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Lightning fatalities in Swaziland: 2000–2007

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Abstract An investigation is undertaken to analyze the human lightning fatalities in Swaziland. A total of 123 victims of lightning-related death were identified from the records of the Royal Swaziland Police Service and the local printed media for the period 2000–2007. An annual average fatality rate of 15.5 people per million, the highest recorded rate in the world, was obtained. The results also reveal that 66% were male, most (67%) of them were within the 10–39 age group with an average age of 28 years. Lightning fatalities occurred from September to May mainly in the afternoon (1400–1800 h). Deaths most commonly occurred indoors inside rural houses (17%), whilst walking (16%) and under a tree (14%). The incidents resulted in multiple fatalities in 22% of the cases with an average of 1.4 casualties per incident. The need for awareness campaigns, protection measures and detailed investigation is highlighted.

Keywords Lightning · Fatality · Hazard · Thunderstorm

1 Introduction

Studies of natural hazards and disasters across the world have been and are increasingly receiving interest around the world mainly because their associated risks are embedded in our political, economic, and social institutions as 'acts of God' that result in adverse societal impacts (Committee on Disaster Research in the Social Sciences 2007). Lightning is one of the significant but underestimated hazards to people and infrastructure. The many deaths and injuries to livestock, fires as well as untold millions of dollars in damage to buildings, communications systems, power lines and electrical systems are attributed to lightning (Kithil 1995). Five main mechanisms of lightning-related injury and death have been identified, namely direct strike, touch voltage, side flash (or surface arc), step voltage and unconnected upward discharge (Anderson 2001; Lewis 1997; Walsh et al. 2000).

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Since time immemorial, mankind has always beheld lightning (and thunder) with great awe with various religious and traditional interpretations that view it as a sign of the anger of the gods from ancient mythology (Hammond 1994) mainly because of its destructive nature. Swazis traditionally observe towering scary darkened clouds on the west combined with fast-blowing wind from the west as signs of imminent fierce hailstorm accompanied by thunder and lightning (UNEP 2007). The Greeks, on the other hand, regarded the god Zeus as the bearer of thunder and lightning (Encyclopædia Britannica 2008). Swazis culturally hold the belief that lightning is either an act of witchcraft or an expression of anger by the gods or God. Kuper (1947), observed that traditionally Swazis believe in two types of thunder/lightning; that which is sent by the king and that which is sent by witches or wizards. The former is assumed to be harmless and a source of crop vitality. Interestingly, one of the earlier Swazi Kings and the author's ancestor, King Ndvungunye, was struck dead by a bolt of lightning in the early nineteenth century (c. 1805) in the south of the country (Jones 1993; Westcott and Hamilton 1992). Kuper (1952) also observed a strong belief in the source of lightning being a bird that dwells in deep pools. Many such myths still exist and some undermine the necessity to take precautionary measures in many countries including Swaziland thus increasing the risk and effects of lightning injuries.

Swaziland has estimated ground lightning flash densities of more than 12 flashes/km^2/year (Anderson et al. 1984), mainly occurring in the Highveld where there is a high incidence of thunderstorm occurrences every year. As a consequence, the local power grid system in the western (Highveld) part of the country is also prone to lightning strikes that cripple power stations across the nation, resulting in significant economic loss (Mswane and Gaunt 2005). Large parts of western Swaziland have been identified as a zone of high convective activity and intense thunderstorms (Goliger and Retief 2007) and furthermore, every year, many people and livestock are injured or killed by lightning, but unfortunately no statistics have been kept by the Central Statistics Office or the Ministry of Health and Social Welfare or any relevant agency to show the number of people killed by this hazard over the years.

Countless studies have been carried out in the developed world, primarily in the United States, mainly quantifying lightning fatality and injury statistics or detailed case reports with suggestions as to treatment, and explanations as to the exact mechanisms of death (Walsh et al. 2000). However, only a few articles have dealt with the effect of lightning fatalities in populations with respect to time, space, and circumstances in southern Africa (for example Blumenthal 2005; Castle and Kreft 1974; Meel 2007). Moreover, there has not been any specific and systematic study or reporting conducted on the lightning fatalities in Swaziland except for a brief analysis of newspaper clips by Eriksson and Smith (1986). The goal of this study was therefore to estimate the frequency and to examine the characteristics of lightning casualties in Swaziland from 2000 to 2007. Lightning-related events are considered relative to the activities taken by casualties, the age and gender of the casualties. The results from this study will also enable one to extract information on the risky time and activities/circumstances in Swaziland in an effort to initiate a public awareness and lightning safety campaign.

2 Study area

The Kingdom of Swaziland is land-locked and sandwiched between South Africa to the north, west and south, and Mozambique to the east with a total land area of 17,364 km^2. Straddling latitudes 25°43′ and 27°19′S, and longitudes 30°47.5′ and 32°06′E, the country supports a large variety of landscapes, geology, climate, and natural vegetation.

The climate, which is generally subtropical, is largely controlled by the altitudinal variations that range from over 1,800 m in the northwest down to below 100 m in the east. The climate is also strongly influenced by the country's position on the eastern side of southern Africa, which exposes it to moist maritime tropical air coming off the Indian Ocean for most of the year. The topography is mainly influenced by the underlying geology mainly composed of granitic, basaltic and rhyolitic rocks (Doveton 1937; Remmelzvaal 1993). A bulk of the country's precipitation falls in summer (September–March) usually in the form of lightning-bearing thunderstorms and frontal rains. The climatic variations within the country are largely controlled by the strongly differentiated topography of the country's six physiographic or eco-climatic zones namely: the Highveld, Upper and Lower Middleveld, Western and Eastern Lowveld and the Lubombo Plateau (Doveton 1937; Gibbons 1981; Goudie and Price-Williams 1983; Remmelzvaal 1993). The Lubombo Plateau or mountain range separates the Swaziland coastal plains from the Mozambique coastal plains whilst the Highveld is an extension of the Drakensburg range but, unlike the Drakensburg, is deeply dissected by the jointing and faulting resulting in strong convective thunderstorms which are frequent in this part of the country (Goliger and Retief 2007). The eco-climatic zones determine the sub-humid and temperate conditions with typical annual rainfall ranging from 1,450 mm in the Highveld to semiarid and warm conditions with an average annual rainfall of 550 mm in the Lowveld (Goudie and Price-Williams 1983; Remmelzvaal 1993). Consequently, high temperatures of up to the 40°C are recorded in the Eastern Lowveld, whilst low temperatures and sometimes frost are recorded most frequently in the Highveld.

The 2007 census put the current de facto population of Swaziland at 1,018,449, a very small increase from the 1997 figure of 929,718, three quarters of which lives in rural areas (Central Statistics Office 2008). Almost three quarters of the population lives in the Highveld (32%) and Middleveld (40%) (Central Statistics Office 2008), the eco-climatic zones of high thunderstorm activity. Most of the population is living under low socio-economic conditions, with two-thirds of the population living below the poverty line and more than half the working population unemployed (Ngwenya and Hassan 2005). In Swaziland, similar to other developing countries, a large proportion of rural dwelling structures have very little or no modern engineering input (Goliger and Retief 2007). The disproportionate population distribution with respect to the eco-climatic zones coupled with the socio-economic disparities contributes to the differences in exposure to natural hazards such as lightning.

3 Methodology

Similar studies that have been conducted in various parts of the world largely depend on historical information and newspaper articles, the latter being the dominant data source (Mills et al. 2008). Whilst the limitation of underreporting and lack of standard casualty definitions are commonly cited, they are more applicable to injuries than to fatalities (Coates et al. 1993; Curran et al. 2000; Duclos et al. 1990; Holle et al. 2005; Mills et al. 2008). Mills et al. (2008) acknowledge that newspaper sources are limited by the geographical coverage of those papers relative to the area under investigation, the relevance of a particular lightning incident relative to other stories, the availability or limitations of electronic or catalogue searches, and the reliability of sources.

The primary source of the data used in this study was the Royal Swaziland Police Service's (RSPS) monthly incidents data. The advantage of these records is that they are derived from police stations and police posts spread throughout the country. The records accessed were from the year January 2003 to December 2007. The information contained in these records consists of date, locality, age and gender of each lightning victim. However, the RSPS records give very scanty information on the circumstances during the event and they do not contain the time of the event. Moreover, information for the years 2000–2002 was not available and since the interest of the study was for the years 2000–2007, it was necessary to include other sources, especially the local printed media. Hence narrations from the local dailies, *The Times of Swaziland* and *The Swazi Observer*, which also provide survivor and witness reports were utilized as ancillary sources to validate some of the police reports and to extend the records back to the year 2000. This involved physical reading of every newspaper published during 2000–2007. The data were then collated and analyzed to ascertain the circumstances or activity during the strike, age and gender of all victims, and temporal (yearly, monthly and hourly) variations in lightning fatality occurrences.

4 Results and discussion

4.1 Inter-annual variations

A total of 123 fatalities were reported during the period from 2000 to 2007 and the year-to-year variations in lightning fatalities are shown in Table 1 illustrating considerable inter-annual variations (standard error = 2.34, $\sigma = 6.63$). For instance, the year 2003 had 25% above the 2000–2007 annual fatality average. The increase in fatalities in 2003 could be attributed to multiple deaths from single lightning strikes and increased thunderstorm activity during that year. However, it is important to mention that the variations could also be attributed to the inter-annual variations in the climatic patterns affecting southern Africa, mainly resulting from regional and global climatic perturbations and teleconnections (e.g. as explained by Cook 2000; Jury and Pathack 1993; Jury et al. 2000; Levey and Jury 1996; Lyons 1991).

The number of lightning fatalities, normalized by population, vary from year to year with an average rate of 15.5 per million people per year for the 8-year period, a rate that is significantly higher than the estimated rate of 6 per million obtained by Holle and López (2003) for southern Africa and other less-developed nations. This figure is also notably higher than all the figures reviewed by Mills et al. (2008) and that of Cuba, estimated to be

Table 1 Annual lightning fatality rates in Swaziland, 2000–2007

Year	Fatalities per million people
2000	3.1
2001	19.7
2002	8.2
2003	24.4
2004	18.1
2005	16.9
2006	17.8
2007	15.7
Average	15.5

leading with 6.16 deaths per million (NationMaster.com 2007). In their analysis of lightning fatalities obtained from press clippings for the period of September 1973 to April 1985, Eriksson and Smith (1986) obtained a total of 24 fatalities for Swaziland giving an average of two fatalities per annum, equivalent to an average of four fatalities per million when considering population. This value is much below the value obtained in this study. Eriksson and Smith's (1986) result was likely an underestimate resulting from underreporting from the press as a result of lack of penetration into rural areas at that time and the predominant cultural practices of secrecy with regards to beliefs about lightning deaths. The current rate obtained for Swaziland is also comparable to the rates before the 1930s in South Africa obtained by Eriksson and Smith (1986) and pre-1950 rates in Canada by Mills et al. (2008). The highest published rate is 12.3 per million recorded among the rural people in Zimbabwe by Castle and Kreft (1974). However, as already mentioned, there could be possible underreporting even with the current estimates, more especially, with respect to deaths that result from severe injuries occurring days after the incident. The traditional beliefs and superstition surrounding lightning death could also result in underreporting since such victims are most likely still buried secretly so as to avoid the 'contamination' of the rest of the family (Kuper 1947).

4.2 Monthly variations

Most victims were killed during the summer months (Fig. 1) between September of the preceding year and May of the following year. The peak months are between October and February when 88% of fatalities occurred. The greatest number of fatalities occurred in November (33%) with the second most in December (19%). The higher percentage in November includes a disproportionate share of multiple fatality incidents. The period from September to April coincides with the summer season in the country and October to March is the period of intense thunderstorm activity. No one was struck by lightning during the winter months of June to August. The results correlate well with the seasonal lightning activity patterns observed by Dlamini (2006) using data from the Lightning Imaging Sensor (LIS) onboard the Tropical Rainfall Measuring Mission (TRMM).

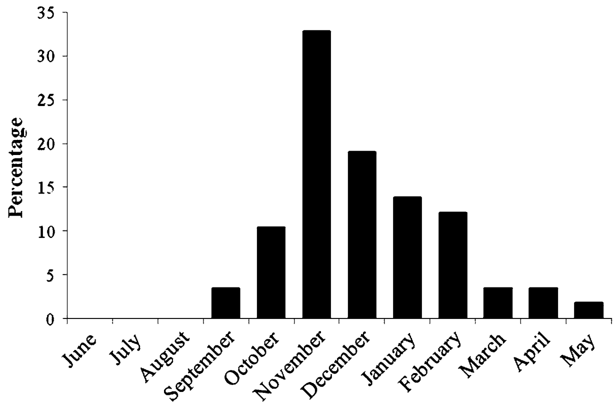


Fig. 1 Monthly distribution of lightning fatalities, 2000–2007

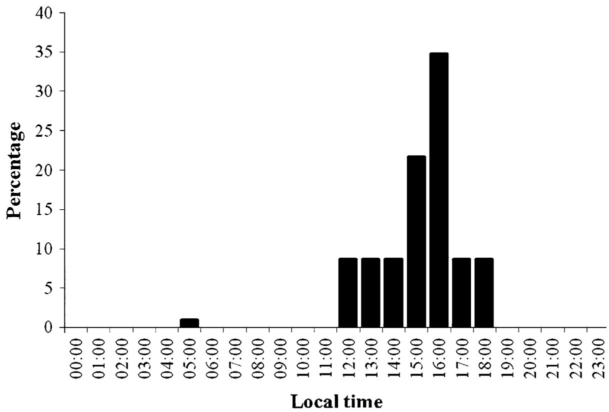
4.3 Diurnal variations

Following Coates et al.'s (1993) approach, the data were divided into objective and subjective data. Objective data is that data where the time was available from the newspaper articles, for instance, '1400 h' or '1730 h' whilst subjective data was given as broad approximate periods of the day, for example, 'in the afternoon' or 'at night'.

A majority of lightning casualty reports occurred in the afternoon and early evening (Fig. 2) mainly between 1200 and 1800 h local time which coincide with the typical Swazi summer afternoon thunderstorms. They show a steady increase toward a maximum at 1600 h, followed by a decrease after the maximum. Only one fatality was reported in the morning at 0530 h. Holle et al. (1993) noted that if an event is recorded as occurring on the hour, it is likely that the actual time of the incident was unknown or probably occurred before the recorded time in the storm report. Moreover, local rural people are known to judge time based on the position of the sun relative to the sky. It is therefore important to note that some of the reported events probably occurred an hour earlier. The results are in agreement with Collier et al. (2006)'s who determined that peak lightning occurred at 1700 h in the southern African region and Dlamini's (2006) findings of peak lightning activity in the afternoon with peak activity between 1400 and 2000 h local time. This is also consistent with the observed patterns of storms by Preston-Whyte and Tyson (1988) developing in the late afternoon and early evening in southern Africa. Similarly, Eriksson and Smith (1986) found peak fatalities between 1200 and 1800 h, which have a positive correlation with the diurnal variation in thunderstorm activity.

From the subjective data, 93% of the casualties occurred in the afternoon and a very few (7%) occurred at night. No observations were made in the morning hours, again highlighting the dominant effect of convection due to solar thermal forcing. The results are comparable to those obtained in the US (Curran et al. 2000), Australia at 1200–1800 h (Coates et al. 1993), Singapore (Pakiam et al. 1981) and neighbouring South Africa (Eriksson and Smith 1986). This therefore points to the need to be cautious of the time of the day for certain activities which might be considered risky. Similarly, schools might have to make certain measures to protect children who have to walk home after school hours, which is typically between 1300 and 1400 h for primary schools and 2 h later for high schools.

Fig. 2 Diurnal distribution of lightning fatalities in Swaziland, 2000–2007



4.4 Gender and age variations

The results point out discernable gender and age-based variations in lightning fatalities. Comparatively, more males than females have been killed by lightning strikes with males accounting for 68.3% of all fatalities, as shown in Fig. 3. Eriksson and Smith (1986) obtained a figure of 64% for southern Africa. This is most likely accounted for by the larger proportion of males' outdoors mainly engaged in traditional chores or risky activities. This is comparable to findings in other regions such as Australia (Coates et al. 1993) and in the USA (Holle et al. 2005). Almost a quarter (25.8%) of the lightning strike victims in Swaziland were between the ages of 10 and 19, a majority (18.6%) of which were males, followed by the 30–39 age class. Broadly, the 10–39 age class accounts for two-thirds (67%) of the total fatalities. The median age obtained for Swaziland was 28.5 years. The results are similar to those obtained by Meel (2007) who found most (26.5%) of victims having the ages of 11–20 in the Transkei area of South Africa. In the UK, Elsom (2001) also reported that males were struck more often than women (65% male and 35% female) and that the average age was 30 years (median 26). Similarly, Pakiam et al. (1981) and Duclos et al. (1990) found high incidents in this age class with median and mean ages of 27.3 and 31.8 years, respectively. In the US, Duclos and Sanderson (1990) obtained a median age of 26.3 years.

The results are an indication of the differentiated vulnerability caused by gender-based social norms and roles for different age groups of active rural dwellers. Those vulnerable are mainly middle-aged men and women, and children who are the active age groups mainly involved in outdoor activities. Children are increasingly more vulnerable as in most cases walking from school or undertaking daily domestic chores. There is a gradual decrease in fatalities from 40 years upwards. This appears to be consistent with the general trend, especially in the past times, of older people being confined indoors as they grow up, either by choice or by traditional circumstance, even though the rural dwelling are also at risk.

These findings point to the need for a proactive approach on the part of adults (guardians/parents and teachers alike), who are responsible for children, to deal with threats from lightning. However, it is also important to note that the proportion of females is relatively high due to the activities of women in the rural areas and it is discussed in a later section on circumstances and activities. 'This population-level association between age and gender and casualties is founded in the social preference for particular activities

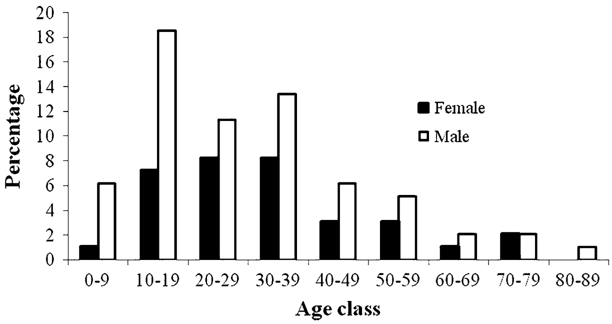


Fig. 3 Distribution of lightning fatalities in Swaziland by age and sex, 2000–2007

that lead to increased outdoor exposure rather than any medical predisposition to injury' (Mills et al. 2008).

4.5 Victims per incident

The most common situation was for one victim to be involved per lightning incident with an average of 1.4 fatalities per incident. This is similar to the findings by Curran et al. (2000). From Fig. 4 it is clear that a majority (78%) of events were single fatalities, 12.1% were double fatalities and the rest involved were more than two people killed per incident. Eriksson and Smith (1986) obtained 63% for single fatalities. However, single incidents, though rare, can account for a large proportion of fatalities in any given year and these are typically in Zionist church services or in groups engaged in outdoor activities. The largest fatality incident was on 7 December 2003 in Mbeka in the Mankayane (Highveld) area during an event that killed nine people and injured six others.

The tendency to congregate, therefore, increasingly poses a greater risk especially if the people are in exposed and risky circumstances discussed in the following section. A case in point is the 8 January 2004 incident where a total of 70 boys were injured whilst participating in the annual *Incwala* traditional ceremony at Lobamba. This event usually takes place during the months of December and January, which are also months of intense thunderstorm activity.

4.6 Activity or circumstance during incident

Details of or information on the circumstances during the lightning strike were available for 64% of the cases. This is a comparatively higher figure considering the 48% and 40% obtained by Coates et al. (1993) and Curran et al. (2000), respectively. These details on the circumstances were based on narrations from interviews by the local dailies, The *Times of Swaziland* and *The Swazi Observer* whilst a few were noted from the RSPS reports. For instance, if the victim was on his or her way to or from school or place of employment, the activity was coded as 'walking home'.

A significant number (17%) of the victims, both male and female, were struck whilst walking in houses, 16% in the open (walking) whereas 14% were struck whilst sitting or

Fig. 4 Fatalities per incident in Swaziland, 2000–2007

standing under a tree (Table 2). Table 2 points to the fact the majority of the fatalities occurred outdoors in open areas or whilst taking shelter under trees. However, if the category of church service and inside houses is merged into one category of indoors, the figure rises to 25%, which is a very significant outcome. Mills et al. (2008) found that 68% of fatalities occurred in open areas or under trees. Prentice (1972) recorded 34% of outdoor fatalities in Australia to be on foot and exposed and 31% under trees or other shelter. Cuenca et al. (1992) also observed that a tree was struck in 26% of all lightning fatalities. Taking shelter under trees is also therefore clearly very hazardous. This is an important finding considering the traditional Swazi belief that several tree species, such as the sausage tree (*Kigelia africana*) and *Ochna arborea*, repel lightning and hence are planted in and around homesteads (Dlamini 1981). The indigenous methods used to prevent people from being hit by lightning also include taking refuge under trees that are believed to repel lightning. Long (2005) lists a total of 29 plant species that are culturally believed by Swazis to either protect against or ward off lightning. Loffler and Loffler (2005) also list seven trees that are used as charms or protection against lightning. It would be interesting to undertake a research into the relative lightning strikes to such trees to determine their claimed efficacy in lighting protection. On the contrary, there are certain trees that are thought to be prone to lightning strikes such as *Sclerocarya caffra*, *Vangueria esculenta* and *Gardenia cornuta* and are not planted around or near homesteads. Other indigenous lightning avoidance measures include avoiding footpaths with running water during a thunderstorm (UNEP 2007).

Similar to the patterns found in gender patterns, the activity of individuals, which are dictated largely by social norms and roles, have a major bearing on the casualty patterns in the country. Historically and socially, males are expected to engage in physical outdoor activities or chores such as herding cattle, ploughing, and sport, among other activities. However, women are also involved in outdoor activities such as collecting firewood and often times walk long distances doing their daily chores of providing for their families or young ones, thus exposing them to the hazards of lightning strikes.

The risk profile for a structure is also influenced by factors such as the relative location and dimensions of the structure, including extraneous objects surrounding the structure,

Table 2 Lightning fatalities grouped by circumstance or activity during incident

Circumstances	Percentage
In house	17
Walking home	16
Under tree	14
Church service	8
Bus stop	2
Herding cattle	2
In a classroom	2
Bathing	1
Collecting firewood	1
Ploughing	1
Repairing vehicle	1
Sitting outside	1
Watching soccer	1
Unknown	38

and the lightning parameters (Dickson 2006; Mazzetti and Flisowski 2007). It is, therefore, highly probable that the large proportion of casualties inside rural dwellings is due to the type of construction and the poorly grounded structures. During some of the lightning strikes to rural dwellers, reports of the eventual burning of the huts were abundant suggesting the lack of protection and huge lightning risk of these structures. The rural structures are often built in exposed areas such as hillsides and ridgelines which increase the chance of direct lightning strikes to the structures and any services entering the structure. The Zionist religious sect's form of worship, as already mentioned, coupled with the locality and types of most of the worship structures is a significant source of fatalities. Typically these structures are stick and mud in rural areas with very little or no grounding, hence the risk of personal injury or death may be higher on the worshippers, who congregate in large numbers. In the peri-urban and semi-urbanized areas, high-density low cost houses have a reduced chance of a direct strike to a structure although the structures are also more exposed.

Eriksson and Smith (1986)'s findings on lightning fatalities in South Africa over a 12-year period also revealed that 36% of all fatalities—and 77% of all fatalities inside structures—were in traditional rural huts with mean mortalities of about 1.5 fatalities per million for urban areas and eight fatalities per million for rural areas. Castle and Kreft (1974) also attributed the high lightning incidents in Zimbabwe to the construction methods and locations of rural dwellings where 21% of incidents occurred in traditional huts. The same can be said in the case of Swaziland where most of the rural structures are typically wood and mud structures with non-continuous metallic or grass roofing and very little or no earthing or similar protection. Typically these also do not have electricity, plumbing, and telephone services and/or other conductors. On another note Johwa (2004) alludes to studies undertaken in Zimbabwe which link the smoke formed by fuelwood or similar combustion from traditional kitchen huts as a source of opposite charge necessary for initiating lightning strikes. This, however, could not be verified for Swaziland since such specific information was not available.

The findings on the lightning fatality locations in this study are strikingly similar to those of the United States in the 1890s when the population was largely rural (Holle et al. 2005). Cuenca et al. (1992) also found a majority (76.1%) of the victims to be from rural areas. In modern buildings, fatal strikes can only occur when a person is in direct contact with power, telephone, or plumbing that brings the lightning's current into a building (Holle et al. 2005). Adekoya and Nolte (2005) also note that the decline in US fatalities over the years is a result of increased individual awareness of the risks, greater adoption of appropriate precautions, and an improved medical response to lightning victims.

5 Conclusion and recommendations

Although lightning fatalities can be related to coincidental circumstances, they are still mainly determined by the activity and location of the individual or group of individuals during the thunderstorm. This implies that the fatalities are mainly a result of the choices that people make and thus are potentially preventable. Contemporary fatality rates estimated for Swaziland are likely the highest determined for any part of the world. This seems to be explained, to a large degree, by the characteristic socio-cultural and dwelling differences between Swaziland and other countries. Most fatalities occurred either outdoors or in unprotected, unsafe rural dwellings, the latter accounting for most fatalities. More than three-quarters of fatalities had single fatalities, and one-fifth recreation-related, although the proportion of recreational lightning fatalities has increased with time. The age group most at risk is the school-going and working class, accounting for more than two-thirds of the fatalities.

The gravity of the hazards of lightning that lead to deaths highlights the need for scientific and technological advancement, proper engineering and technical practices, dissemination of knowledge and public awareness with respect to lightning protection in the country. The 2007 Colombo Declaration on Lightning Protection and Safety, an outcome of the International Roundtable on Lightning Protection held from 22nd to 25th May 2007 at Colombo, Sri Lanka, makes very good recommendations which could be used to map a way forward for the country. Although lightning alerts in the country may seem impossible at the moment, stressing lightning awareness and safety and diffusing some of the cultural beliefs and addressing the socio-economic imbalances may save a lot of lives. Regulations and standards regarding infrastructure requirements for lightning protection, especially for buildings housing a large numbers of people at a time such as churches and schools, should be put in place and implemented. Standards such as those formulated by the Technical Committee TC81 (IEC 62305) of the International Electrical Commission and those existing in other countries could be adopted and applied. It is crucial therefore that the approximate location, tolerable and dimensions of a structure and other lightning parameters and other modern protection measures are considered to determine the lightning risk. Using average ground lightning flash density values, it would be possible to ascertain the relative risk to lightning. The new South African Weather Services Lightning Detection Network (SAWS LDN) can hopefully help in the next few years to accurately determine the some of the lightning parameters. The Royal Swaziland Police Service, together with the Fire and Emergency Services, Ministry of Health and Social Welfare should develop a protocol of recording lightning fatalities that will include information on the variables discussed in this paper, i.e. age, sex, time, circumstances/activity during incident, injuries, degree/type of injury, and location. This can help develop a concise lightning casualty database for the country and in the development of mitigation strategies. Furthermore, geographical variations in lightning fatalities can be investigated to identify lightning fatality hotspots.

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