were prohibited, many were moved to on-line venues which allowed people to attend virtually who could not have found funding or time to attend an international lightning conference. Interest in lightning safety advocacy seems to have grown exponentially in the past decade. This is evidenced by attendance at multiple online conferences preparing for International Lightning Safety Day in 2021 that included registration by as many as 300 people from 38 countries across 15 time zones [15]. At these virtual conferences, attendees have become acquainted with others who have similar challenges, aspirations, and interests. Creativity, persistence, and sharing of ideas and support have produced websites, webinars, and other programs despite the lack of actual monetary funding. For instance, SALNet instituted a multidisciplinary seminar series in mid-2022 that has attracted many regular attendees but costs little or nothing to produce, in large part because the organizers and speakers volunteer their time.

IV. Challenges to Lightning Safety Advocacy Programs

A. Complicated and Competing Lightning Protection Standards

Lightning safety is nearly impossible to achieve unless there are 'lightning safe' areas for people to evacuate to when thunderstorms are in their area. One of the most concrete and direct methods of saving lives is to provide lightning safe buildings and vehicles. Ethics and regard for human life require that any lightning protection (LP) system assures an increased level of safety for those at risk and gives good value for the monetary investment to purchase and install them.

While the International Electrotechnical Commission (IEC) 62305 series may be the most recognized and rigidly validated set of standards, many others are in use, often incorporating alternative lightning protection materials and designs that may be untested or in conflict with IEC 62305 [16, 17]. Even when a country adopts IEC62305, there is no guarantee of dissemination of the standards or enforcement. There may be little or no knowledge of a nation's accepted standards by LP purveyors, resulting in local LP designers and installers repeating what they have been practicing for decades and which they may truly believe to be effective. Unfortunately, design and installation of alternative LP noncompliant with IEC-based standards is not a problem isolated to the developing world but is rampant in developed countries as well, including the United States.

Another factor that hinders the use of IEC standards is the cost. It has been estimated that less than one third of the world's population can afford IEC compliant LP. Even when a client is educated and wants to use IEC standards, high quality or compliant materials may not be available in their country so shipping and import fees add further cost. In ACLENet's experience, many schools, churches, and medical centers which have sought standardized, high-quality LP may be pressured by local designers and donors to install cheaper, non-standard LP, or by frightened staff and other

end-users to install something quickly before the next storm season, regardless of its compliance and reliability.

For IEC standards to be implemented in countries where lightning risk is highest and quality LP is most needed, there must be an effort to *maximize safety while minimizing cost* [18-23].

B. Infrastructure

Many developing nations have massive difficulties with basic infrastructure that makes promoting lightning safety programs a low priority. Issues include:

Homes and buildings: Many or most homes and other buildings are not lightning safe since there are few or no conducting paths for a direct or nearby strike to prevent its impact from entering the structures [18]. Buildings such as thatch-roofed homes and makeshift market stalls often have essentially no wiring or plumbing. In addition, in many villages, there are no lightning safe buildings nearby or within walking distance when lightning approaches. 'When Thunder Roars, Go Indoors' and similar slogans, although effective in areas with lightning safe structures, are not yet applicable to the developing world because few communities have lightning safe structures to which the population can evacuate. In fact, in the case of thatched roofs, it may be more dangerous to recommend going inside than staying outdoors [24].

Vehicles: In the developed world, fully enclosed metal-topped vehicles are readily available almost everywhere most of the time. However, in less developed countries, there may be no such vehicles within walking distance where everyone can wait out a thunderstorm.

C. Lack of Data on Lightning Deaths and Injuries

Without national data that lightning is a significant hazard, it is difficult to catalyze government action or recruit donors. Holle has documented the countries where data has been gathered on lightning deaths [25]. One of the first things advocates should consider doing is a study in their country to define the problem and document those at risk, including their age and gender, the time of year they were injured, their housing or availability of lightning safe structures, what activity they were engaged in, and other risk factors. Multiple studies by Holle can serve as a template for the advocate [26-31]. These data points can help to define public education programs that can be implemented which target those most at risk. Additionally, baseline data is essential to measure the effect of advocacy programs.

Many developing countries have limited monitoring of meteorological and other natural disasters. As a result, the frequent incidents with small numbers of lightning deaths and injuries per event escape their attention. Additionally, local people may be reluctant to report lightning injury due to cultural beliefs that victims were 'cursed' or that talking about lightning can bring it down on themselves or family members – both negatively impacting the family [32-38].

D. Lack of Recognition of Lightning as a Disaster or Weather Threat by Governments, Resulting in Inaction

In the past, the World Meteorological Organization (WMO), World Health Organization (WHO), and United Nations Office for Disaster Risk Reduction (UNDRR) typically classified natural disasters as large events with many injuries such as tropical cyclones, tsunamis, and earthquakes, often using a criterion of ten or more deaths for inclusion. This tendency is evident in the Sendai Framework for disaster risk reduction [39].

While lightning is the most common weather threat to life encountered by people around the world, deaths and injuries are not well documented, few reliable national databases exist, and occurrences often involve only a few people, not meeting criteria such as 'ten deaths per incident' to be considered [25]. As a result, lightning is infrequently recognized as a disaster, although the actual annual death toll may be as large or larger than other natural disasters. Another argument supporting the importance of demographic lightning risk studies is the recent reclassification of lightning by the Nepalese government as a high priority national disaster based on Sharma et al's study documenting lightning risk compared to other weather threats [28].

Lightning fatalities are frequently more consistent from year to year than fatalities caused by intermittent or infrequent large hazard events. This issue is true for most natural hazards databases and programs at every level. Refocusing both the government and public's perception of lightning as the most common weather threat to life faced by people worldwide is essential to change attitudes and raise awareness.

E. Education

Public education about lightning risk and safety is lacking in most developing nations. Because there is no widespread knowledge of lightning science, how lightning is formed, where it strikes, mechanisms of injury and other facts, long standing folk beliefs have developed over generations about the sudden and seemingly random impacts of lightning. Superstition, witchcraft, myths, and other untruths are spread orally among the population from generation to generation. This is true in South America, Asia, and Africa [32-39]. An unpublished study by Gilbert Phiri in Malawi using respected elders as 'myth busters' contributed to significant decrease in these beliefs in his community [40]. Public education and debunking of myths is an essential key for advocacy programs.

In terms of education, it is important to know the groups most vulnerable to the impacts of lightning so they can be preferentially targeted. Are they farmers [26, 29, 42, 43], people in their homes [44], fishermen [45], or students at school [46]? Who are the most lightning-susceptible groups, in terms of quality of housing and schools, participation in farming, age, and gender in each location? Studies have shown that these factors vary from country to country [26-31].

In many countries, multiple languages and dialects are spoken by relatively small groups; this is especially true in Africa. Developing safety messages in print, broadcast, and online should ideally be done in each language, but this can be expensive and involve a large effort for the number of people reached [47]. Low literacy rates continue to be a

problem in many of the least developed nations so that print is not the best way to reach the population. Signage or other methods may be more effective. If used, signage should be in the local language and incorporate images for non-readers such as in the Fig. 2 school yard poster developed by ACLENet for the primary schools it has protected.

In many locations where lightning is prevalent, internet penetration and reliable electrical power is poor. In rural Uganda, television and internet are seldom available, and newspapers are used only by government officials and the literate in larger communities, but nearly everyone has a battery powered radio at their work or home so, when funds are available, ACLENet uses radio broadcasts to disseminate information, and again, this is best done in the local language.

F. Severe Weather Warnings and Forecasts Non-existent

Meteorological programs in developing countries often exist only to serve airports since weather information is required by international airlines. Little or no forecasts are given to the public about rain, wind, lightning, or other weather threats so creating warning systems and apps that the developed world takes for granted are not possible in most places. However, Mahomed et al reported a pilot study in KwaZulu Natal, South Africa, that may be effective in other locations [48, 49].

Even when forecasts are available, public knowledge about how to use them may be lacking and another area where advocates can target their efforts. Behavioral guidance must be part of public service messages and should include a few easy to remember 'Do this' messages instead of a long list of 'Don't do this' messages which few can remember in an emergency situation.

Extensive studies have been made in the U.S. and other locations about guidelines for when to reach a lightning safe location and when to call an all-clear [50]. Ideally, guidelines in developing countries should be formulated with the target population in mind and disseminated in advance of the thunderstorm season so that effective and efficient responses to the threat of lightning can take place.

G. Fundraising

There is typically little or no funding for lightning education and protection within the government agencies that have so many other more pressing challenges. As a result, other methods need to be considered [47, 51-53].

Outside large funders such as USAID, the World Bank, and others seldom recognize lightning risk. For example, it has been estimated that as many as 24,000 people are killed and ten times as many injured by lightning every year around the world [54]. This estimate was originally made when the world's population was 20% smaller than it is today so that the totals are likely much higher now. This is a large number, comparable to other natural hazards, and repeats every year. Unfortunately, since most lightning events impact only one or a few people, it is difficult to raise the level of awareness of large funding agencies that typically address more significant events such as tropical cyclones, earthquakes, and flooding.

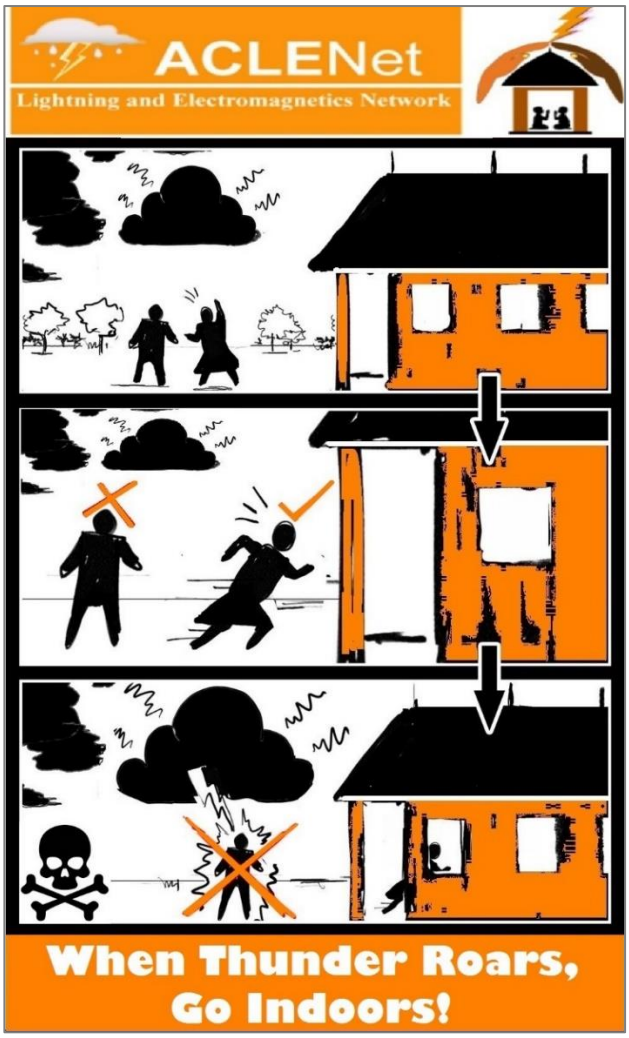

Fig. 2. Lightning safety sign developed for non-readers by ACLENet. Check marks and X's are what teachers use to correct student papers so children are used to this indicator. Note air terminals on top of the school building.

Disaster funding, particularly with Covid, tends to be reactive and after the disaster has occurred more often than proactive and preventive.

Lightning injury prevention, just as lightning studies, is multidisciplinary. At the same time, it is very specialized with few current funders aware or concerned. As a result, keywords for grant searches and grant reviewers related to lightning are inadequate since lightning is a phenomenon that does not readily fit into existing disaster, education, health, community development, or other categories. Additionally modern funders like to have metrics to measure the impact of their funds and these may be difficult to collect for large or dispersed rural populations with poor reporting of injuries and no reliable national injury baseline. To request funding for lightning studies, and injury research and education, the problem needs to be well articulated.

Many safety advocacy programs have arisen over the last few years. The more attention that can be focused on lightning injuries, particularly with the use of media, the more likely different audiences and funders will become concerned about it.

V. Summary and Conclusions

ACLENet has experienced a wide variety of challenges in attempting to advance lightning safety in Africa but has been blessed with volunteers from around the world who help to further its mission. As with most advocacy programs, there are such large obstacles that it is necessary to make choices about what can be accomplished by small and mostly volunteer organizations with limited funding. Choosing which projects to pursue is a balance of available funding, available staff, talents and knowledge of the leaders, deciding which efforts are most likely to succeed, and identifying which issues will generate the most interest and highest likelihood of success at a given time and location.

This paper has outlined the challenges, proposed solutions, given references for studies on outcomes, educational resources, and templates for how to do demographic studies. It is common sense that programs working together and sharing information, data, and ideas can accomplish more than by working alone. Every safety advocate can contribute to saving lives, no matter how small or large their input.

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