Approach Paper
on
Protection against Lightning (PaL)

April 2021

APP/National Disaster Risk Reduction Centre (NDRC)

1. Introduction:

National Disaster Risk Reduction Centre (NDRC) Nepal is implementing the second phase of the Asian Preparedness Partnership (APP) "Increased locally-led actions to prepare for, respond to, and recover from disasters in selected high-risk countries of Asia" in Nepal. This is a joint venture supported by Asian Disaster Preparedness Center (ADPC) and executed by Disaster Management Division, Ministry of Home Affairs, Government of Nepal. This assignment is one of the proposed actions and outcome of the objectives set forth in the project design.

2. Background:

The 'Asian Preparedness Partnership' (APP) was launched in August 2017, with representation from the Government, Local Humanitarian Networks, and the Private Sector in Cambodia, Myanmar, Nepal, Pakistan, Philippines, and Sri Lanka. The APP strives to improve the interface and partnerships between Governments, Local Humanitarian Organizations, and the Private Sector and to build the disaster preparedness and emergency response capacities of local actors through improved coordination mechanisms, training and capacity development, knowledge resources, innovations, and south-south learning and knowledge exchange. Since its inception, the APP has mobilized key humanitarian actors in each country to establish and operationalize the National Preparedness Partnerships while gaining wider recognition as a multi-sectoral platform to prepare for, respond to, and recover from disasters.

3. Rationale

Lightning incidents and their deleterious effects to the human beings, livestock and other physical properties are the global issues. With the advancement of technology, particularly in the electrical and electronic arena, the threat of lightning has further escalated. However, the impact of lightning hazards in the developed nations is much less as compared to the developing nations. Furthermore, electrical faults due to various reasons are becoming major threats not only to the rural populations but also to the urban populations and settlements. The adverse effect of lightning can be mitigated by adopting appropriate measures on Protection against Lightning (PaL).

Lightning continues to be one of the deadliest disasters in Nepal, with thunder strikes claiming dozens of lives every year. According to the National Emergency Operation Centre (NEOC), lightning killed 67 people and injured 397 in a year between April 14, 2018, and April 9, 2019. Despite the continuous loss of lives and property in lightning incidents, the issue is not getting the required attention from the concerned agencies. The number of deaths and property loss is on the rise, and this urges urgent need to initiate work on a policy discourse to address the issues on PaL. This approach paper[1] discusses about the issues, ways to mitigate accidents, policy improvement, and roles of various stakeholders to mitigate lightning risk and PaL in Nepal.

4. Purpose of the assignment

One of the key objectives of the project under "Output 1.2.2 Capacity Development Program institutionalized within Training Institutes and /or Universities" is to support the institutionalization process. Under this, Sub Activity 1, proposed to Develop an Approach Paper on Protection Against Lightning (PAL)" to review existing training and education materials on PaL. A series of consultations is set with National-Level institutions like the National Academy for Science and Technology (NAST), Institute of Engineering (IOE) of Tribhuvan University, Ministry of Home Affairs (MOHA)/National Disaster Risk Reduction and Management Authority (NDRRMA), and private sector to develop the approach paper. This will further contribute on the enhancement of the technical capability on administering PaL and its integration and institutionalization in Building Code and Academic curricula in Nepal. Such an approach paper is essential to streamline the DRM/lightning issues in the

[1] This Approach Paper has been developed with the support from Dr. Shriram Sharma (PhD) Chairman, Atmospheric and Lightning Research Center, Nepal, South Asian Lightning Network

academic curricula at the national level and further support to institutionalize capacity-building initiatives, is anticipated

5. A brief outline of the PaL issue in global and local context

1. Overview

Lightning is the most spectacular and most common natural activity that occurs ubiquitously in our atmosphere. At any given time, about 50- 100 lightning activities occur in the atmosphere across the globe, and a quarter of them striking our beautiful planet. Lightning causes injuries and deaths in nearly all parts of the world, more commonly in tropical and subtropical areas than in mid latitudes and rarely in the arctic areas. Lightning kills and injures a significant number of people as well as livestock every year and damages property including infrastructure in industries such as utilities, communications systems, electronics, and many others, adversely affecting not only the company but also communities causing tremendous economic and social losses. Transmission towers, communication towers, transmission lines and other tall physical structures are more vulnerable to the lightning activities. Lightning ignites fires that may bring an entire building or a house down to ashes. At a lower degree of damage, the lightning current may destroy electrical, electronic and communication equipment beyond repair. Over 24,000 people are speculated to have been killed and over 240,000 people are estimated to have incurred injuries by lightning each year globally (Cooper and Holle, 2019) whereas, according to the data available at Disaster Risk Reduction (DRR) portal of the Ministry of Home Affairs (MoHA) Nepal, an average of 108 people per year have been killed over the period of 9 years (April, 2011 to April 2020) in Nepal alone. About, three folds of people have been reported to have sustained injuries during the same period.

While lightning incidents occur all over the world, they have generally been poorly documented except in a few countries. Natural hazards such as earthquake, landslides, flash floods, and extreme cold or heat tend to kill more people in a particular incident and are more likely to involve governments' response, an outpouring of aid to the victims, data collection, and attempts at prevention. They are also more likely to be published in the media, making the public more cognizant of these risks. However, lightning injuries, with some exceptions, tend to injure only one or two individuals at a time, also making them less likely to come to the attention of the media or government, especially in rural or less developed areas where communication systems may be poor or nonexistent.

Nepal is not an exception of lightning being underrated hazard. As a matter of fact, demography pertinent to the lightning fatalities and incidents are found to be archived in DRR portal of the MoHA only after 2011. Evidently, the lightning hazards did not receive much attention and as a result very little has been done towards mitigating the loss of lives and property due to lightning. Figure 1 shows the potentiality of the lightning hazard in Nepal, as it ranks first among all the natural hazards (except earthquake) in terms of human fatalities. The number of fatalities can still be significantly higher than what is recorded as many of the incidents go unreported.

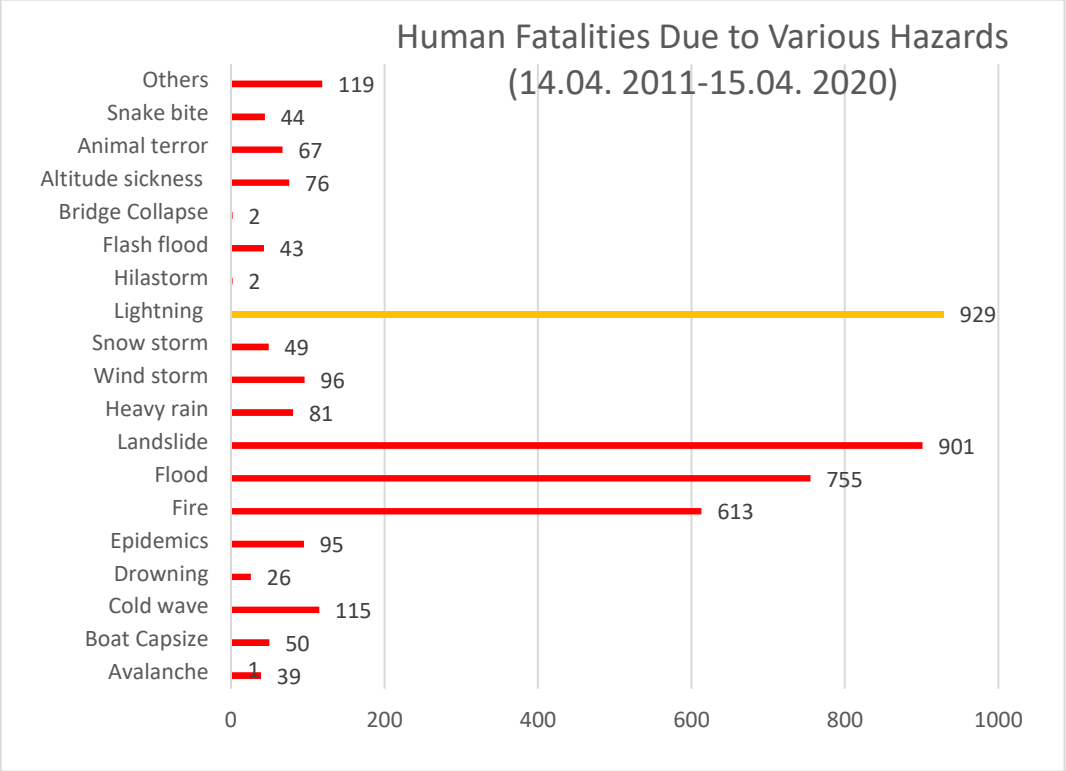


Figure 1: Graphical presentation human fatalities due to various hazards excluding that due to earthquake incurred by Nepal during past 9 years (14.04.2011 to 14.04.2020). As depicted in the graph, lightning is the largest killer among all the hazards excluding earth quake (not shown in the graph).

Although, the number of lightning fatalities and injuries in the developed world has been steadily declining over the last century, the number of lightning casualties in the lesser developed regions is not decreasing due to billions of people living in lightning-vulnerable houses/ buildings, working outdoors in labor-intensive manual agriculture, and other identifiable socioeconomic factors.

Moreover, Nepal, being a hilly subtropical country, receives more lightning flashes that terminate to the ground as compared to those countries with similar geographical locations and hence is more prone to the lightning hazards. Consequently, the vulnerability to the physical structures and life can be expected to be higher in Nepal than in the other countries.

Lightning on the other hand, is a major cause of electrical over voltages or surges that often lead to the electrical faults causing damages to the appliances and fire. Electrical faults leading to various accidents are a commonplace not only in the developing world but also in the developed world. Despite the strict adherence with electrical code, 50% of the home fires have been reported to be caused by electrical faults even in the USA (Richard Campbell March 2019, NFPA).

In many developing countries, especially in rural areas, the electricity theft by placing hooks on the power distribution lines, is wide spread. This is an invitation for lethal electrical injuries. Often the home fires and fatalities in the developing world go unnoticed. Although, fire is recognized as a hazard, the causes of fire hardly receive much heed. In many of these countries, electrical codes are not strictly implemented even if they are available. As an evidence, 35 people were reported to have been killed by electrical faults in Nepal, whereas, 31 people sustained injuries during 2019-2020 as per Nepal Electricity Authority. During the same period 52

livestock were killed due to electrical faults. Many of such fatalities go unreported and hence this demography is an underestimated one.

In this approach paper, we propose various ways to mitigate the loss of lives and property damage due to either directly by lightning or indirectly through electrical faults.

2. Status of Hazards due to Lightning and Electrical faults

The actual number of worldwide annual deaths and injuries is unknown. Although, the documented minimum number of lightning fatalities around the world currently exceeds 4,000 per year, that does not include many of the countries which are extremely prone to the lightning hazards, it may reach up to as high as 24,000 deaths per year (Cooper and Holle 2019). There were 28 countries included in the study of lightning fatalities that estimates 4,429 per year (Holle 2016), as are depicted in figure 2. A lightning event can cause one or a few deaths and injuries at a time, but a very large number of such cases are spread over the globe throughout the year.

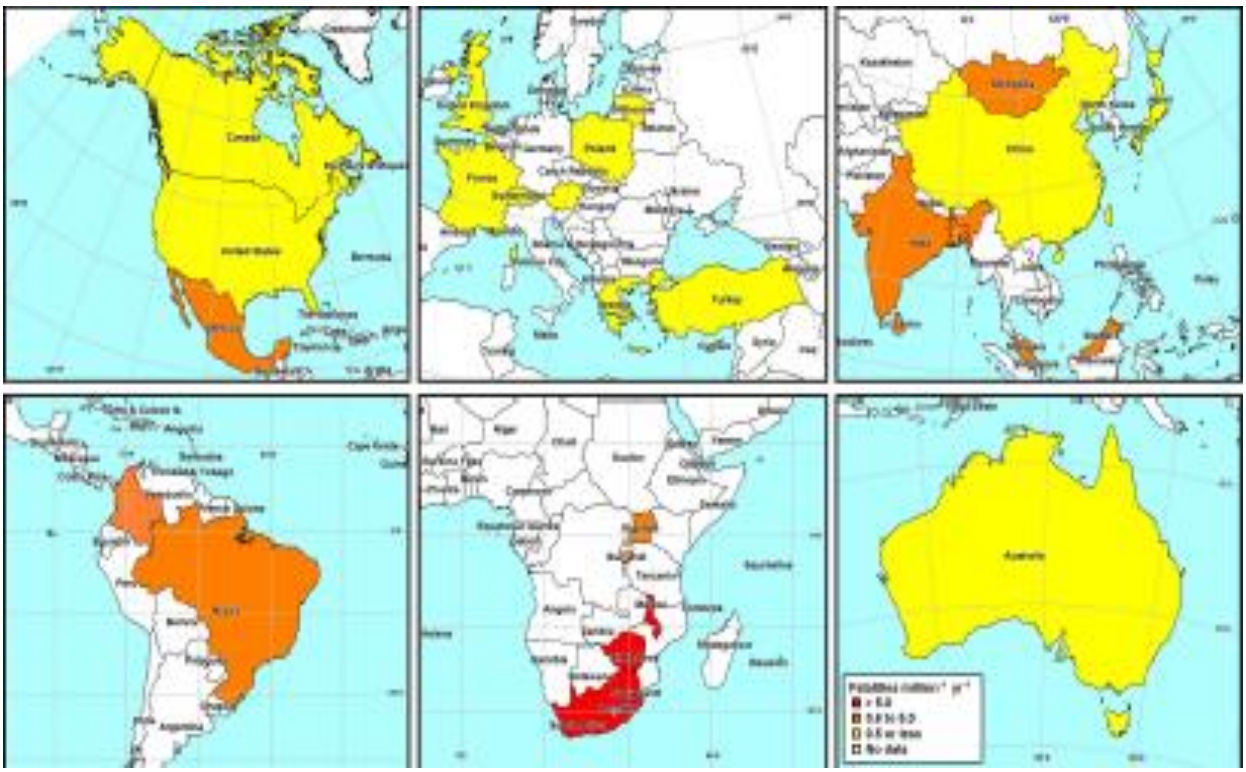


Figure 2: Fatality rates per million people per year by continent. Red shading indicates rates >5.0 fatalities per million per year, orange is 0.6 to 5.0, and yellow is 0.5 or less. White indicates no national summaries have been published for periods ending in 1979 or later (Adapted from Holle 2016). Please not that Nepal has not been included in the map as there was no study carried out at the time of that study.

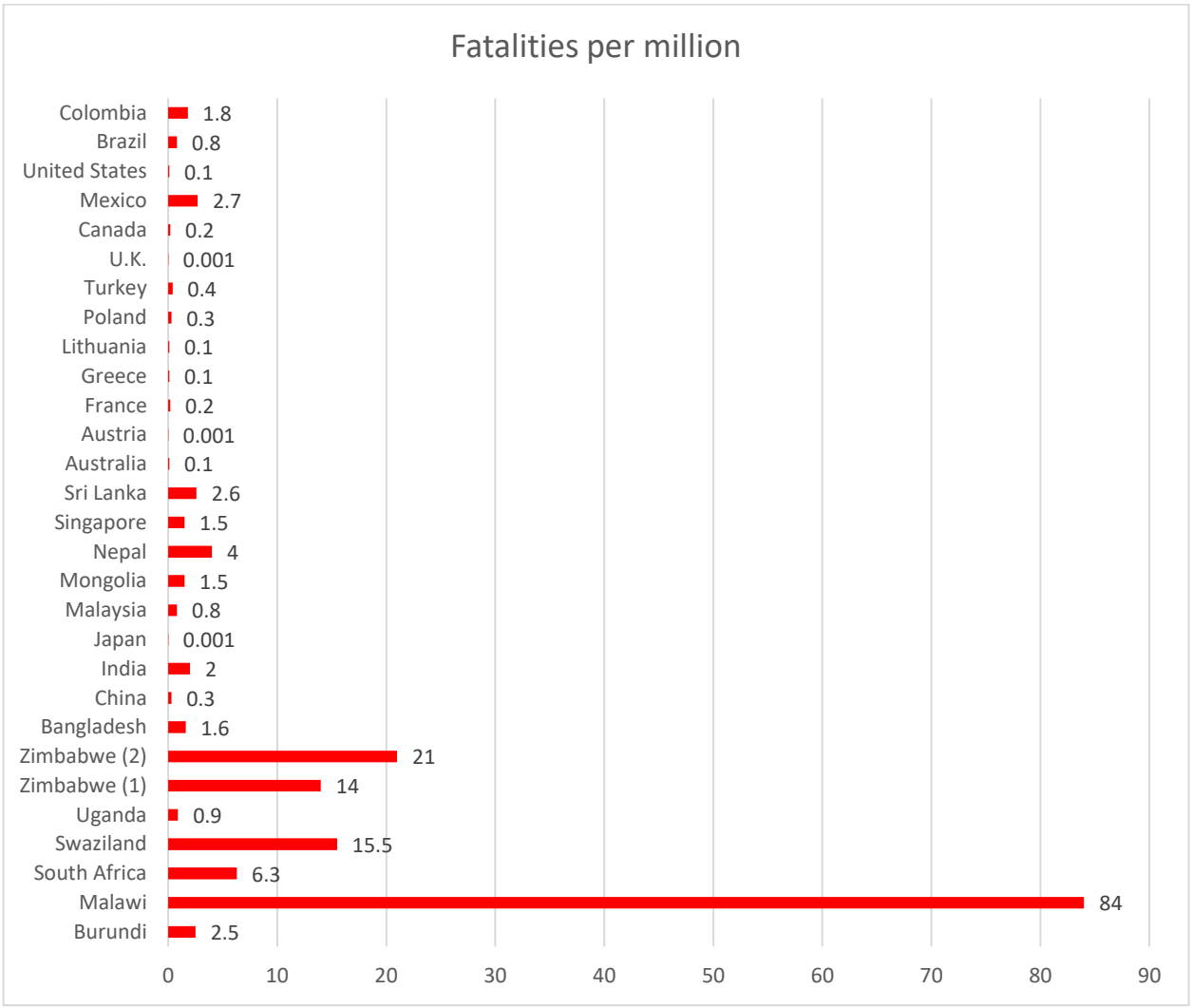


Figure 3: Graphical presentation of the lightning fatalities per million per year for 28 countries across the globe including Nepal. In the graph Zimbabwe has been placed in two places following to two different studies. It is worth noting here that Nepal ranks fifth out of 28 countries in the chart and ranks first outside African continent in terms human fatalities per million per year. The demographic data shown here are adapted from Holle (2016) except for Nepal.

In the developed portions of the world, most lightning events kill or injure one person at a time (Curran et al. 2000). This lower toll per event is attributable to the widespread availability of safe areas such as substantial buildings and fully enclosed all-metal vehicles, as well as lightning injury prevention education, improved medical care, lesser lightning density in temperate zones where many developed countries are located, and other identifiable factors.

In developing regions, ten or more people are sometimes reported as killed in a single lightning event (Cooper and Holle 2019). It is worth recalling that over 100 people were killed by lightning in days in the two Indian states of Bihar and Uttar Pradesh on 23-24 June 2020, whereas 4 people were killed in Saptari and two in Makawanpur districts of Nepal on 24th June, 2020.

Such a large number of fatalities in the developing countries have been attributed by Cooper and Holle, (2019) to a combination of:

a) Increased exposure due to labor-intensive work practices, including agriculture.
b) Lack of lightning-safe structures and vehicles.
c) Different outcomes where multiple people are killed in lightning-unsafe homes, open churches, and school rooms rather than injured as occur in more developed countries.

d) Large lightning density in some regions of the tropics and subtropics.

As a result, the summation of sporadic but frequent global lightning fatalities accumulates to become very large totals. But they are especially elusive to count, in part due to the smaller number of deaths and injuries per instance from lightning that are often unreported, compared with the massive weather-related events. Occasionally, the media will group several separate lightning events with fatalities in a nation or region that occur during a period of a few days. This grouping leads to the realization of how often such sporadic, but multiple, fatalities are actually occurring.

2.1 Individual and Family Losses from Injury

Lightning kills and injures a significant number of people ever year as well as livestock, often the measure of wealth in developing nations, and damages property including infrastructure in industries such as utilities, communications systems, electronics, and many others, adversely affecting not only the company but also communities and nations struggling to develop stable economies.

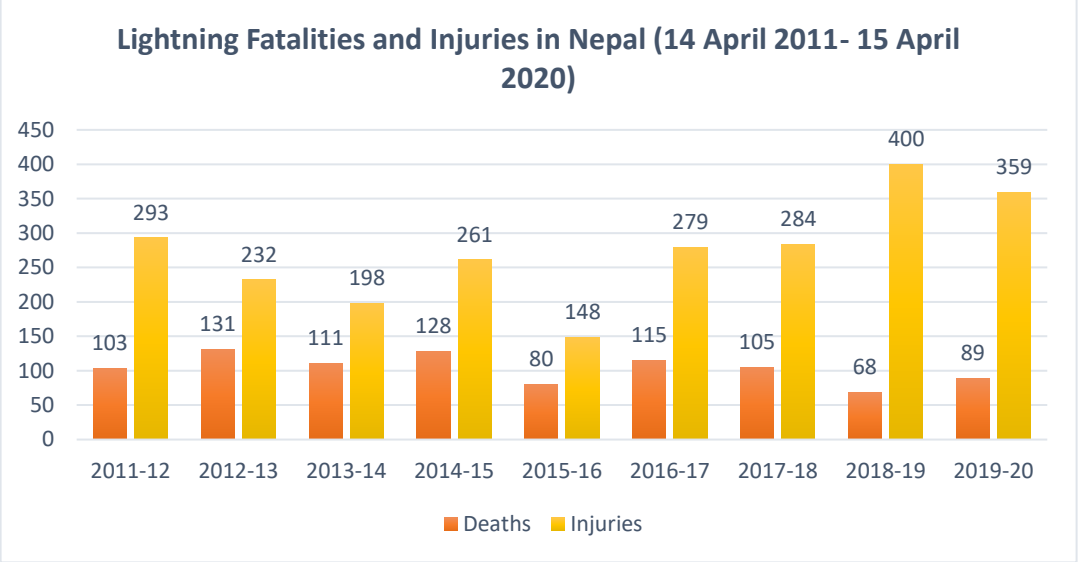
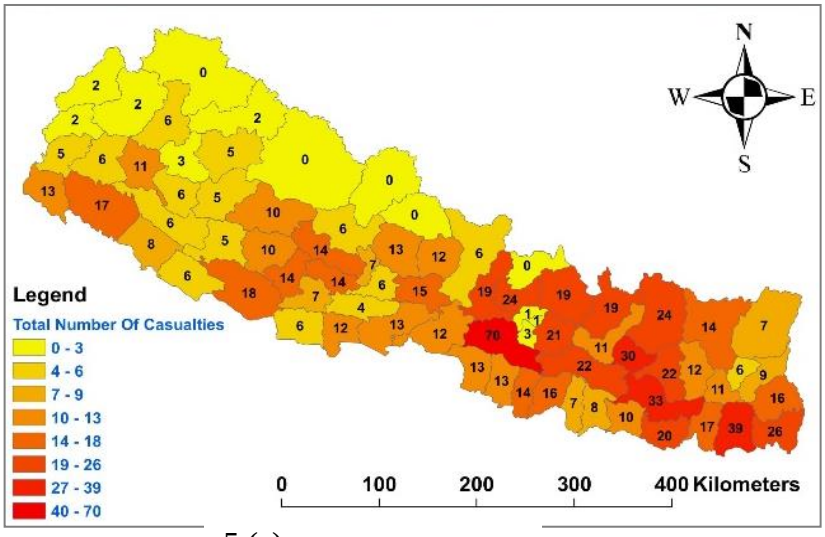


Figure 4: Graphical representation of the lightning fatalities and injuries in Nepal recorded for the last 9 years 14.04.2011-15.04.2020). The data was obtained from the DRR portal of Ministry of Home Affairs, Govt. of Nepal.

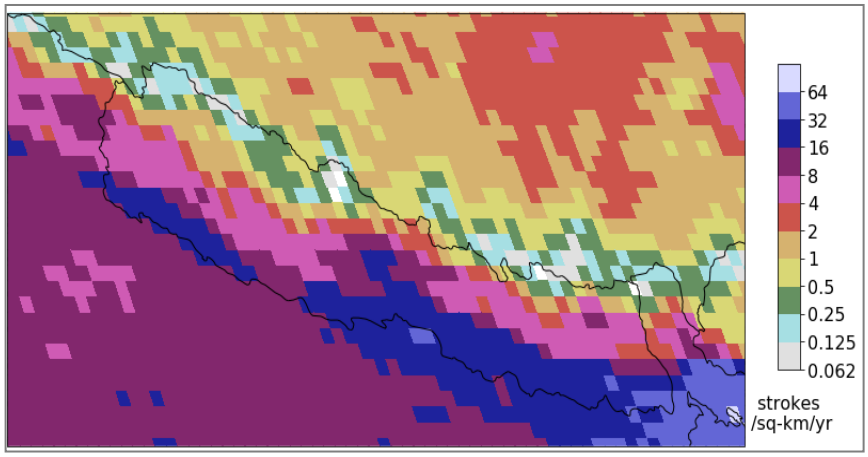
As is seen from the figures 3, out of 28 countries in which the study was done for human fatalities per million per year, Nepal ranks fifth with the rate of 4 people per million per year, following South Africa (6.3 per million per year) whereas, Malawi stands the first with the fatality rate of 84 people per million per year. Also, as presented in figure 4, the total number of lightning incidents (fatalities and injuries) has been increasing over Nepal. Also shown in figure 5 is the distribution of the human deaths due to lightning over various districts of Nepal. It is noted here that of all the 77 districts Makawanpur ranks the first in terms loss of human lives. The distribution of the human fatalities for three geographical divisions can be summarized as

a) There were altogether 929 reported fatalities from April 14, 2011-April 13, 2020
b) 43 people were killed from mountainous districts (@2.64 per million)
c) 585 people were killed from hilly districts (@ 5.28 people per million)
d) 301 people were killed from Terai (plain) districts (@ 2.68 people per million); and,

e) No fatalities were recorded from the regions above 6000 m.



5 (a)



5 (b)

Figure 5: (a) District wise distribution of lightning fatalities over Nepal recorded during the past 9 years at DRR portal MoFA, Govt. of Nepal. (b) Lightning Density map of Nepal exhibiting the density to be highest in the south eastern part of Nepal, followed by Chure range. Nearly 3 million strokes per year have been recorded from 2016-2019 (Map: Courtesy- Ronald Holle (Vaisala Corporation)

The above distribution of the fatalities over the three geographical regions clearly shows that life on the hilly districts is much more vulnerable than the districts of the other regions. Evidently, there is an urgent need of addressing the problem of lightning hazards over the hilly districts as a first priority.

The economic effects of lightning damage to property are large, varied, and widely spread across society. In addition to loss of life and health, there are direct and indirect costs from lightning which affect a wide spectrum from individual homeowners and small businesses to large companies such as cultural and national heritage sites.

2.2 Personal and Small Business Property Losses

Lightning is responsible for losses to individuals and communities, especially in high density, poor infrastructure areas where exposure tends to be high and lightning-safe shelters are largely unavailable. It causes direct damage by killing herds of cattle, pigs, goats, and sheep in areas where personal wealth is measured in animals and by burning homes and small businesses. Indirect damage can occur when electrical transmission is interrupted, especially where the electrical grid does not include redundancy or when no alternate sources of energy such as generators are available. Examples of damage include water pumping in villages and irrigation systems on farms; refrigeration and cooking facilities in restaurants and groceries; data transmission, storage, and credit card processing in small businesses; and a myriad of other impacts on small businesses.
The death of livestock, often the measure of a family's wealth in developing countries, can be devastating. When a group of cattle or sheep are killed the family's main source of income is destroyed because there is usually no compensation from insurance or government agencies.

A majority of the people in the rural areas of Nepal (be at hilly region or Terai region) make their livelihood from the livestock. Rural population living over high hills between 2,500m to 3,500m, rear the sheep for their livelihood. We often come across the news reports of killing of hundreds of sheep by a single lightning flash. One of such incidents has been depicted in figure 6, where about 500 sheep were killed by lightning on August 23, 2020, in the Patrasi Rural Municipality of the Jumla district, Nepal.

Figure 6: Photograph of sheep killed by lightning while grazing in pastures of Patrasi rural municipality of Jumla district western Nepal on August 23, 2020.

Although several hundreds to thousands of livestock are reported to have been killed by lightning every year in Nepal, the economic loss incurred by the farmers has not been properly estimated. Most of the small industries such as poultry, hatchery, and manufacturing factories issues due to lightning strikes (directly or indirectly), that may result in a huge economic loss. Since society has become massively dependent on systems driven by electric power, outages and voltage sags lasting only a portion of a second can cause major disruptions to computer-based data transfers, manufacturing, and other situations. For example, short lightning-caused interruption can destroy an entire batch of computer chips or other sensitive materials during manufacturing at a very large cost per incident.

2.3 Utilities

Power transmission and distribution have a long history of damage from lightning. In most countries, the utility infrastructure is elevated and isolated, often giving poles, lines, towers, and substations significant lightning exposure. While utility service provider (as Nepal electricity Authority) may monitor their power quality, few know the percentage of voltage fluctuations and interruptions that are

due to lightning. Losses due to lightning are passed on to the customer since all costs of electricity generation and delivery are part of rate calculations. These are broadly estimated to be in the billions of dollars worldwide.

In developing countries where electric utility interruption may occur frequently for many non-lightning reasons, any interruption stops delivery of power downstream, leaving many businesses, small and large, with goods that cannot be preserved by refrigeration, communication deficits and often data loss for all of industry, lack of lights to carry on night work, and lack of electricity to power other equipment necessary for running the business, necessitating purchase of generators that often use fossil fuels. Depending on the regulations about emissions for these power sources, they may cause the individual, other people in the home, business, or community to suffer from such impacts as fumes, smoke, carbon monoxide exposure, and risk of fire.

Fatal accidents triggered by the fuel operated gadgets are a commonplace in Nepal, particularly during the winter season.

2.4 Banking and finance

Banking, finance, and data systems can be harmed by very small surges of power, not to mention direct lightning damage. For both large and small businesses, loss of data such as client mailing lists, invoicing, project proposals, and monitoring, as well as other data, may take weeks to rebuild, if it is possible at all. In fact, claims of data loss from lightning have become a large area of insurance fraud in some areas.

2.5 Historic Sites and Monuments

Valuable monuments and historic sites have been damaged by lightning leading to cultural losses to structures that often represent national identity and history. In developed countries, these sites are often given lightning protection, but this may not be the case in more remote areas or in developing countries. In the context of Nepal, most of the historical and cultural monuments do not have lightning protection system installed. Although, it is apparent that lightning protection system was practiced in the past, as most of such structures do possess metallic protrusion on the roof, they are now likely to be preserved as ornaments. The historical and cultural monuments are often the target to the lightning strikes as they are mostly build on hilltops. An example of a historical building struck by lightning is depicted in figure 7. The UNESCO world heritage site Pratappur temple at Swayambhunath, was damaged by a lightning strike on February 14, 2011.

Figure 7: Photograph of the UNESCO world heritage monument, Pratappur temple at Swayambhunath, damaged by lightning strike that occurred on Feb. 14 2011 at about 5 am.

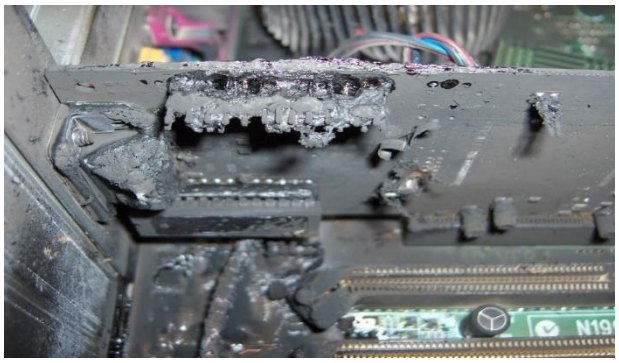


Figure 8 (a) Snapshot of the electronic circuit of a computer damaged due to electrical surge triggered by lightning.

Figure 8 (b) A snapshot of a house gutted by an electrical fault down to ashes.

Figure 8 (c) A snapshot of Soaltee city apartment in which fire broke out due to electrical short circuit on January 18, 2021.

6. Policy gaps and opportunities exist to incorporate PaL in the DRM policies/ strategies.

Although, lightning has been observed to be the most potential threat to the public and physical structures after earthquake, it remained one of the most underrated hazards in Nepal. Although, there have been some awareness and training programs organized by various organization, it has got no place in the National Level Disaster Risk Management policy, as of today. Nevertheless, there have been several occasions where the representatives from

the Disaster Management Division of the Ministry of Home Affairs and Ministry of Urban Development have attended the PaL training programs.

One of the crucial measures for mitigating the loss of lives and structures due to lightning is a safe shelter. To the best of our knowledge building safe shelters against lightning hazards is not practiced in Nepal, neither has it been considered in the Building Code as such. More importantly, despite the excessive dependency of public on the electricity at every walk of life, the Electrical Code has not upgraded since 2003. It is therefore, the loss of lives and property due to electrical faults is another underrated issue and is closely related with the lightning hazards. While addressing the issue of electrical faults during the upgradation of the Electrical Code, the issue of protection against lightning can simultaneously be addressed. It is to be noted that the Electrical Code has recently been upgraded incorporating a chapter on lightning protection system, although, it is yet to be implemented by the Department of Urban Development and Building Construction (DUDBC). However, there is a huge underlying challenge to be encountered by DUDBC to bring this code into effect, owing to the fact that there is a dearth of manpower for the implementation.

I. Adopting PaL in Nepal: A brief SWOT analysis

The purpose of Protection against Lightning (PaL) is to protect structures and it occupants such as people within them, power systems, electronics, and other infrastructures from damage by lightning strike as well as by electrical surges that may accompany lightning strikes. Although, lightning has been a threat to the human beings since the time immemorial, the protection against lightning hazards begun in the modern era only after Benjamin Franklin's experiment in 1752. The nature of lightning discharge was understood after the two famous experiments namely Sentry box experiment and kite experiment. However, much of the science of lightning was understood during the latter part of 20th century and accordingly protective measures. However, with the advancement of technology and excessive usage of electrical and electronic appliances, the threat has further escalated necessitating the need of advanced protective measures. Despite all the technological advancement, the status of protective measures in the developing countries is rather miserable and Nepal is not any exception. At a time when the developed countries have been strictly adhering with the code for lightning protection incorporated in their building codes, many of the developing countries are still unaware of such a code or standard. A pathetic situation is encountered when one finds that even the electrical engineers, who are supposed to be the masters, are unaware of the standards and codes and is the case for most of the developing countries. Nevertheless, for the developing countries there are always opportunities to adopt such codes and standards. The following are some strengths for the developing countries like Nepal adopting the PaL.

a) Strength:

i) Nepal is now in the stage of rapid urbanization, with many new constructions are coming up. In the new construction, it will be much convenient to implement the code.

ii) Nepal is in the process of political metamorphosis along with the administrative modality adopting federal system. While transforming into federal system, at least seven provincial capitals are to be established. To establish such capitals, aggressive constructions are imperative, that would lead to an easy adoption of the PaL measures.

iii) Yet another strength would be to implement the code simultaneously in all the provinces.

iv) Moreover, in the recent past over 400 engineers and about the same number of sub-engineers from national and provincial levels have been educated on the various aspects of PaL with the coordination of Asian Disaster Preparedness Center (ADPC), WWF's Hariyoban Programme, Ministry of Internal Affairs and Law of Provinces 3, and 5, Nepal Engineers Association, Lightning and Atmospheric Research Center, South Asian Lightning Network, Cape electric India, NAM S & T Center New Delhi, African Center for Lightning Electromagnetics.

v) ADPC, on the other hand has, already prepared a training manual on PaL for the engineers that can be used as an excellent reference to train the engineers across the country.

vi) The engineers and sub engineers who were educated during the past couple of years are well aware of the international standards on lightning protection being prepared by International Electrotechnical

Commission (IEC) and are also aware of the non-standard protection system that have infiltrated the market.

b) Weaknesses

i) Currently there is no code available for ready-to-use to the engineers or skilled persons, though DUDBC has a draft of it.
ii) There a very few engineers who are well acquainted with the code to be implemented simultaneously in all the provinces.
iii) The political and administrative instability is the other issue that does not support the smooth adoption of such codes.
iv) Lack of coordination among the various institutions such as Nepal Electricity Authority and DUDBC, leads to the delay in effective implementation of the Code.

c) Opportunities:

i) The tremendous advancement in technology necessitates the advancement in the protective system. As a result, there has been a significant progress in the protective devices, such as Surge Protective Devices in last decade. Nepal can enjoy such advancement without investing on research and development. As Nepal recently introduced the federal system, it would be an excellent opportunity for the nation to adopt the codes at all provinces simultaneously.
ii) Nepal has the privilege of availing the knowledge that has been accomplished as a result of various researches across the world.

d) Threat

i) Although, the world has made a significant progress in technology and has developed scientifically proven accessories/ components, the adulteration of the non-standard products is also in abundance in the global market and the developing nations are more prone to such products. Nepal is not an exception of such vulnerable countries owing to the fact that we do not have a proper code to control such fraudulent products. So, while adopting the Lightning protection system it is very likely that consumers may get easily deceived by the proponents and vendors of such products.

II. Approaches to adopt PaL

Mitigation of deleterious effects of lightning hazards and electrical faults requires short term and long term approaches involving multispectral and multidimensional aspects. Enlisted below are the short term and long term approaches:

a. Short-Term Approach

1. Raising awareness in the public, particularly addressing the vulnerable community/society by:
   - Organizing seminars for school teachers in the rural areas.
   - Distributing pamphlets and posters on safety messages.
   - Playing awareness videos and PSA through national and local media.
   - Demonstrate drills, engaging teachers and students.
   - Install Lightning protection system on a few school buildings as per IEC and use them as model structures.
2. Training engineers on the scientific methods of installation of lightning protection system and electrical safety.
3. Organizing seminar for the representatives of local authorities to apprise them about safe shelters.
4. Organizing awareness program for Hospital managements both on lightning protection and electrical safety issues.
5. Organizing seminars for hotel associations on PaL and electrical faults
6. Organizing orientation program for the curriculum development centers (CTEVT, IoE, IoM, TU, high school etc) towards incorporating PaL and safety issues in the respective curricula.

7. Organize training programs for electricians, sub engineers and Diploma holders from CTEVT on electrical engineering. Provide them a hands-on training on LPS installation.
8. Conducting ToT for about 20 electrical engineers in association with Nepal Electricity Authority. Trainers so trained will be responsible to train semi-skilled human resources across the country.

b. Long-Term Approaches

1. Implementation of Electrical Code incorporating in the National Building Code.
2. Conducting training programs for local level engineers on Electrical Code.
3. Recruiting Electrical Engineers at each municipality (1 in a rural municipality, 2 in municipality, 3 in sub-metropolitan city and 4 in Metropolitan city).
4. Implement the Electrical Code at local level.
5. Establishing a strong electrical auditing body equipped with all the technical aids in coordination with NEA. The body would be responsible for auditing, monitoring, preparing technical reports and recommendations.
6. Making the electrical auditing mandatory to the sensitive structures such as hospitals, hotels, banks, financial institutions, diagnostic institutions, corporate buildings, business complexes, industries, fuel stations/storage, and common public building etc.
7. A simplified guidebook on LPS and electrical safety electricians for their ready reference.
8. Prepare and implement curricula on lightning and protective measures against lightning at various levels such as Diploma (CTEVT), Bachelors (electrical engineering), Masters (disaster management), etc.

III. Suggestions and recommendations:

In order to mitigate the loss of deleterious effects of lightning and electrical faults can be achieved by multispectral involvement and contribution. Following are the recommendations and suggestions to various sectors who could significantly play role towards mitigating loss of lives and property damage.

1) Government

The federal government is expected to play a pivotal role in the mitigation all kinds of disaster risk engaging the local and provincial governments and involving other humanitarian and development agencies, private sector, academia and civil society. Following are the activities that the government is expected to carry out to achieve the goals of mitigating risk of disaster.

a) Prioritize the lightning and electrical hazards in the list of disasters that has to be addressed by the National Disaster Risk Reduction and Management Authority (NDRRMA) and its local concerned authorities.
b) Adopt the Electrical Code incorporating lightning protection code in the Building Code through DUDBC without a delay.
c) Conduct training programs for the engineers at various levels on lightning protection and electrical safety.
d) Facilitate to establish an electrical auditing firm comprising of trained auditors.
e) Recruit Electrical Engineers at all levels responsible for checking the electrical design in the proposed buildings/structures and monitor the structure before the issuance of building completion certificate. (With the involvement and initiation from Ministry of Federal Affairs and General Administration)
f) Make the installation of lightning protection system and electrical code mandatory to the sensitive structures such as hospitals, hotels, banks, army, police barracks, fuel stations, cultural heritage monuments, business complexes, industries, schools etc.
g) Involve and engage curriculum development centers of various level to upgrade their curricula to address the hazards due to lightning and electrical faults.
h) Identify the lightning prone areas and vulnerable communities (involving the academia) and engage the local authorities to take initiatives for the mitigation of hazards.
i) Establish forecasting system and early warning mechanism for warning the public about the impending risk.

j) Encourage private sectors to manufacture the components of lightning protection system, and establish a standardization laboratory to test the components as per International Electrotechnical Commission (IEC).
k) Make a statutory provision to get standardize certification for the lightning protection products being supplied by various manufacturer.
l) Encourage academic institutions for conducting research in the field of lightning and electrical surges, helpful to mitigate the loss of lives and property damage and improve the quality of power supply.
m) Establish a research and training center either under Nepal Academy of Science and Technology (NAST), Tribhuvan University, Technical University or as an Independent entity to conduct research on the various aspects of lightning, electrical installation, transmission system and conduct trainings on PaL and other electrical safety issues.

2) Humanitarian and development agencies

The humanitarian organizations play vital role in disseminating the knowledge to the society working closely with the local governments and civil society. In the context of mitigating the loss of life and property damage due to lightning hazards and electrical faults humanitarian organizations can play a crucial role by:

a) Assisting the government in developing awareness materials such as pamphlets, posters, animation videos, PSA etc.
b) Raising awareness in the vulnerable communities and various other sectors in coordination with NDRRMA.
c) Assisting local authorities for training engineers and sub-engineers at their disposal.
d) Supporting various curriculum development centers to upgrade the existing curricula incorporating the PaL at the respective level.
e) Supporting and encouraging academic institution/universities to conduct research.
f) Coordinating with various societies and associations to apprise the prospective threat in their respective fields and conducting awareness programs for the adoption of PaL.
g) Encouraging private sectors towards manufacturing the LPS components locally.
h) Encouraging private sector to establish a testing laboratory for standardization in close coordination with the government.
i) Assisting the public schools of vulnerable location to have the LPS installed.

3) Private sector

The role of private sector in mitigating the risk due to various disasters is inevitable. The following contributions are expected from the private sector in the perspective of lightning and electrical hazards:

a) Manufacture the materials/components of lightning protection system in coordination with the government, research organizations/ NAST, with an assistance of academic institutions.
b) Establish a standardization laboratory in coordination with the government in order to assure the quality and to control the fraudulent products.
c) Assist the academic institutions to conduct research activities as per the need of the state
d) Support the government as a corporate social responsibility to help mitigate the hazards.

4) Academia and civil society

The objectives of mitigating the deleterious effects of lightning and electrical faults cannot be achieved without an involvement and contribution of academia and civil society. The following role and responsibilities are expected from the academia and civil society:

a) Academia are expected to conduct research to
(i) Identify the lightning prone areas and hotspots.
(ii) Map the lightning activities over the Nepal to carryout risk assessment.
(iii) Identify the vulnerable community/society.

(iv) Investigate the trends of lightning activities and their association with anthropogenic activities.
(v) Investigate the causes of electrical faults

b) Academia are expected to prepare curricula for various levels incorporating methods to mitigate the loss of lives and property damage due to lightning.
c) Academia are expected to disseminate the knowledge /awareness to the various levels in coordination with the government organizations, humanitarian organizations and civil society.
d) Academia are expected to design simplified guide for the electricians and semi-skilled human resources on installation of lightning protection system and electrical safety measures.
e) The civil society is expected to strictly adhere with the Electrical Code prepared and circulated by DUDBC cooperating the local authority.
f) The civil society is expected to disseminate the knowledge to all level of the society.

IV. The Way Forward:

Lightning is one of the most potential threat to the human lives, livestock, communication system, transmission system, physical properties particularly electronic and electrical appliances etc. In order to mitigate the hazardous impact of lightning a multi-sectoral and multi-dimensional approach is required. Similarly, house fire caused by electrical faults is increasingly becoming another potential hazard. As, both the above threats can be addressed simultaneously, this approach paper provides a general roadmap for the concerned sectors to take necessary steps towards mitigating the threats. To accomplish the objectives of this approach paper, various sectors are to be consolidated.

- For the purpose, a national level orientation program shall be organized for all the stake holders in association with National Disaster Risk Reduction and Management Authority (NDRRMA).
- Such orientation programs shall also be organized at the provincial level as well as local level.
- A training program shall be organized as a Training of Trainers (ToT) involving at least 20 trainers, who in turn will disseminate the knowledge to the provincial and local level. The trainers shall be selected from among the electrical engineers and a priority will be given to the electrical engineers who are engaged in teaching engineering students at undergraduate and diploma level.
- The training shall be conducted in association with Department of Urban Development and Building Construction (DUDBC).
- The trainers shall be sent to the seven provinces in order to train local level electricians and electrical sub-engineers.
- This shall be done in partnership with the provincial level technical institutes that conduct Diploma classes in electrical engineering under the Council of Technical Education and Vocational Training (CTEVT).

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