

# Statistics of Casualties and Damage Caused by Lightning Strikes in Korea from 2000 to 2007

Dong-Seong Kim\* · Bok-Hee Lee · Duk-Kyu Jeon\*\*

## Abstract

This paper presents statistics on lightning-caused damage to humans, structures, and electrical and electronic equipment. To reduce the number and amount of casualties and damage caused by lightning strikes, the statistical analysis of lightning-related damage reports is important in establishing lightning protection measures. The statistics of lightning death, injury and damage in Korea from 2000 to 2007 were primarily derived from mass media. As a result, the annual average of lightning-caused deaths in Korea is about 5. Most lightning casualties involve people who work outdoors such as farmers and recreationists. Data on lightning-caused injuries to humans and damage to structures in this paper may be underestimated since the available data from mass media are incomplete. The actual lightning-caused casualties and damage in Korea may be greater than those presented in this paper.

Key Words : Lightning, Lightning-caused deaths and injuries, Lightning damage, Lightning risk, Lightning protection

## 1. Introduction

Lightning is an extremely significant weather hazard and one of the greatest threats related to thunderstorms. In the United States, lightning is the second most efficient weather-related killer among the four major storm-related hazards of floods, lightning, tornadoes, and hurricanes. Many people are injured or killed due to misinformation

and inappropriate behavior during thunderstorms. Worldwide, annually there are a few thousand lightning deaths and tens of thousands of lightning injuries [1].

Lightning also causes great damage to a variety of objects and systems, including electrical and electronic systems and buildings. Recently, information technology devices and systems have come into wide-spread use in many fields of industry, business, and public services, etc. Thus, the loss of power supply due to lightning can cause vital problems, such as data loss in computer systems, or paralysis in administrative and bank service networks. The social cost relevant to lightning damages is drastically increasing, and appropriate lightning protection is becoming a subject of special interest in

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present-day life. Therefore, reasonable lightning protection measures have become more important than ever before [1,2]. Investigations or reports on casualties and damage caused by lightning are rare in Korea. It has been reported that lightning damage to apartments is increasing every year [3,4]. In order to reduce the number of lightning-caused human casualties and to prepare the optimal effective lightning protection in technical and economical aspects, it is essential to understand the present status and causes of lightning-related damage in lightning protection studies. The aim of the present paper is to examine the statistics of lightning-caused casualties and damage in Korea from 2002 to 2007 and to discuss appropriate protection measures against lightning.

## 2. Methodology

It is difficult to accurately investigate the number and cause of occurrence of lightning-caused casualties and damage for various reasons. Lightning fatality statistics in a number of countries are derived primarily from public media [1,5,6]. Practically the only source of information on lightning-caused casualties and damage in Korea is central or regional public media. In this paper, statistics on lightning-caused casualties and damage were collected from mass media, such as TV or radio broadcasting, newspaper clippings describing lightning-related deaths, injuries to humans, and damage to structures and electrical power systems. Fortunately, many data relevant to lightning-caused human casualties and damage to structures have been amassed using computerized systems and internet networks.

## 3. Results and Discussion

### 3.1 Lightning-caused human casualties

Lightning causes serious damage to a wide range of objects and installations, including humans, animals, structures, power systems, electrical and electronic equipment. In this paper, statistics on the data derived from mass media regarding lightning-related casualties, deaths, injuries, and damage to structures and public facilities in Korea from 2000 to 2007 were analyzed. This analysis presented figures of statistical data by the place of occurrence and by year. The lightning season in Korea begins in April and ends in October, most lightning strikes being recorded in summer.

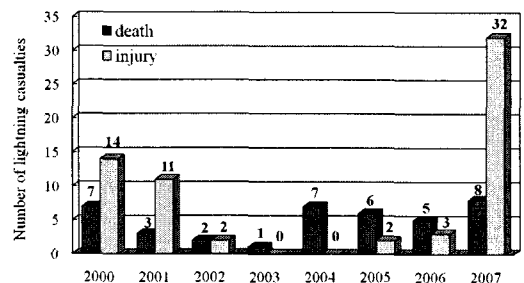


Fig. 1. Histograms of the annual number of lightning-caused casualties in Korea

Figure 1 shows histograms of the annual number of lightning-caused casualties, deaths and injuries in Korea for a period of 8 years. The total number of lightning-related casualties in Korea is 103 over that period. The numbers of lightning-related deaths and injuries are 39 and 64 in that time, respectively. The ratio of lightning-caused deaths to the total lightning-caused casualties is approximately 38[%], a percentage similar to those reported in the literature [6-7]. The average numbers of

lightning-caused deaths and injuries per year in Korea from 2000 to 2007 are approximately 5 and 8, respectively. That is, approximately 13 people are injured or killed due to lightning each year in Korea.

Figure 2 shows statistics on the number of lightning-caused casualties by province in Korea for a period of 8 years. The lightning-caused casualties are much higher in the area of high lightning strike density. It is noted that lightning-caused casualties are slightly more frequent on the west side of South Korea, but they occur evenly all over the country. Serious lightning casualties particularly occurred at the Yonghyoul summit of Mt. Bokhan on July 29, 2007. Four people died by direct lightning strike and more than twenty people were injured [8].

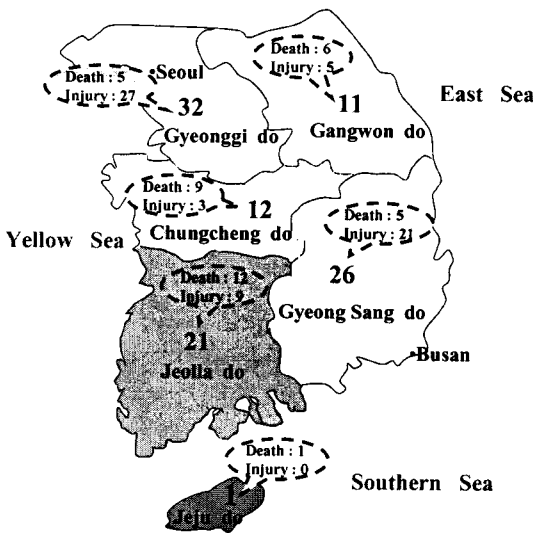
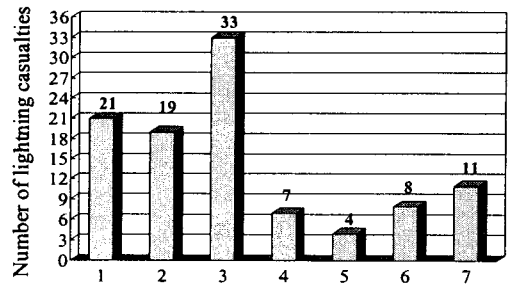


Fig. 2. Distributions of the number of the lightning-caused casualties by province in Korea from 2000 to 2007

Distributions of lightning-caused deaths and injuries to humans by place of occurrence were compiled as shown in Fig. 3. Most of these deaths and injuries involved people who work and enjoy the outdoors, mostly farmers, fishermen and

women, and recreationists.



- 1: Open fields (farming, construction, etc)
- 2: Outdoor training, construction work of telephone
- 3: Outdoor recreation (golf, fishing, climbing, etc)
- 4: Fire due to lightning strikes
- 5: Under trees
- 6: Sea bathing, boating, water related
- 7: Others

Fig. 3. Histograms of lightning-caused deaths and injuries to humans by place of occurrence in Korea from 2000 to 2007

The best way to reduce the number of lightning-caused casualties is to avoid unnecessary exposure to the threat of lightning during thunderstorm activity and to take appropriate action when threatened by lightning. Individuals are ultimately responsible for their own personal safety [9]. To reduce the number of lightning casualties (deaths + injuries) in the United States, over the past 30 years the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NWS) have worked to find ways to draw attention to the dangers associated with lightning and to educate the public on the dangers of lightning. Lightning fatalities have gradually declined over the past 30 years. The average for the 30 year period from 1971 to 2000 was about 73 documented deaths per year. An estimated average of about 41 deaths per year for the most recent 5 years has been documented since 2001 when the NOAA and the

NWS launched their lightning safety awareness campaign [10]. Consequently, the lightning safety awareness campaign in the United States has been an effective measure to reduce lightning-caused casualties and damage.

No place is absolutely safe from lightning threat but some places are safer than others. Large enclosed structures tend to be much safer than smaller or open structures. In general, fully enclosed metal vehicles such as cars, trucks, buses, vans, and fully enclosed farm vehicles, etc, with the windows rolled up provide good shelter from lightning. Avoidance of locations in or near high places and open fields, isolated trees, unprotected gazebos, rain or picnic shelters, baseball dugouts, communication towers, flagpoles, light poles, bleachers, metal fences, convertibles, golf carts, and water [9,11-12] is also recommended.

### 3.2 Lightning-caused damage to structures

The global mortality rate may be about 1,000 per year. According to the data from the United Kingdom, the risk of being killed by lightning is about 1 in 8. However, if accidents occurring outdoors alone are considered the rate increases to 1 in 4. Over 70[%] of those struck by lightning survive [13].

Lightning can strike high structures and industrial facilities, and it may cause significant physical damage to structures and electrical and electronic systems. Thus, consequential loss may be caused. Figure 4 illustrates the distributions of the frequency of lightning-caused damage by province for a period of 8 years. Also, Figures 5 and 6 illustrate the distributions of lightning-caused damages by the type of structure and by facility. Lightning strikes cause damage to

electrical and electronics facilities and loss of power supply as well as related control and relaying systems.

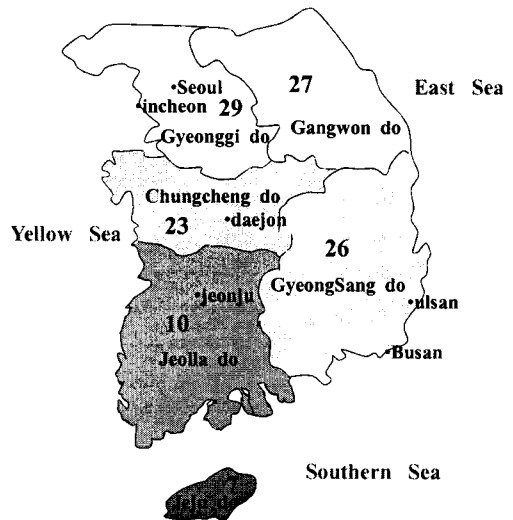


Fig. 4. Distributions of lightning-caused damage to structures by the region of occurrence in Korea from 2000 through 2007

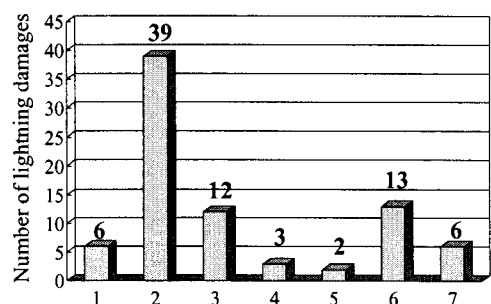


Fig. 5. Histograms of lightning-caused damage by the type of structure

Fig. 5. Histograms of lightning-caused damage by the type of structure

A large number of lightning-caused damages to structures occurred in the middle part of South Korea. The annual number of lightning-caused damage to structures was about 15 as shown in Fig. 7. The data in this paper were collected and

analyzed based on newspapers and TV broadcasting. The mass media report lightning-caused injuries and damages, which normally are treated as a matter of grave concern. Since minor lightning injuries and damage are ignored, the data presented in this paper may be underestimated.

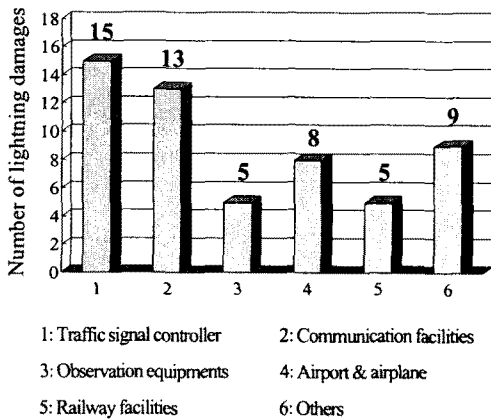


Fig. 6. Histograms of lightning-caused damage by facility

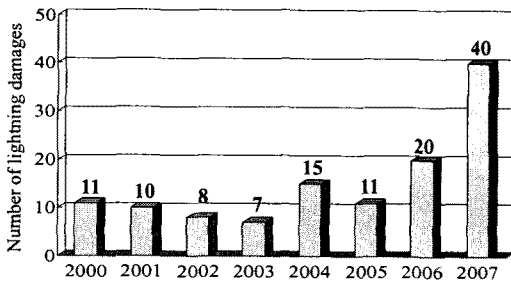


Fig. 7. Annual number of lightning-caused damages to structures in Korea

In Korea, the ratio of the number of occurrences of positive lightning to that of negative lightning is 1 to 4, and the occurrence of lightning is concentrated in summer due to many typhoons and thunderstorms. Thus, much lightning-caused damage occurs during summer. The average magnitude of a lightning current is approximately

20[kA]. Also, lightning strike density is high in the west of Korea. The annual number of thunderstorm days in Korea is about 30 [14].

Lightning-caused damage to structures and facilities as well as lightning-caused human casualties occurred evenly in the middle area of Korea. The high rate in the middle area of Korea is compatible with high Keraunic activity in this area. An analysis of the data in this paper can bring an awareness of heavy lightning-caused casualties and serious damage and provide useful knowledge for directing lightning protection activities.

#### 4. Conclusions

In this paper, lightning-caused human casualties and damage to structures were statistically analyzed on the basis of the data obtained from mass media like newspapers, TV or radio station in Korea from 2000 through 2007. As a result, the annual number of lightning-caused deaths in Korea is approximately 5. Most of all lightning fatalities and damage occurred during outdoor activities in open areas in summer. The data on lightning related casualties and damage in this paper may be underestimated because the data were taken from mass media while actual lightning damage in Korea may be much greater than those presented in this paper. The reason is that only serious affairs that make headline news are usually published as an article in newspapers and minor lightning-related damage event are rarely reported by mass media.

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## Biography

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Dong-seong Kim was born in Korea on March 1, 1970. He received his M.S. degree in the Department of Electrical Engineering from Inha University in 2006. He is currently working toward a Ph.D. degree in Electrical Engineering at Inha University. He is currently the manager at the Korea Electrical Safety Corporation. His research interests are in the area of lightning, grounding, wind power, Korea Electro-technical Regulation and high voltage engineering.

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