

Karnataka State Disaster Management Authority

Revenue Department (Disaster Management)

Government of Karnataka



Karnataka State Thunderstorm & Lightning Action Plan - 2023-24



GOVT. OF KARNATAKA

Karnataka State Thunderstorm & Lightning Action Plan - 2023-24

**Revenue Department
(Disaster Management)
Government of Karnataka**

Message

India is geographically diverse and tropical, hence highly prone to Lightning. Lightning season in India starts during March, followed by pre-monsoon, terminal monsoon, heavy rainfall, and cyclones. Coastal and hilly regions witness Lightning due to local geographical and weather conditions. Due to climate change and extreme weather events such as massive and unpredicted rainfall-induced Thunderstorm & Lightning are becoming more common all over the Country, particularly in Eastern India, parts of Southern India, Coastal regions, river basins, Himalayan foothills and the North-Eastern region.

Thunderstorms & Lightning associated with hailstorms/squalls and Strong winds can lead to dangerous consequences and can cause loss of human and animal lives. Thus, the concerned authorities must take appropriate Preparedness and mitigation measures to minimize the impact of thunderstorms & Lightning on the population in vulnerable areas.

Karnataka state has always taken innovative and proactive steps towards Disaster preparedness and mitigation measures. Continuing that tradition, the Karnataka State Disaster Management Authority (KSDMA) has been preparing the Action Plan since last year about Karnataka Thunderstorm & Lightning associated with Hailstorm/Squall & Strong winds, and it has been updated for the year 2023. It is envisioned to minimize the probable hardship faced by the community due to thunderstorms & Lightning in the State.

I appreciate the efforts of Dr Manoj Rajan, Commissioner KSDMA, for proactively developing this comprehensive Thunderstorm & Lightning associated with Hailstorm/Squall and Strong winds Action Plan 2022 for the State.

I urge all the concerned Departments and Agencies to make use of this action plan to take necessary measures and also suggest conducting community outreach programs to create awareness amongst the public to implement Thunderstorm & Lightning with associated weather phenomena mitigation / remedial measures to be taken at the community level as well as an individual.

Vandita Sharma, IAS
Chief Secretary,
Government of Karnataka

Foreword

Lightning has emerged as one of the most impactful natural hazards in India. Lightning has shown increasing trends in its occurrence, and so have the fatalities. The rise in the frequency and intensity is mainly due to climate change extremes like global warming, a sharp rise in temperatures and extremely heavy rains, a long gap between two rainy days, depletion of water bodies, pollution and environmental degradation. No part of India is untouched by Lightning. This makes large populations and infrastructures highly vulnerable to Lightning.

Thunderstorms & Lightning associated strong winds have emerged as significant weather-related natural hazards in recent years, affecting different parts of the State. In recent years, the severity and frequency of thunderstorms and lightning events have increased many folds due to rising global temperatures and climate change. In-cloud Lightning comprises the vast majority of lightning activity in the atmosphere. It often serves as a precursor to extreme weather conditions, including heavy rain and hail, gusty winds, and dangerous cloud-to-ground lightning strikes.

These natural events often strike the poor sections of our society. Karnataka has witnessed deaths every year due to cloud-to-ground lightning events. Therefore, it is paramount to analyze various factors, understand the veracity of the issue and the rationale for its solutions through formulating the preparedness and mitigation measures, and invest in disaster risk reduction, which can save lives, livestock and property.

KSDMA has updated the Thunderstorm and Lightning Action Plan for the year 2023 for Karnataka State as per the NDMA guidelines focused on preparedness, mitigation measures, capacity building, early warning mechanism and defined roles and responsibilities for various departments.

I appreciate the Commissioner, KSDMA and his team in preparation of the Thunderstorm & Lightning Action Plan – 2023 for the State. I hope all stakeholders benefit from this Plan.

V. Rashmi Mahesh, IAS
Relief Commissioner
Government of Karnataka

Preface

Lightning and thunderstorms are mainly caused due to instability in weather created by mixing heat with moisture. The instability in weather systems is observed mainly during the transition from one season to another, say summer to monsoon or monsoon to winter. Local geographical features also play an essential role in developing congenial conditions for thunderstorms and Lightning, especially in hills, jungles, water bodies, river basins, plains etc.

The Lightning causes several deaths and loss of property in India. High population density makes our Country one of the most vulnerable to disasters. Thunderstorms & Lightning/Squalls/hailstorms, and Strong Winds have emerged as significant weather hazards in recent years, affecting different parts of the Country in both severity and frequency. According to the National Crime Record Bureau (NCRB) report's mortality data from 1967 to 2021, fatalities have sharply risen in recent years. Lightning fatalities since the last three years are almost steady, around 2800 plus across the Country.

Thunderstorms & Lightning have typical characteristics such as the formation of a squall, strong updraft and downdraft, towering cumulonimbus clouds associated with turbulence and icing, in-cloud electrification and associated Lightning, localized heavy rain and hailstorm with strong winds, generally occurring in arid and semi-arid regions. Experts believe that due to rising global temperature and climate change (IPCC Special Report, 2018 - Global Warming of 1.5 °C), the severity and frequency of thunderstorms will rise in the years ahead and may increase the number of incidents in future.

The current action plan attempts to fill the existing gaps, addresses challenges, and draws strategies for stakeholder agencies with well-defined timelines, roadmaps and Standard Operating Procedures (SOPs). The Plan helps to develop measures for the assessment, forecast, preparedness and mitigation through coordinated efforts with multiple agencies and undertake reconstruction as an opportunity to build disaster-resilient infrastructure.

Preparedness for Lightning is a critical issue. To mitigate the losses due to Lightning strikes in the State, Karnataka State Natural Disaster Monitoring Centre (KSNDMC) has developed and operationalized a system to provide location-specific Early Warnings to the general public and government executives across the State about the Thunderstorm & Lightning strikes. A network of Lightning Detection Sensor stations is installed in the State, providing data about the Thunderstorms and Lightning (Cloud to Cloud and Cloud to Ground) to the KSNDMC server in real time. Based on real-time data, early warnings and advisories are being generated

and disseminated to the public. During 2021 and 2022, the number of lightning alerts issued was 4.8 crores and 3.5 crores, respectively.

I acknowledge sincere appreciation to Sri. S.S.M. Gavaskar, Sri. N.G. Keerthy, Sri. Raju. M and other team members for their contributions in preparing the Action Plan-2023.

Dr. Manoj Rajan, IFS
Commissioner,
Karnataka State Disaster Management Authority,
Government of Karnataka

Message.....	1
Foreword.....	2
Preface	3
CHAPTER 1: INTRODUCTION	7
1.1 Definitions & Classification of Thunderstorms and associated with weather phenomena11	
A. Thunderstorms	11
B. Squall	11
C. Hailstorm	12
D. Lightning	12
CHAPTER 2: THUNDERSTORMS & LIGHTNING VULNERABILITY - KARNATAKA.....	14
2.1 Lightning Vulnerability in Karnataka	14
2.2 last 12 years, lightning casualties in Karnataka	14
CHAPTER 3: LIGHTNING MONITORING & EARLY WARNING SYSTEM (LEWS) - KARNATAKA.....	22
3.1 Early Warning & Dissemination.....	23
3.2 Sidilu Mobile App.....	24
3.3 Forecast and Issuance of Alerts / Warnings.....	26
CHAPTER 4: THUNDERSTORM & LIGHTNING ACTION PLAN AND ITS APPROACH.....	29
4.1 Rationale for preparing Action Plan.....	29
4.2 Objectives.....	30
4.3 Key Strategies.....	30
4.4 Steps to Develop an Action Plan.....	31
4.5 Dissemination & Communication strategies of Warning Messages.....	34
4.6 Communication Strategy and Drafting of Key Do's and Don'ts.....	35
4.7 Public Awareness, Community Outreach & IEC.....	35
CHAPTER 5: LIGHTNING DATA ANALYSIS - KARNATAKA.....	37
5.1. Spatial Lightning Density:.....	37
Spatial Lightning Density.....	37
5.2. District-wise observed Lightning events for the last 3 years (2020 - 2022):.....	38
5.3. Top ten date's highest lightning events observed – 2022:.....	39
5.4. Top ten highest lightning events observed in districts during 2022:.....	39

5.5. Top ten highest lightning events observed in districts during 2020 – 2022:.....	39
Lightning casualties in Karnataka in the last 12 years	42
CHAPTER 6: PREVENTION, MITIGATION AND PREPAREDNESS MEASURES.....	45
6.1. Preventive Measures.....	45
6.2. Mitigation and Preparedness Measures.....	46
6.3. Structural Mitigation Measures.....	48
6.4. Action – Before, During and After.....	50
CHAPTER 7: CAPACITY BUILDING	54
7.1 TLSD/HSW Education.....	54
7.2 Target Groups for Capacity Building.....	54
7.3 Capacity Building of Professionals.....	55
7.4 Training.....	55
7.5 Research and Development.....	55
CHAPTER 8: ROLES AND RESPONSIBILITY.....	57
8.1 Department-specific measures to prevent lightning-related injury & casualties, and property damage.	57
8.2 Matrix of Karnataka State Action plans for Thunderstorms & Lightning:.....	62
8.3 Roles and Responsibilities Matrix for Management of Thunderstorms, Lightning, Dust/Hailstorm, Squall and Strong Winds	64
THUNDERSTORM & LIGHTNING: DO'S AND DON'TS	69

CHAPTER-I

INTRODUCTION

CHAPTER 1: INTRODUCTION

Lightning is a hydro-meteorological global phenomenon mostly common in tropical countries. India has mostly a tropical climate and varied geography and is highly prone to Lightning and thunderstorms. Lightning is a routine part of weather whenever there is instability in the atmosphere which is more common during the transition from one season to another. India is a monsoon-dominant country, and Lightning is intimately associated with the monsoon. After a hot summer, as the monsoon advances, along with rain, lightning strikes are an integral part of it.

The occurrence of Lightning has significantly increased in frequency and intensity. There is an increase in Lightning from 1.48 crores (2019-2020) to 1.85 crores (2020-2021) which is an increase of approximately 34% in lightning strikes. This rise is mainly due to increased extreme climate events attributable to global warming, depletion of water bodies, deforestation, pollution and environmental degradation.

Thunderstorms and Lightning have emerged as significant weather hazards in recent years and have affected many parts of the Country. Lightning-related mortality in humans and animals has been high and has shown a rising trend—most deaths recorded in rural areas of farmers, cattle grazers, fishermen, labourers, and children. The National Crime Record Bureau (NCRB) reports mortality data from 1967 to 2021, showing that there has been a sharp rise in fatalities in recent years. Lightning fatalities since the last three years are almost steady, around 2800 plus.

Based on the statistics, the number of casualties caused by Lightning is higher among men than women. The higher death rate among men is due to their presence in vulnerable situations, such as working in open fields or walking in unprotected terrain in pursuit of livelihood activities. Most men are income earners, and their deaths significantly impact their families. These deaths increase the number of single-parent or female-headed households that

are often vulnerable to other risks affecting their communities. This is a significant socio-economic impact on distressed families in rural areas.

Though entire India is affected by Lightning as per region-wise seasonality, eastern India, North Eastern, and coastal states are most affected. The Chhota Nagpur plateau comprising north Odisha, the southern part of West Bengal, Jharkhand, Chhattisgarh, the eastern part of Madhya Pradesh, southern Bihar, the Sonbhadra area of Uttar Pradesh, etc., form an area of intense Lightning throughout the year. This plateau cum hilly area is inhabited by a sizeable tribal population whose housing pattern is mainly kutcha huts, and they live off the land. Due to this, they are exposed to lightning strikes and hence suffer frequent casualties. Similar is the case with tribals in North East, Andhra Pradesh, Telangana, **Karnataka**, Gujarat, Kerala and Rajasthan. It has also been observed that the impact of Lightning is not proportional to the lightning occurrences but rather varies from area to area.

The rise in Lightning has been attributed to **climate change and global warming**. The essential condition for generating Lightning is the instability in weather conditions due to heat and moisture, which leads to lifting/convection and thunderstorms, Lightning, hail and squalls. Global warming has increased the land surface temperature, sea surface temperature (SST) and atmospheric temperature. Due to the increased heat, more moisture is being generated and added to the atmosphere. When this moisture meets the hot, warm earth's surface, it creates fast convection giving rise to frequent Lightning. In addition, pollution, increase in emission, rise in aerosol level, etc., are other attributes of climate that significantly contribute to Lightning. The loss of tree cover and depletion of water bodies in urban areas has also contributed to the phenomenon. A study by The University of California identified that in the USA, with every 1°C rise in temperature, a corresponding rise in Lightning by 12% was observed.

Experts believe that due to rising global temperature and climate change (IPCC Special Report, 2018 - Global Warming of 1.5 °C), the severity and frequency of thunderstorms will rise in the

years ahead and may also increase the number of incidents in future. Thunderstorms have typical characteristics such as the formation of a squall, strong updraft and downdraft, towering cumulonimbus clouds associated with turbulence and icing, in-cloud electrification and associated Lightning, localized heavy rain and hailstorm.

Thunderstorms & Lightning devastate agriculture, aviation, surface transport, power, communication and other socio-economic sectors. Managing these requires active and continuous monitoring and participation of all the stakeholders. NDMA had brought out timely and relevant consensus guidelines for thunderstorms & Lightning along with other natural hazards taking the inputs from the domain expert groups/sub-groups, including representatives of various ministries /departments and state governments along with other stakeholders.

Lightning is a sudden electrostatic discharge that occurs during a Thunderstorm. This discharge occurs between electrically charged regions of a cloud called intra-cloud Lightning (IC), between Cloud to Cloud (CC lightning), or between a cloud and the ground (CG lightning). The charged atmospheric regions temporarily equalize themselves through this discharge, referred to as a flash. A lightning flash can also be a strike if it involves an object on the ground. Lightning creates light in the form of black body radiation from the scorching plasma created by the electron flow and sound in the form of thunder. Lightning may be seen and not heard at a distance too great for the sound to carry as far as the light from the strike or flash.

Lightning has a total path length of a few kilometers. Its peak power and total energy are very high, with the peak power discharge in the order of 100 million watts per meter of the channel and the peak channel temperature approaching 30,000 °C. Peak currents in a lightning discharge range up to hundreds of kilo amperes (kA), typically 40 kA. A lot of energy (about 1 billion joules) is released during a lightning strike. Predicting the precise time and location

of Lightning is very difficult. However, a season or a period of lightning occurrence is known in many regions.

This action plan presents salient features of thunderstorms and associated weather phenomena and guidance for early warning and communication, keeping existing gaps, challenges and opportunities in mind. These also draw the strategy to be followed by all stakeholder agencies with well-defined timelines, roadmaps and Standard Operating Procedures (SOPs) to follow.

According to the India Meteorological Department (IMD), the Average annual frequency of thunderstorms in India was released during 1981 -2010 indicated in **Figure 1**.

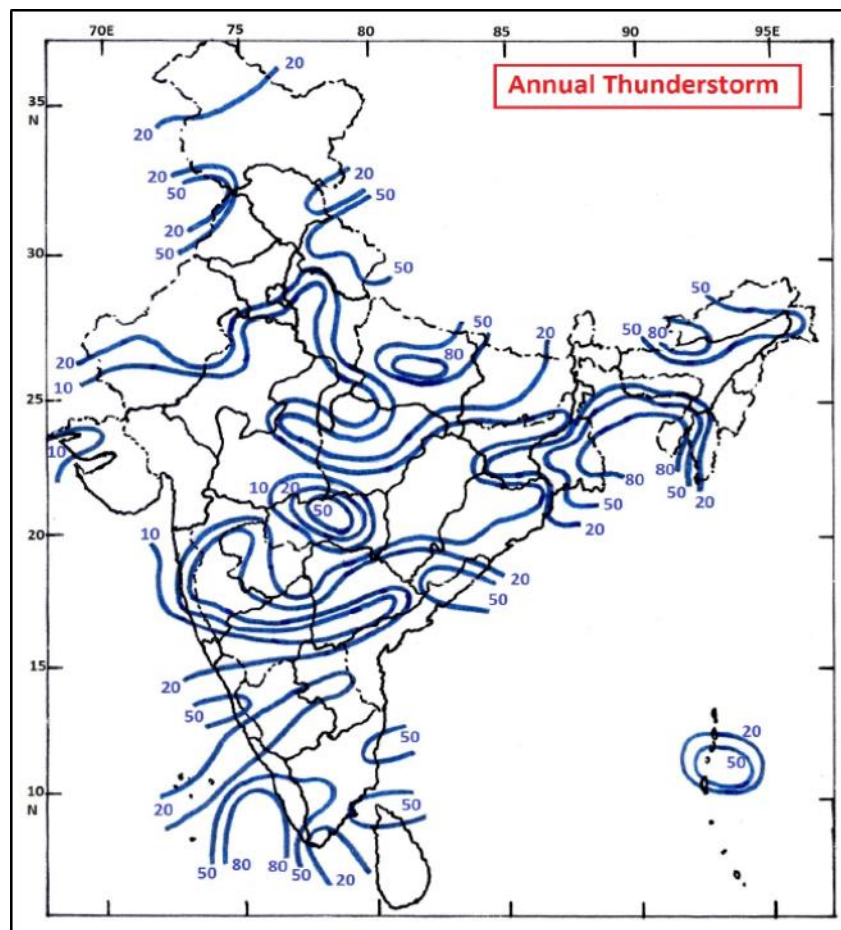


Figure 1: Average annual frequency of thunderstorms in India during 1981 -2010 (IMD)

The Cloud-Ground (C-G) lightning strikes distribution was mapped for India from April 2020 to March 2021. The below map reveals lightning-prone zones, also called lightning hotspots.

1.1 Definitions & Classification of Thunderstorms and associated with weather phenomena

A. Thunderstorms

A thunderstorm is said to have occurred if thunder is heard or Lightning is seen. Usually, the thunder can be heard up to 40 km from the source of origin. Thunderstorms fall in the category of Meso-gamma weather systems with a spatial extent of around 2~20 km and a temporal scale of a few hours. Considering their intensity, the thunderstorms in India are categorized as follows:

- **Moderate thunderstorm:** Loud peals of thunder with associated lightning flashes, moderate to heavy rain spells and maximum wind speed of 29 to 74 kmph.
- **Severe thunderstorm:** Continuous thunder, occasional hailstorm, and maximum wind speed exceeding 74 kmph.

Thunderstorms occur around the year in different parts of the Country. However, their frequency and intensity are maximum during the summer months (March to June) as the most critical factor for thunderstorms is the intense heating up of the atmosphere at the surface level.

B. Squall

A squall is a sudden increase in wind speed of at least 29 kmph (16 knots), with speed rising to 40 kmph (22 knots) or more and lasting for at least one minute. It is of two types:

- **Moderate squall:** If the surface wind speed (in gusts) is up to 74 kmph.
- **Severe squall:** If the surface wind speed (in gusts) exceeds 74 kmph.

The climatology of the spatial distribution of the occurrence of a squall is almost the same as that of thunderstorms. The frequency and intensity of squalls are maximum over eastern and north-eastern States. Also, its frequency is maximum during the pre-monsoon season, with an increasing trend from March to May in different parts of the Country. However, there is a secondary maximum in the winter season over northwest India.

C. Hailstorm

India, with about 29 hail days of moderate to severe intensity per year, is among the countries that experience a very high frequency of hail. Hailstorms are mainly observed during the winter and pre-monsoon seasons, with virtually no events after the onset of the southwest monsoon.

It appears to be associated with a particular cell of the convective cloud rather than a storm. Hail occurs in the mature stage if at all it occurs. Cells where hails occur, have updrafts of more significant than average intensity, exceeding 15 meters per second. It is of three types:

- **Slight Hailstorm:** If it is sparsely distributed, usually small in size and often mixed with rain.
- **Moderate Hailstorm:** If it is abundant enough to whiten the ground.
- **Strong Hailstorm:** If it includes at least a proportion of large stones.

D. Lightning

Lightning is a high-energy luminous electrical discharge accompanied by thunder. It is of three types:

- 1) Thundercloud or Intra-cloud Lightning (IC)
- 2) Cloud-to-cloud or Inter-cloud lightning (CC)
- 3) Cloud-to-ground Lightning (CG)

The third type of Lightning takes a toll on lives and property and, therefore, is of more concern to us. However, inter-cloud and intra-cloud Lightning are dangerous as they may hit aircraft.

These are also the precursor to cloud-to-ground Lightning. Lightning has a total path length of a few kilometres. Its peak power and total energy are very high, with the peak power discharge in the order of 100 million watts per meter of the channel and the peak channel temperature approaching 30,000 °C. Peak currents in a lightning discharge range up to hundreds of kilo amperes (kA), typically 40 kA. Predicting the precise time and location of

Lightning is very difficult. However, a season or a period of lightning occurrence is known in many regions.

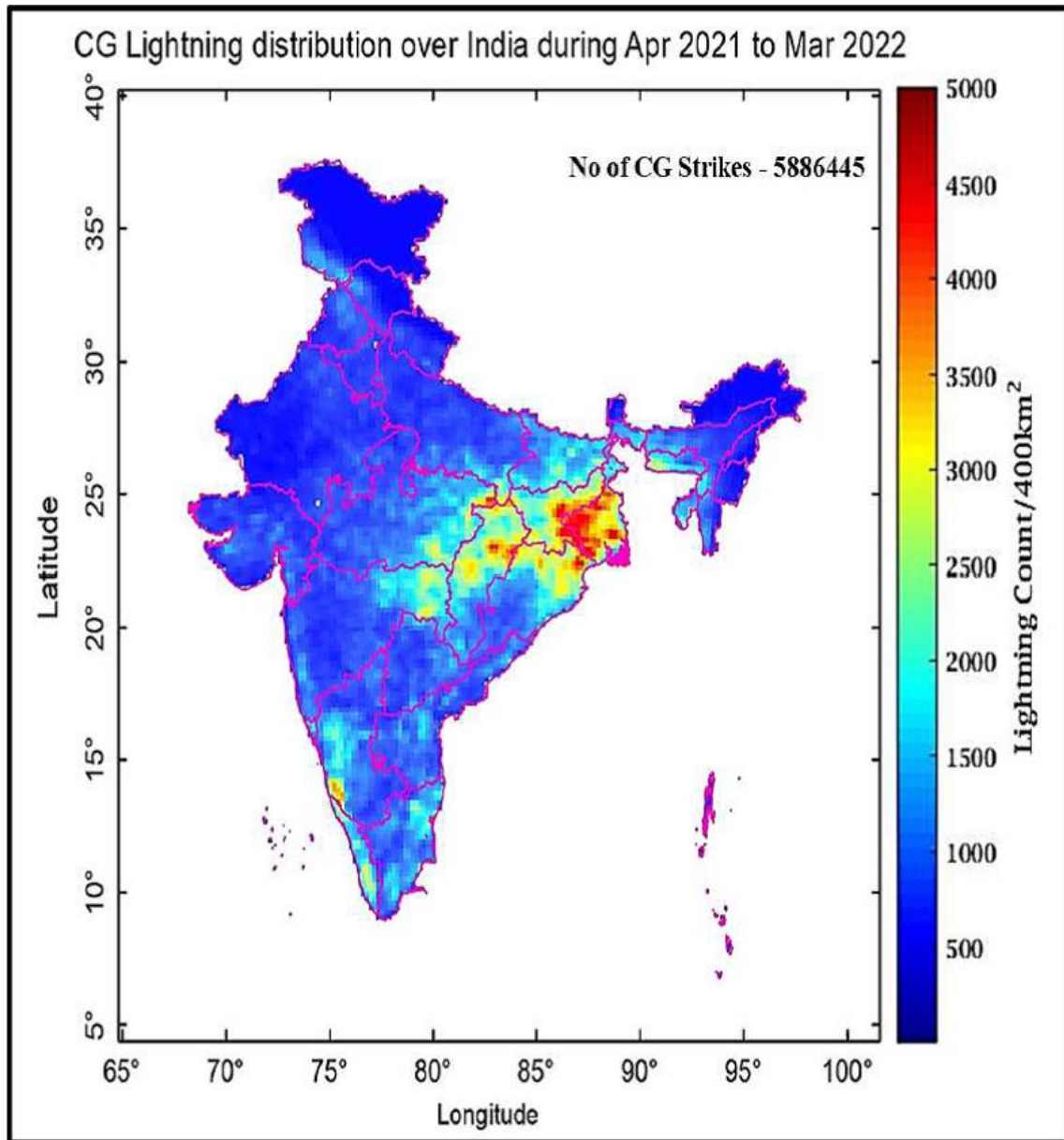


Figure 2: C-G Lightning strikes distribution over India from Apr 2021 to Mar 2022

CHAPTER-II

THUNDERSTORMS & LIGHTNING VULNERABILITY KARNATAKA

CHAPTER 2: THUNDERSTORMS & LIGHTNING VULNERABILITY - KARNATAKA

2.1 Lightning Vulnerability in Karnataka

Thunderstorms & Lightning strikes have been causing loss of life and property in Karnataka. About 910 people have lost their lives due to lightning strikes in the Karnataka State during 2011-2022. Apart from the loss of life, there is a massive loss of livestock and infrastructure due to yearly lightning strikes in the State. Lightning-related mortality in humans and animals has been high. Most deaths were recorded in rural areas of farmers, cattle grazers, fishermen, labourers, and children. The National Crime Record Bureau (NCRB) report's mortality data from 1967 to 2021 shows a sharp rise in fatalities in recent years. Lightning fatalities in the last three years are more than 90, as shown in Figure 3 below.

2.2 last 12 years, lightning casualties in Karnataka

Karnataka state ranked 8th in deaths due to Lightning in the Country (Source: Annual Lightning Report 2020-21 by CROPC). Based on the statistics, the number of casualties caused by Lightning is higher among men than women. The higher death rate among men is due to their presence in vulnerable situations, such as working in open fields or walking in unprotected terrain in pursuit of livelihood activities. Most men are income earners, and their deaths significantly impact their families. These deaths increase the number of single-parent or female-headed households that are often vulnerable to other risks affecting their communities. This is a significant socio-economic impact on distressed families in rural areas.

Year	Number of Deaths
2011	37
2012	33
2013	38
2014	79
2015	72
2016	59
2017	96
2018	118
2019	101
2020	79
2021	100
2022	98

Table. 1: Year-wise deaths reported due to Thunderstorm & Lightning – State

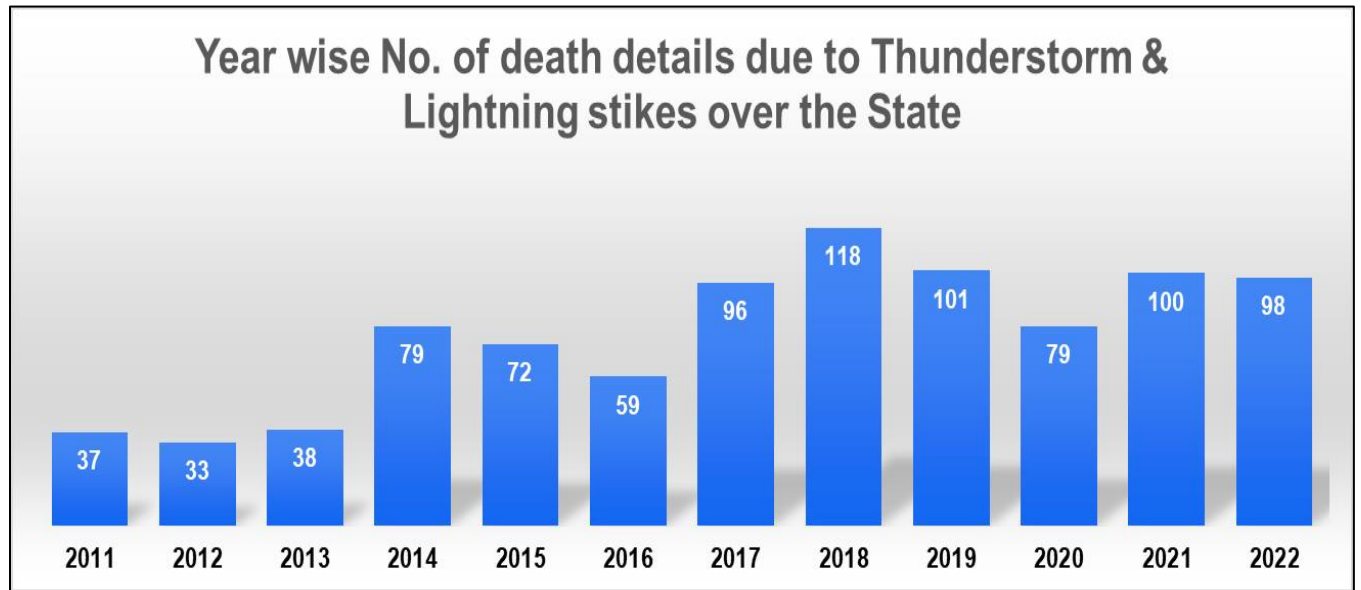


Figure 3: Year-wise No. of deaths due to Thunderstorm & Lightning in the State

Lightning deaths were spread across all the districts of the State. Belagavi district observed the No. of deaths high during 2011-2022. The human deaths during the last twelve years, from 2011 to 2022 District wise, have been provided in the Table.

S.No	District	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
1	Belagavi	5	4	13	8	13	8	8	10	6	4	6	7	92
2	Vijayapura	5	3	2	6	1	5	8	10	11	7	11	8	77
3	Gadag	0	0	0	13	3	3	14	9	5	5	4	7	63
4	Chitradurga	8	3	6	3	6	4	6	3	4	3	2	5	53
5	Bidar	0	0	0	0	0	0	0	16	10	10	8	7	51
6	Koppal	2	3	6	8	4	3	3	6	3	2	3	7	50
7	Tumakuru	3	4	0	5	5	1	5	7	8	4	6	1	49
8	Haveri	0	3	2	4	4	9	5	7	5	4	0	5	48
9	Yadgir	0	0	0	0	4	0	7	8	10	2	6	9	46
10	Dharwad	3	2	0	0	3	5	3	6	7	4	4	4	41
11	Ballari	0	0	1	5	1	3	5	6	7	6	1	5	40
12	Bagalkot	0	4	0	8	1	6	1	0	2	5	4	4	35
13	Mysuru	0	1	1	0	4	1	15	1	8	1	0	2	34
14	Raichur	2	2	0	3	2	1	1	1	3	7	7	3	32
15	Chamarajanagara	4	4	3	4	7	1	2	0	0	2	0	2	29
16	Shivamogga	3	0	0	2	6	6	3	3	1	1	2	0	27
17	Davanagere	0	0	2	8	2	1	0	5	2	0	4	1	25
18	Chikkamgaluru	0	0	1	1	1	0	3	3	4	3	0	0	16
19	Udupi	2	0	1	1	3	0	0	2	0	3	2	1	15
20	Dakshina Kannada	0	0	0	0	0	0	1	2	0	1	7	3	14
21	Vijayanagara	-	-	-	-	-	-	-	-	-	-	10	4	14
22	Kalaburagi	-	-	-	-	-	-	-	-	-	-	7	6	13
23	Uttara Kannada	0	0	0	0	0	0	2	4	1	3	2	0	12
24	Hassan	-	-	-	-	-	-		3	2	0	1	5	11
25	Mandya	0	0	0	0	1	2	0	4	0	2	2	0	11
26	Chikkaballapura	0	0	0	0	1	0	3	2	0	0	0	0	6
27	Kolar	0	0	0	0	0	0	0	0	1	0	0	2	3
28	Bangalore Urban	0	0	0	0	0	0	1	0	1	0	0	0	2
29	Bengaluru Rural	0	0	0	0	0	0	0	0	0	0	1	0	1
30	Kodagu	-	-	-	-	-	-	-	-	-	-	0	0	0
31	Ramanagara	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		37	33	38	79	72	59	96	118	101	79	100	98	910

Table. 2: District-wise human death details due to Lightning during 2011-2022

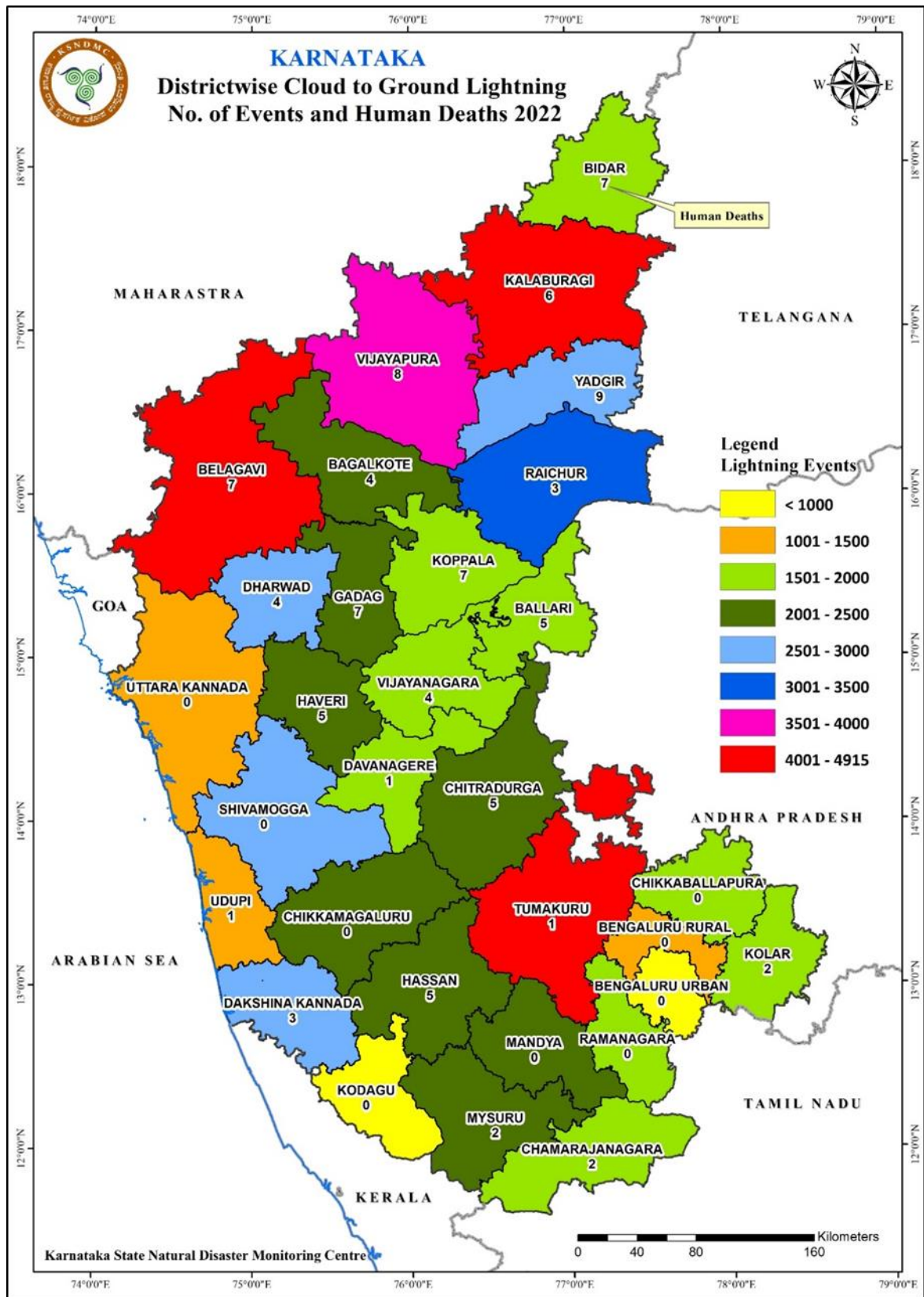


Figure 4: District-wise deaths and No. Of C-G lightning events during the year 2022

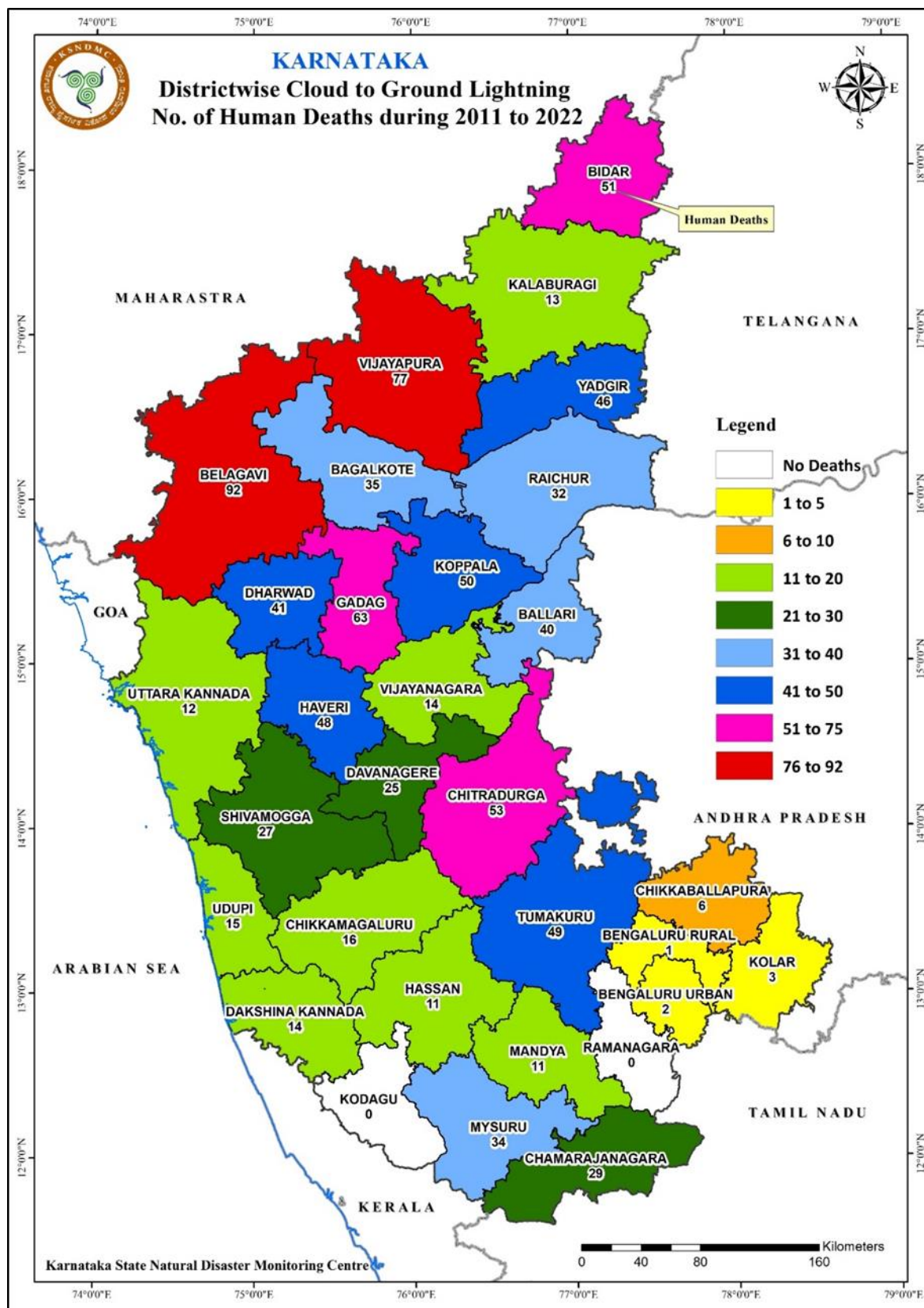


Figure 5: Last 12 years District-wise No. of deaths due to Thunderstorm & Lightning

Rural and forest areas are the most vulnerable, given the presence of tall trees and water bodies. A majority of the lightning victims are people working in the fields in rural areas. For example, a study has shown that 96% of the total lightning-related deaths in the Country were reported among people working in the fields, mainly farmers in rural areas are more (Source: CROPC). Lightning is also a major cause of electrical power breakdowns and forest fires. It can also damage communication and computer equipment and affect aircraft navigation systems.

Lightning has been generally observed in most of the parts during the second half of the day. However, during intense cloud movement with high wind speed, especially during the monsoon and cyclonic activities, Lightning may occur anytime. Lightning also depends on local geographical conditions like its differences in coastal regions, hilly areas and river basins.

A moderate thunderstorm can damage thatched huts, kutcha roads, standing crops, orchards, power and communication lines. Rooftops may also blow off. Unattached or loosely tied metal sheets may fly. It can also damage power and communication lines and roads, flooding escape routes, breaking tree branches, uprooting large trees, etc.

Since the inception of the lightning monitoring network in the State, the total No. Cloud to Ground (C-G) events were mapped district-wise from June-2018 to Dec-2022. Using GIS techniques, potentially vulnerable areas are identified based on these events. More focus is being given through DEWS and awareness programs to take appropriate mitigating measures to minimize the impacts on humans, livestock & property due to lightning strikes.

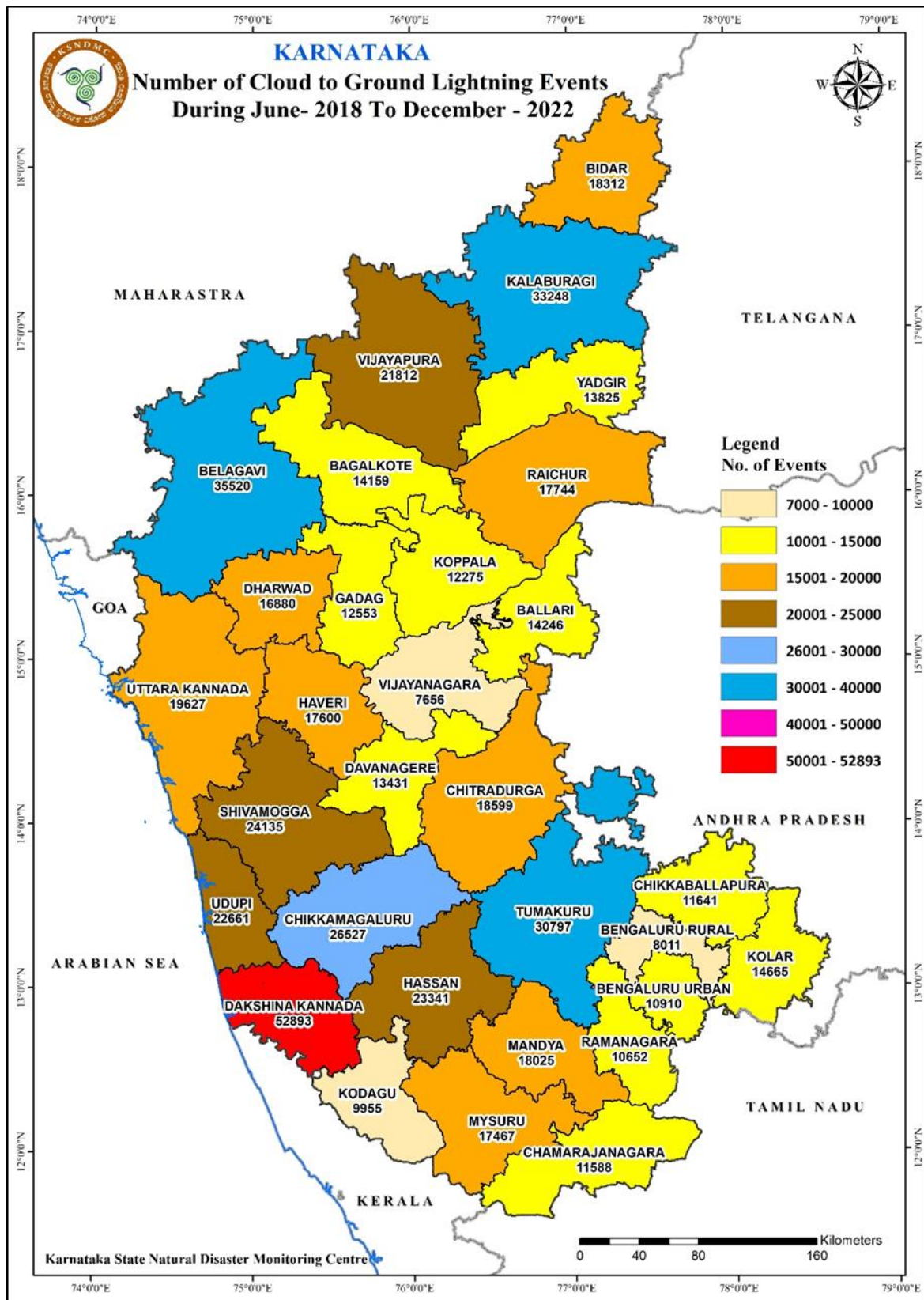


Figure 6: Cloud to Ground (C-G) Total No. of events from June 2018 to Dec 2022

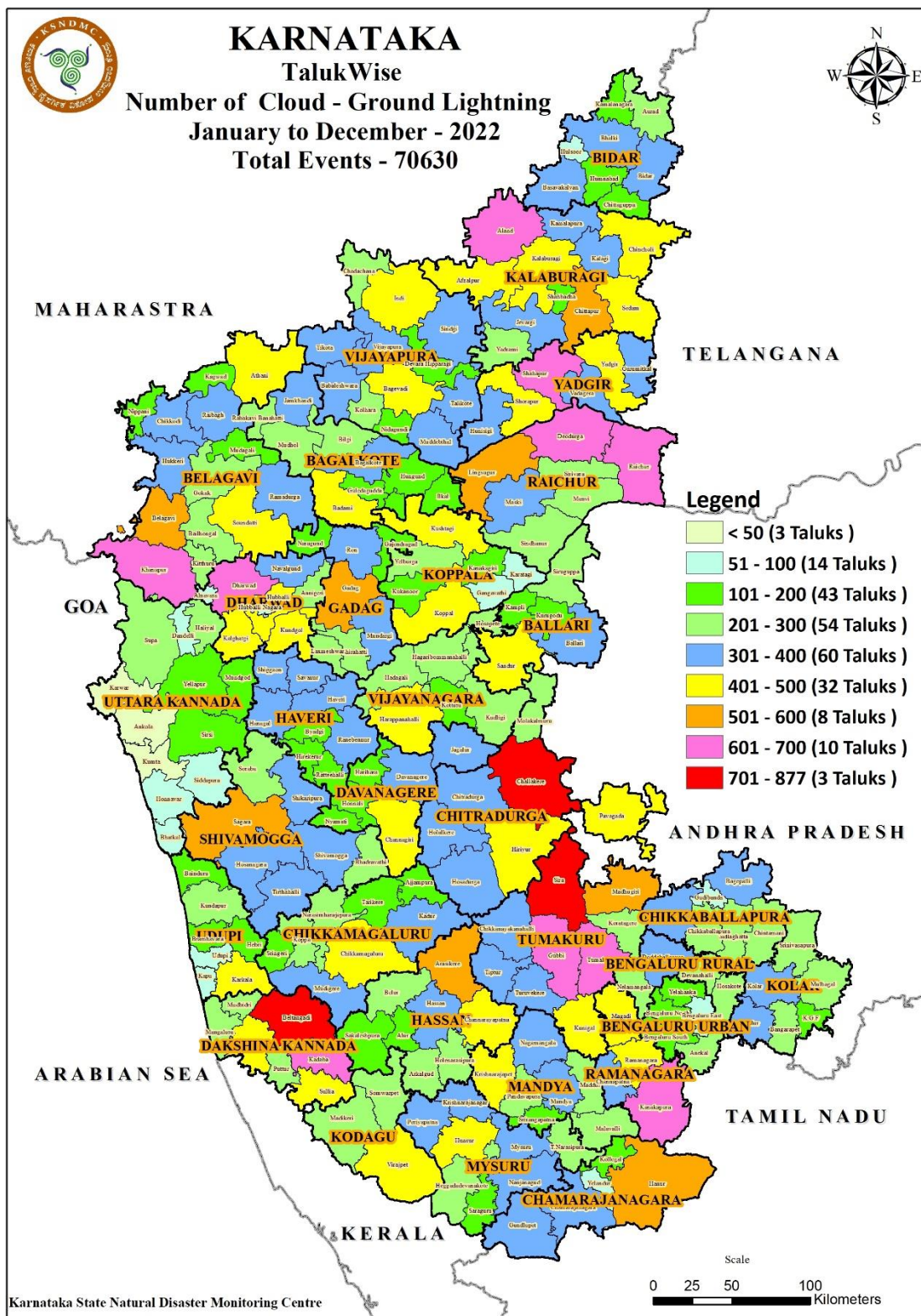


Figure 7: Taluk wise Cloud to Ground (C-G) Total No. of events during the year 2022

CHAPTER-III

LIGHTNING MONITORING & EARLY WARNING SYSTEM (LEWS) - KARNATAKA

CHAPTER 3: LIGHTNING MONITORING & EARLY WARNING SYSTEM (LEWS) - KARNATAKA

To mitigate the losses due to Lightning strikes in the State, Karnataka State Natural Disaster Monitoring Centre (KSNDMC) has developed and operationalized a system to provide location-specific Early Warnings to the Government Executives and general public across the State about Thunderstorms & Lightning strikes. A network of Lightning Detection Sensor stations is installed in the State, providing data about the Thunderstorms and Lightning (Cloud to Cloud and Cloud to Ground) to the KSNDMC server in real time. Based on real-time data, early warnings and advisories are being generated and disseminated to the public. These early warnings were mapped to each Grampanchayath (GP); hence the alert will be issued at the GP level. During 2021 and 2022, the No. of lightning alerts issued is 4.8 crore and 3.5 crore, respectively.

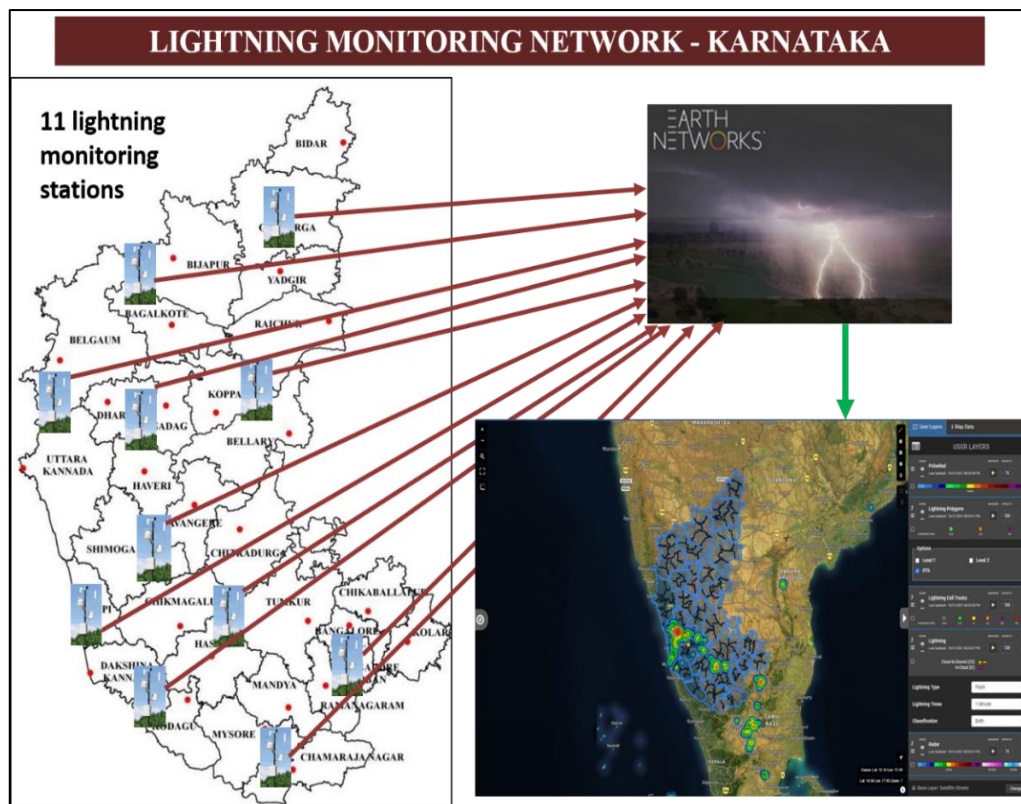


Figure 8: Lightning Network in Karnataka State

A dedicated link for spheric maps for lightning and thunderstorm events to visualize in real-time is available for the State. Using these credentials, the development of a thunderstorm cell and its projection for movement of cell track and likely influencing area and type of Lightning (C-C or C-G) also can be seen. Weather and satellite product layers are also available so that it helps completely track the movement of the thunderstorm cell and its severity. In a nutshell, the user can get more information about thunderstorms and lightning developments using spheric maps.

3.1 Early Warning & Dissemination

KSNDMC has developed a unique integrated public alert and warning system called Disaster Early Warning System (DEWS) to disseminate early warnings to the potentially vulnerable panchayats effectively. DEWS will provide rapid, reliable and effective communication to the public in case of major emergencies such as natural disasters like Floods, Heavy releases from upper catchment reservoirs/ Dams, Hailstorms, Earthquakes, Heavy rains, Lightning & Thunderstorms and Heat waves. Through this DEWS, potentially vulnerable panchayats were equipped with integrated announcement systems. This system has features like text-to-speech, recording service, automated message service, scheduled broadcast of messages & group broadcasting. These pre-defined features will be issued during pre & post-disaster events whenever crossing the limits of defined threshold values. The warning messages will be broadcasted to outdoor receivers with loudspeakers automatically using the DEWS system at that particular Gram Panchayath office before any disaster occurs, with the help of the current high dense weather observational, water level data, Lightning monitoring network and forecast mechanism in the State. A dedicated team of operators and a technical officer monitors regularly. It will follow the criteria for each disaster and issue alert/ early warning accordingly to the likely affected community/area in advance to effectively minimize the loss of life and property in the State.



Fig 9: Different modes of dissemination of Information

3.2 Sidilu Mobile App

Dissemination of Information plays an essential role in Disaster Risk Reduction. KSNDMC has dissemination mechanism in various methods to issue early warnings to all the stakeholders in real-time, such as area-specific SMS alerts, VAUNAMTRA call Centre, Apps, e-mail alerts, and social media platform and based on the real-time lightning data, KSNDMC has developed Mobile App "SIDILU" for disseminating the location-specific Information about Lightning Strikes in the State. Apart from the Early Warnings, the app also provides advisory about safety measures in the form of Do's and Don'ts to the public which will help them secure themselves during the Lightning activity at their location.

This APP will also be disseminating the Early Warnings through SMS to the Panchayath Development Officers' (PDO's) mobile phones and Revenue Inspectors (RI's) of the respective Grampanchayath. Early warning about the lightning strikes will also be disseminated to the public in regional languages through the 24 x 7 Interactive Help Desk "VARUNA MITRA"

operational at KSNDMC. The database, customized to every Grampanchayath of about 28 lakh farmers / general public available at KSNDMC, will also be used for disseminating Lightning Strike Early Warning.

The app offers a comprehensive map view of the real-time occurrences of Lightning (s) around the user's current geo-location within Karnataka. The concentric circles at the centre of the map view show the lightning occurrences that span from a radius within 1 KM (RED – high danger), within 5 KM (ORANGE – moderate danger), within 15 KM (YELLOW – still within the overall dangerous zone) from the user's current geo-location. If Lightning occurs within any of these radiating circles, push notifications will be sent to the mobile user, bringing their attention to the severe weather occurrence.

The app offers a comprehensive map view of the real-time occurrences of Lightning (s) around the user's current geo-location within Karnataka. The concentric circles at the centre of the map view show the lightning occurrences that span from a radius within 1 KM (RED – high danger), within 5 KM (ORANGE – moderate danger), within 15 KM (YELLOW – still within the overall dangerous zone) from the user's current geo-location. If Lightning occurs within any of these radiating circles, push notifications will be sent to the mobile user, bringing their attention to the severe weather occurrence.

This app can be downloaded free of cost from the Google Play store. The app warns smartphone users 30 to 45 minutes before the lightning strike by displaying Information in different colours. An alert in red indicates that the user is in a danger zone with a 90% probability of a lightning strike within a one km radius of the location. Orange shows the possible occurrence of the strike within a 5 km radius and yellow in a 15 km radius.

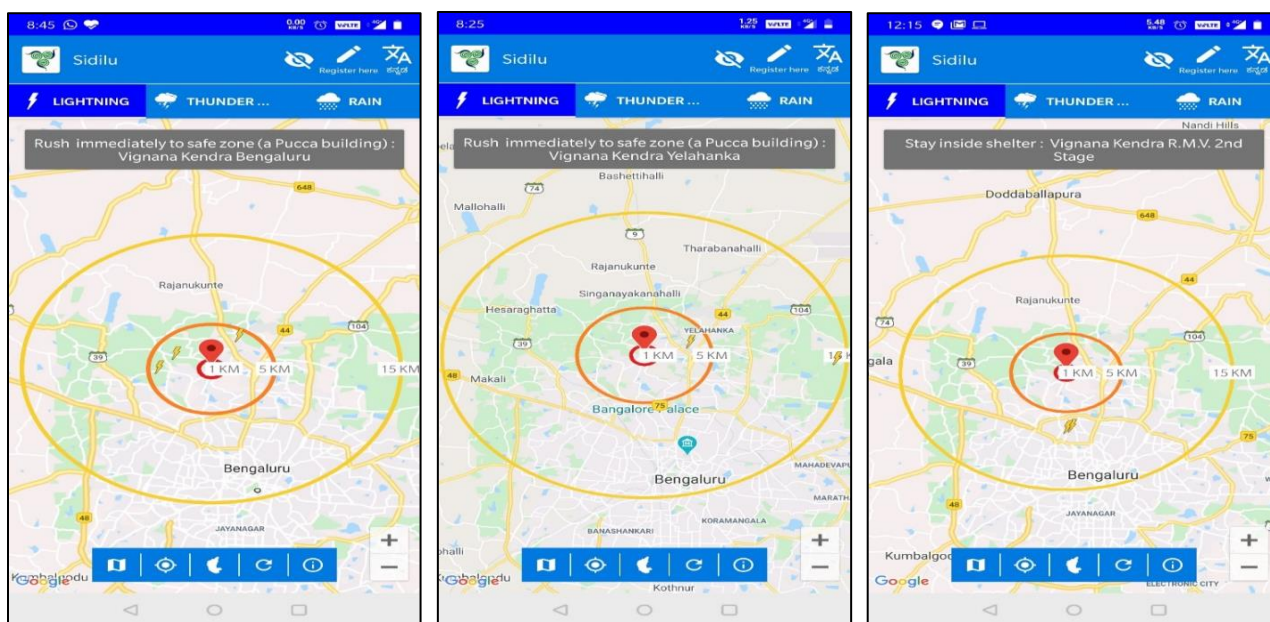
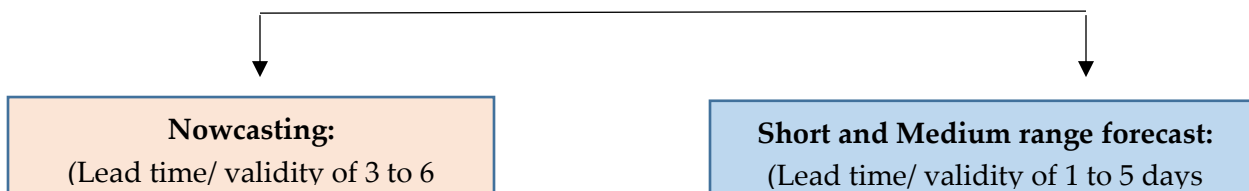


Figure 10: Screenshots of the App SIDILU:

3.3 Forecast and Issuance of Alerts / Warnings

India Meteorological Department (IMD), Ministry of Earth Sciences, is the nodal agency for providing current weather information and forecast, including warnings for all weather-related hazards. Besides, Karnataka State established its own independent early warning and monitoring systems to supplement warnings from the IMD.

Forecasts (Based on Specific Range, Time Duration and Area)



While short to medium range forecast provides the potential areas with a probability of occurrence, nowcasting provides more specific Information about the place/time of occurrence.

A thunderstorm is a small-scale phenomenon with a life cycle of about three hours. It has a dimension of 2 km to 20 km, and therefore, its detection is difficult. Weather monitoring

systems such as automatic weather stations (AWS) provide some basic parameters such as wind speed, wind direction, relative humidity, temperature, pressure, etc., but do not predict Lightning.

Geostationary Weather Satellite captures images from 36,000 km above the earth. It takes about half an hour to capture the image and another half an hour to process the data. So, when someone sees the satellite imagery on IMD's website, it is already one hour late. Due to the short life cycle of thunderstorms, a satellite cannot capture its initiation unless it is a large-scale thunderstorm activity.

The Doppler Weather Radar, which takes an observation every 10 minutes, can detect the occurrence of thunderstorms. Therefore, for better monitoring, there is a need for a more comprehensive network of Doppler Weather Radars in the Country.

Lightning incidents can be detected by the ground-based Lightning Detection Network in real-time. Creating a high-density network in regions vulnerable to lightning strikes is necessary. For measuring squall and gusty winds, a meso-network of observation stations is required in the Country with anemometers that can measure wind speeds up to about 200 kmph. Further, one to two high wind speed recorders can be installed in each squall-prone district.

On the day of the occurrence of a severe weather incident/thunderstorm, State-level offices of the IMD start nowcasting. As nowcasting is valid for the next two to three hours, it gives only a limited lead time. This nowcast at the district level is provided to Relief Commissioners, SEOC, District Collectors, Disaster Management units, etc. This alert is specific and issued for a district with the time of occurrence and associated wind speed.

In the last decade, there has been a significant improvement in monitoring and forecasting thunderstorms. This can be attributed to a good network of Doppler Weather Radars, a dense AWS network, half-hourly satellite observations from INSAT 3D & 3DR satellites, better analysis tools, and advanced computational and communication capabilities. With these, IMD

has started all India nowcast services for localized, high-impact weather incidents such as thunderstorms, squalls and hailstorms with a lead time of up to 3 hours since 2013.

DWR-based observation is the primary source of Information for the nowcast of thunderstorms and associated weather incidents. In the first phase, 403 cities and towns, which come under the coverage of DWRs, have been included for nowcasting of convective weather. This coverage would be increased to represent all districts by 2020 and all blocks by 2025 by expanding DWR networks and forecasting systems.

To be adequate and complete, an Early Warning System needs to comprise four indicating elements, namely:

- (i) Risk knowledge
- (ii) Monitoring and warning service
- (iii) Dissemination and communication
- (iv) Response mechanism and capacity building

Before the preparation of the Action Plan, especially for Lightning, the following actions must be taken:

- 1) Mapping of lightning-affected zones based on:
 - a. Available data of deaths and injuries (both humans and animals) at different places, complete with latitude and longitude points,
 - b. Data of lightning incidents available with Radar/lightning detection System,
 - c. Data available from the National Crime Record Bureau.
- 2) Systemic study of past lightning occurrences by any expert agency or group (to be taken up with State-level knowledge institutions).
- 3) Sharing of data between different agencies for preparation of mitigation plan.
- 4) Installation of lightning and thunderstorm detection devices.
- 5) Generation of a database for future planning.

CHAPTER-IV

THUNDERSTORM & LIGHTNING ACTION PLAN AND ITS APPROACH

CHAPTER 4: THUNDERSTORM & LIGHTNING ACTION PLAN AND ITS APPROACH

4.1 Rationale for preparing Action Plan

A "Disaster" is defined under section 2 (d) of the Disaster Management Act, 2005, as a catastrophe, mishap, calamity or grave occurrence in any area arising from natural or man-made causes and is of such a nature or magnitude as to be beyond the coping capacity of the affected area.

"Disaster Management" has been defined under section 2 (e) of the "Disaster Management Act, 2005" as a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for

- (i) Prevention of danger or threat of any disaster
- (ii) Mitigation or reduction of risk of any disaster or its severity or consequences
- (iii) Capacity building
- (iv) Preparedness to deal with any disaster
- (v) Prompt response to any threatening disaster situation or disaster
- (vi) Assessing the severity or magnitude of effects of any disaster
- (vii) Evacuation, rescue and relief and
- (viii) Rehabilitation and reconstruction (Recovery)

Karnataka State is also one of the states frequently affected by thunderstorms & Lightning, squalls, hailstorms and strong winds during one or the other part of the year with varying intensity and frequency. While these incidents have received lesser attention as compared to other disasters, these incidents cause loss of lives, property, infrastructure, livestock and livelihoods, majorly affecting vulnerable and weaker sections of society (small and marginal farmers, vendors, street hawkers, construction workers, field officials/employees etc.). There is an urgent need to devise a State level strategy and plan to reduce the adverse effects of these disasters. Therefore, with the support of NDMA guidelines, the current action plan has been

created to mitigate and take measures for preparedness with active participation from all line departments and stakeholders.

4.2 Objectives

- A.** To help the Districts and other stakeholders to prepare action plans to significantly reduce the loss of lives, injuries, and economic losses and to improve the coping capacity of the State.
- B.** To develop assessment tools and undertake preparedness and mitigation measures through coordinated inter-agency efforts.
- C.** To evolve a coordinated strategy for Disaster Risk Reduction in the States by involving all the stakeholders (administration, line departments, scientists, engineers, Panchayat Raj Institutions, Non-Governmental Organisations, Community-Based Organizations and communities) in the planning process.

4.3 Key Strategies

Severe and extended incidents of thunderstorms & lightning/squalls/ hailstorms/ strong winds can disrupt social and economic services. Government agencies are critical in preparing and responding to such incidents locally, working closely with all stakeholders on a short, medium and long-term strategic plan.

- a) Establish a qualitative and effective Early Warning System
- b) Inter-agency Coordination and communication
- c) Develop advanced preparedness, mitigation and response plan
- d) Preparedness at the local level for an effective incidence response plan
- e) Capacity building and training
- f) Public awareness and community outreach
- g) Collaboration with Non-Government Organisations and civil society
- h) Assessing the impact – getting feedback for reviewing and updating the Plan

To mitigate the losses due to Lightning strikes in the State, Karnataka State Natural Disaster Monitoring Centre (KSNDMC) has taken up a project to provide location-specific Early

Warnings to the Government Executives and general public across the State about the Lightning strikes. KSNDMC has installed a network of ELEVEN Lightning Detection Sensor stations in the State, collecting data about the Thunderstorm and Lightning (Cloud to Cloud and Cloud to Ground) to KSNDMC in real-time. Based on the data, early warning and related advisories are being generated and disseminated to the public. During the years 2021 & 2022, KSNDMC has issued Lightning Early Warnings to both the urban & rural communities of the State as nowcast alerts are 4.8 and 3.5 crore SMS, respectively.

During 2022, KSNDMC has made MoU with the National Centre for Medium-Range Weather Forecasting Centre (NCMRWF), Ministry of Earth Sciences (MoES) - New Delhi, Government of India, with a scope of having high-resolution dynamical weather model downscaling upto 3 days over Karnataka and also Numerical Weather Prediction (NWP) products with one of the main objective in providing the predictions of Thunderstorms & Lightning along with other extreme weather weathers like Heavy rainfall events & urban flooding.

Like any other natural disaster, the effect of Lightning strikes cannot be avoided entirely. However, the Lightning Early Warning System (LEWS), developed with a broad multidisciplinary knowledge in geophysical, environmental and social science fields, using GIS-based technology and also a robust mechanism in-place for generating maps, providing location-specific alerts to local communities, periodic evaluation of LEWS to minimize false alarms, creating awareness with visualization of impacts and response options for community preparedness intended to effectively minimize the loss of life and property in the State.

4.4 Steps to Develop an Action Plan

Step 1: Government Engagement

Karnataka Govt. has set up an Action Plan, which embraces participation from the State and district administration, line departments, municipal authorities, health agencies, disaster management authorities and local partners. At the state level, a dedicated policy decision–

making committee chaired either by the Principle Secretary/ Relief Commissioner of the State or the State Disaster Management Authority (SDMA) develop an implementing strategy with line departments.

Step 2: Appointing a Nodal Department and Officers

The State had appointed nodal officers at the State and district levels, and at the State level, KSNDMA oversaw the implementation of the Action Plan. It also built the capacity of its key officials and agencies to fulfil their roles and responsibilities as mentioned in the State Action Plan. The State conducted several meetings through VCs and exercises at the local level before the thunderstorms and lightning season, besides resolving communication gaps between all concerned departments, partners and the public.

Step 3: Vulnerability Assessment and Early Warning System

Vulnerable areas were identified based on the last 3 years (2020-2022) C-G strikes data available at KSNDMC to establish priority areas for Early warning, forecast/alert activities to the exposed populations. The State nodal centre (KSNDMC) regularly coordinates with the IMD to develop reliable and accurate localized early warnings and dissemination plans.

Step 4: Drafting and Developing the Action Plan

The State nodal officer and agency will coordinate with all the concerned line departments and prepare an action plan with clearly defined roles and responsibilities.

Step 5: Team Preparation and Coordination

State officials and agencies are well-prepared and informed for the thunderstorms and lightning season. The State had an inter-agency emergency response plan with clearly marked out roles and responsibilities.

Step 6: Implementation and Monitoring

While the government departments (and partners) are responsible for implementing many components of the Action Plan, the public must know how to respond to extreme weather incidents. Information, Education and Communication (IEC) are essential in widely disseminating critical messages to communities in advance. Specific messages were developed to cater to vulnerable groups. During the season, "Do's and Don'ts" are made available in local languages and disseminated through various media channels. Pre-season consultations are in place at the State and the District level before the commencement of the peak season (summer season).

Step 7: Evaluating and Updating the Plan

The approach towards extreme weather incidents is flexible and iterative to determine the strategies to deal with them are effective and have no unintended negative consequences. After every season, the State will assess the efficacy of its Action Plan, Including the processes, outcomes and impacts. Stakeholders will identify gaps and make improvements for the next season. The Plan will be updated annually with the name, designation, contact details, etc., of key officials and concerned departments/ stakeholders to be made aware of these changes.

Step 8: Strategies for Adapting to Climate Change (Long-term plans)

The rise in Lightning has been attributed to climate change and global warming. The essential condition for generating Lightning is the instability in weather conditions due to heat and moisture, which leads to lifting/convection and thunderstorms, Lightning, hail and squall. Global warming has increased the land surface temperature, sea surface temperature (SST) and atmospheric temperature. Due to the increased heat, more moisture is being generated and added to the atmosphere. When this moisture meets the hot, warm earth's surface, it creates fast convection giving rise to frequent Lightning. In addition, pollution, increase in emission, rise in aerosol level, etc., are other attributes of climate that significantly contribute to Lightning. The loss of tree cover and depletion of water bodies in urban areas has also

contributed to the phenomenon. A study by The University of California identified that in the USA, with every 1°C rise in temperature, a corresponding rise in Lightning by 12% was observed. The State undertakes mitigation strategies to reduce the impact of climate change on extreme weather incidents. For e.g., developing disaster-resilient infrastructure and implementing the recommendations in the "Manual on Hazard Resistant Construction in India" for non-engineered buildings.

4.5 Dissemination & Communication strategies of Warning Messages

The dissemination strategy aimed at reaching the last person as soon as possible. During the years 2021 & 2022, KSNDMC has issued Lightning Early Warnings to both the urban & rural communities of the State as nowcast alerts are 4.8 and 3.5 crore SMS, respectively.

The following points are important while preparing Early Warnings/ Alerts:

- a.** The warning messages from agencies like IMD and State level DM author (KSNDMC) provided safety directions; e.g., the nowcasting messages for severe thunderstorm storm may ask the public to take a safe shelter or move indoors in the wake of an inevitable disaster;
- b.** The message is short, clear, in simple language and action-oriented;
- c.** Greater emphasis is placed on inter-agency Coordination while dissemination of warning messages, including public and private media; and
- d.** The following activities may be considered to ensure that everyone in the affected areas is warned in time –
 - (i)** Flash messages/tickers / 'breaking news to be displayed on the local TV news channels;
 - (ii)** Radio announcements through public and private broadcasters;
 - (iii)** Flash messages / SMSes to the users by the mobile operators in the affected areas;

- (iv) In the case of rural areas and small towns, an early warning may be issued by the local authorities using loudspeakers, sirens, etc.; and
- (v) Social Media, including group messaging services, were extensively used.

4.6 Communication Strategy and Drafting of Key Do's and Don'ts

- a. The communication strategy is based on insights of the local population considering the nature of the–
 - i. Messages;
 - ii. Messenger / Medium / Media; and
 - iii. Receiver.
- b. The Communication Strategy aim to promote a culture of DRR and behaviour change through mass awareness campaigns.
- c. The subject matter expert(s) carefully draft Dos and Don'ts/safety tips or techniques in consultation with the IEC expert(s). For this, IEC expert(s) use Research Methodology, Rapid Rural Appraisals and Communication Gap Analysis techniques for a better understanding of-
 - (i) Behaviour patterns or tendencies;
 - (ii) Media consumption;
 - (iii) Local trends of the vulnerable population; and
 - (iv) Available facilities like shelter and contact details.

4.7 Public Awareness, Community Outreach & IEC

Awareness campaigns were carried out based on communication strategy and research insights—Information Education Communication (IEC) activities planned at State and local levels.

A. State level:

- Carry out mass awareness campaigns in local languages;
- Develop media and communication strategies and plans considering local socio-economic and behavioural factors;

- Involve recognized artists of the State, such as folk singers, dancers, and other performers, for more substantial recall value;
- Conduct regular awareness programmes in all districts;
- Conduct regular training programmes for interpersonal communication activities.
- Mass awareness campaigns involving Print, TV, Radio, Social Media, etc.;
- A unique list of Do's and Don'ts and safety tips for weaker and vulnerable sections of society (e.g. women, children, poor, elderly and differently-abled);
- A special list of Do's and Don'ts for animal and livestock safety;
- Encourage line departments of the State Government and local authorities to disseminate Do's and Don'ts widely.

B. Local level:

Due to their proximity to the affected population, the local authorities are in the best position to ensure the last-mile delivery of messages. They may –

- Conduct regular inter-personal communication activities;
- Demonstrate the safety tips to the vulnerable population in their local language, using local customs, cultural aspects and behaviour patterns; Local artists and art forms may be utilized for entertainment-based education programmes; Extensive use of IEC tools and materials (such as flyers, calendars, comic books, etc.) made available for people for reference;
- Strengthen and involve local communities such as RWAs, Municipal bodies, NGOs, Panchayati Raj Institutions, *Anganwadis*, *Gram sabhas*, Medical professionals and other local bodies;
- Give particular emphasis to dissemination in "closed homogeneous groups" such as schools, colleges, offices, cinemas, etc.
- Carry out Out-of-Home campaigns using banners, posters, billboards, etc.
- Carry out special awareness programmes for the differently abled.

CHAPTER-V

LIGHTNING DATA ANALYSIS KARNATAKA

CHAPTER 5: LIGHTNING DATA ANALYSIS - KARNATAKA

Understanding the vulnerability, occurrence, frequency, and period of lightning events over the year is essential for better planning, awareness and mitigation programs.

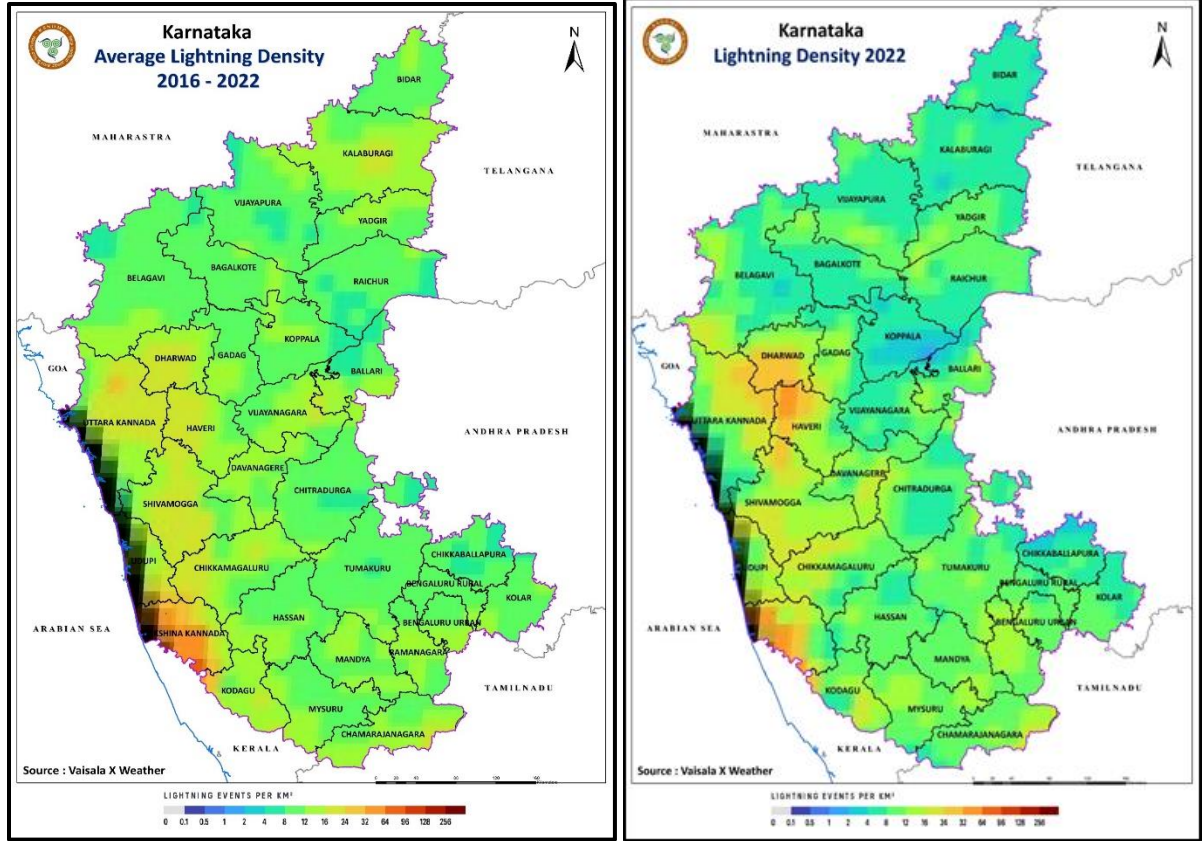
This chapter comprises the lightning events analysis for the last 3 years (2020 - 2022). District-wise comparison of lightning events for the different years and seasons presented graphically. Day-wise comparison of lightning events for 2022 compared to its average is also presented graphically; the top ten highest events that occurred on the date and the top ten districts' highest lightning events observed are identified and presented in Tables 5 & 6.

5.1. Spatial Lightning Density:

Spatial Lightning Density

A private global company of weather, environmental & industrial measurement products and Services Company called VAISALA, which has a global observational network of Lightning & thunderstorms, released a report on lightning density in 2022. It is indicated that the spatially average lightning density per Kilometer Meter square ranges spatially from 1 to 150 events over the State from 2016 to 2022. Lightning density is higher in the Dakshina Kannada, Shivamogga, Uttara Kannada and Kalaburgi districts. Lightning Density for 2022 ranges from 1 to 200 per Kilometer Meter square over the State (Fig 11 a & b). The highest number of lightning events is from 100 to 200 over the Dakshina Kannada, Haveri, Uttara Kannada and Dharwad districts in the State.

According to the annual lightning report 2021-22 by CROPC indicated; the increase in Lightning strikes C-G percentage rise for Karnataka state is 68.74 %, which stands third highest in the Country. It stipulates the importance of creating more awareness, mitigation trials and early warning dissemination to the exposed communities on high priority in the State.



(a)

(b)

Fig 11:– Average Lightning Density (a) & Lightning Density (b) over Karnataka (2016 - 2022)
(Source: Vaisala - 2023)

5.2. District-wise observed Lightning events for the last 3 years (2020 - 2022):

District-wise lightning events details for all the seasons and annually are given in Fig- 13. The Figures show that more lightning events were observed during 2021 compared to the other two years. Dakshina Kannada, Belagavi and Kalaburagi districts are observed a Maximum number of lightning events for all the seasons and annually.

Day-wise observed lightning events for 2022 and the last three years averages are given in Fig- 18. Lightning events in 2022 are high compared to 3 years average for a few districts and days, as indicated in Fig – 18.

5.3. Top ten date's highest lightning events observed – 2022:

The highest number of 3,070 lightning events were observed in one day on 4th May – 2022.

The top ten observed lightning events with observed dates are given in Table - 5

5.4. Top ten highest lightning events observed in districts during 2022:

Tumakuru, Belagavi, Kalaburagi, Vijayapura, Bellary, Dakshina Kannada, Raichur, Dharwad, Yadgir and Chitradurga districts.

5.5. Top ten highest lightning events observed in districts during 2020 – 2022:

Belagavi, Dakshina Kannada, Kalaburagi, Tumakuru, Chikkamagaluru, Shivamogga, Bellary, Vijayapura, Hassan and Chitradurga as given in Table – 6.

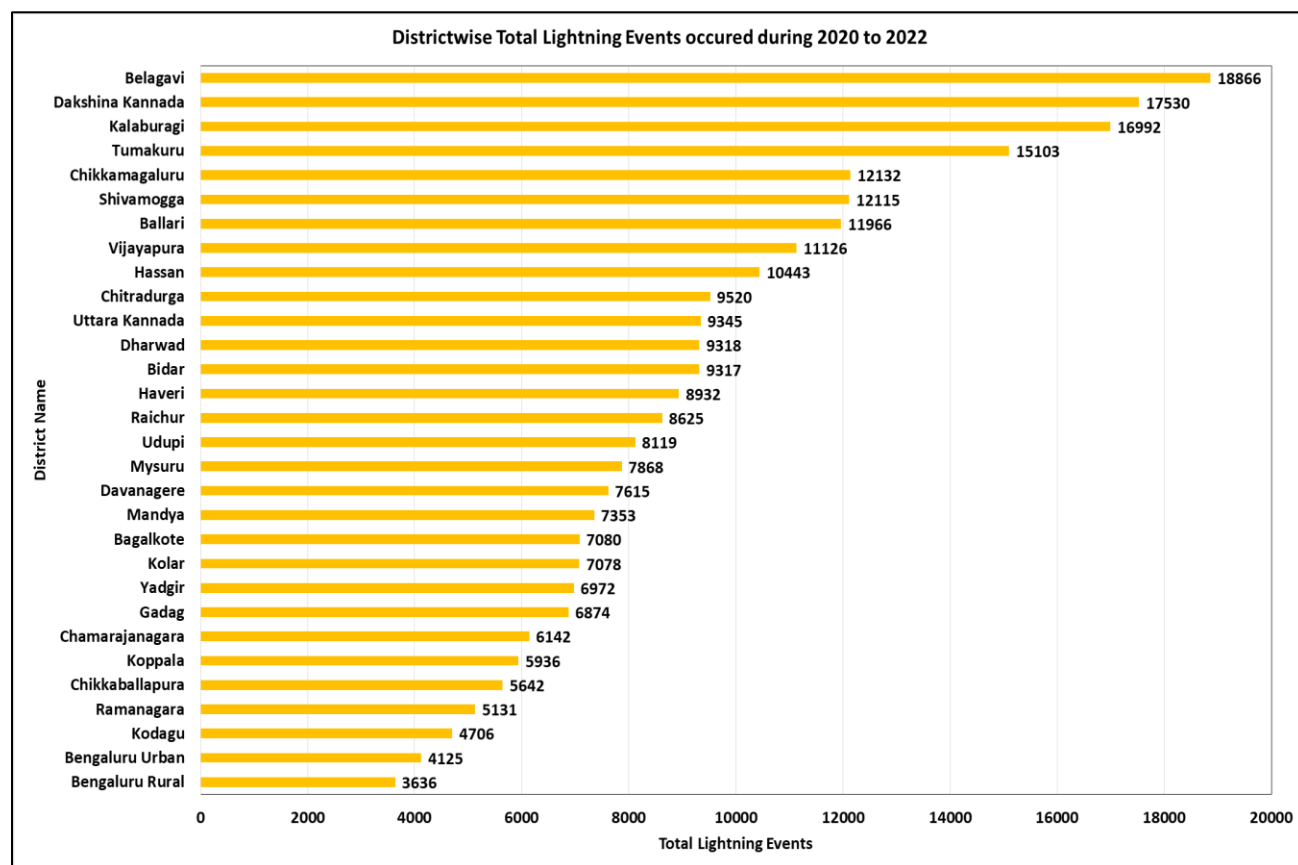


Fig 12: District-wise observed lightning events from 2020 to 2022

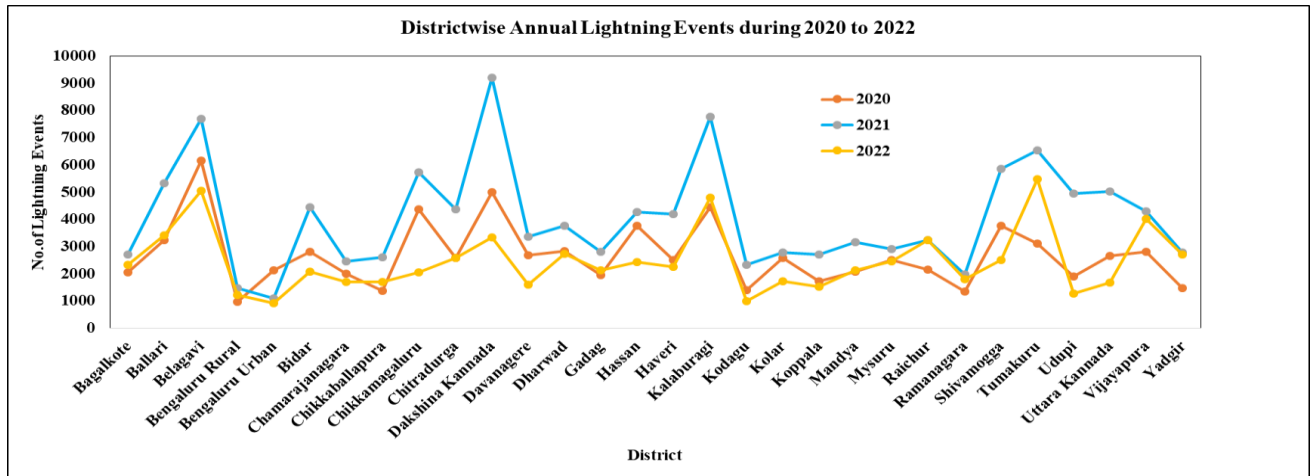


Fig 13: Annual district-wise observed lightning events (2020 - 2022)

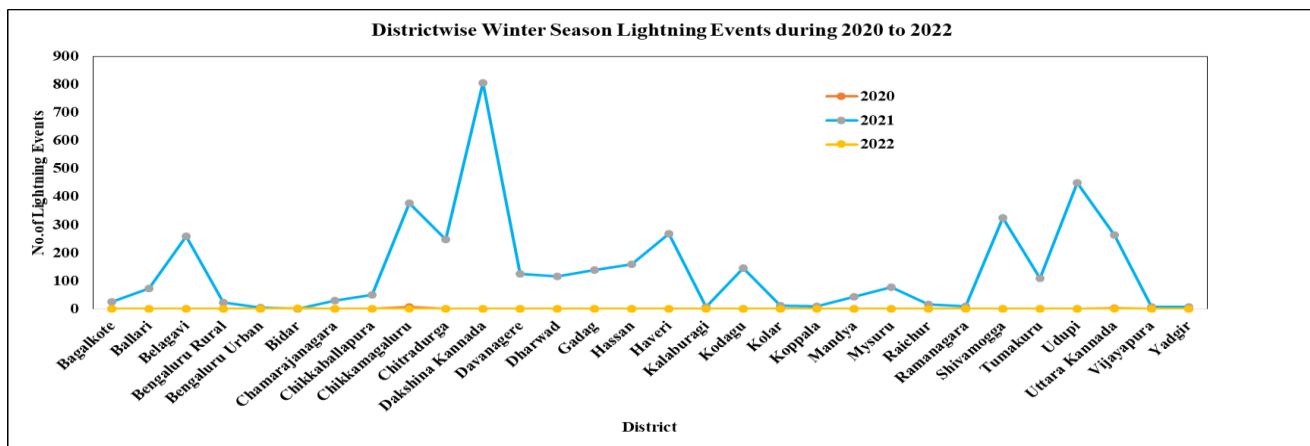


Fig 14: Winter (Jan - Feb) season district-wise observed lightning events (2020 - 2022)

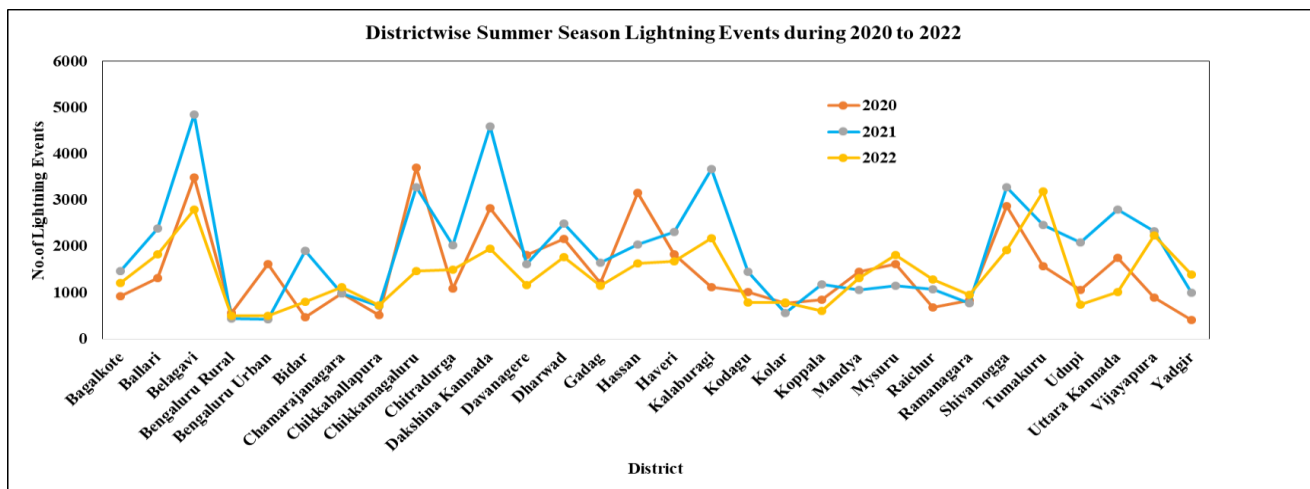


Fig 15: Summer (March-May) season district-wise observed lightning C-G events (2020 - 2022)

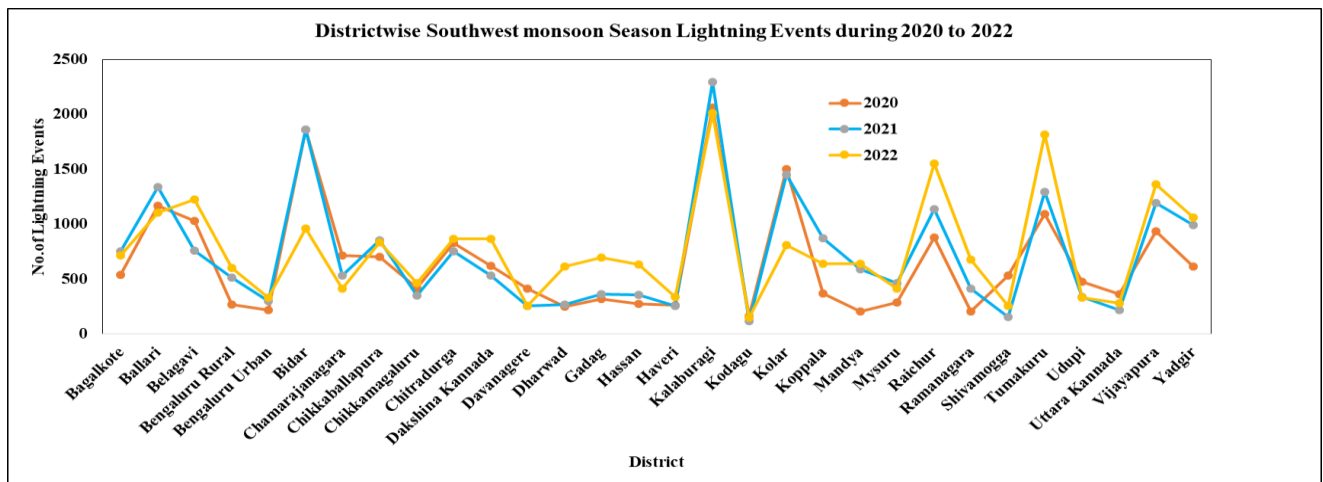


Fig 16: Southwest monsoon (June - September) season district-wise observed lightning events (2020 - 2022)

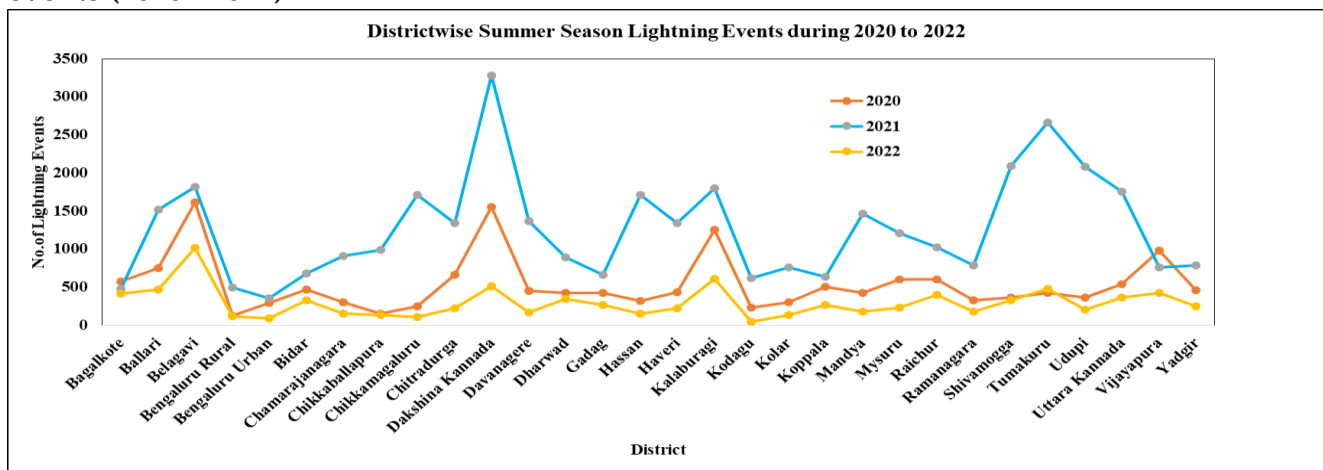


Fig 17: Northeast monsoon (October - December) season district-wise observed lightning events (2020 - 2022)

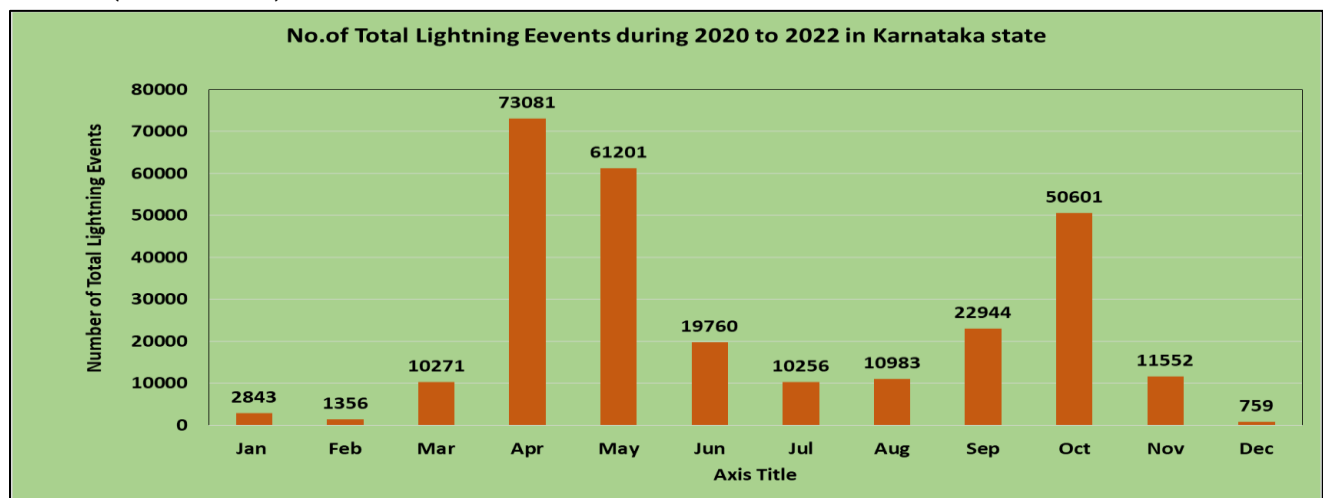


Fig 18: Month-wise total lightning events observed from 2020 to 2022

Lightning casualties in Karnataka in the last 12 years

Karnataka state ranked 8th in deaths due to Lightning in the Country (Fig 16). Based on the statistics, the number of casualties caused by Lightning is higher among men than women. The higher death rate among men is due to their presence in vulnerable situations, such as working in open fields or walking in unprotected terrain in pursuit of livelihood activities. Most men are income earners, and their deaths significantly impact their families. These deaths increase the number of single-parent or female-headed households that are often vulnerable to other risks affecting their communities. This is a significant socio-economic impact on distressed families in rural areas.

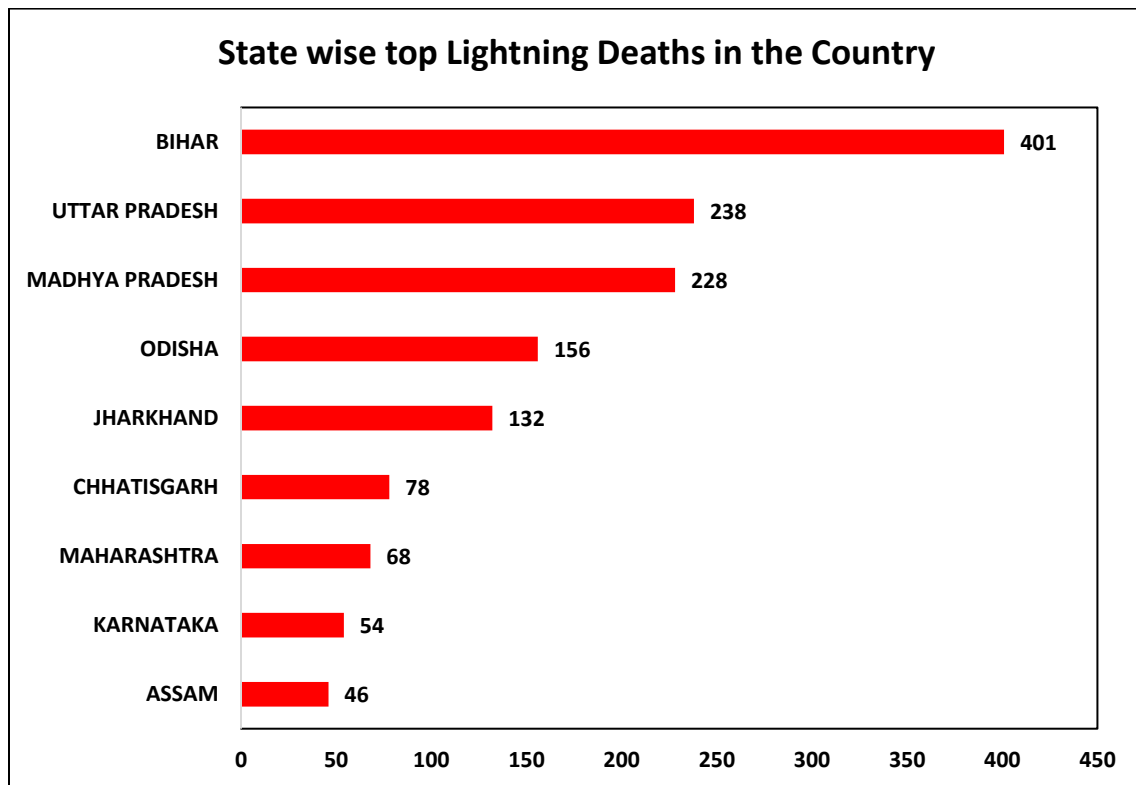


Fig-16: Karnataka State stands 8th out of the 16 States in Lightning deaths. (Source: Annual lightning report 2020 - 21, CROPC)

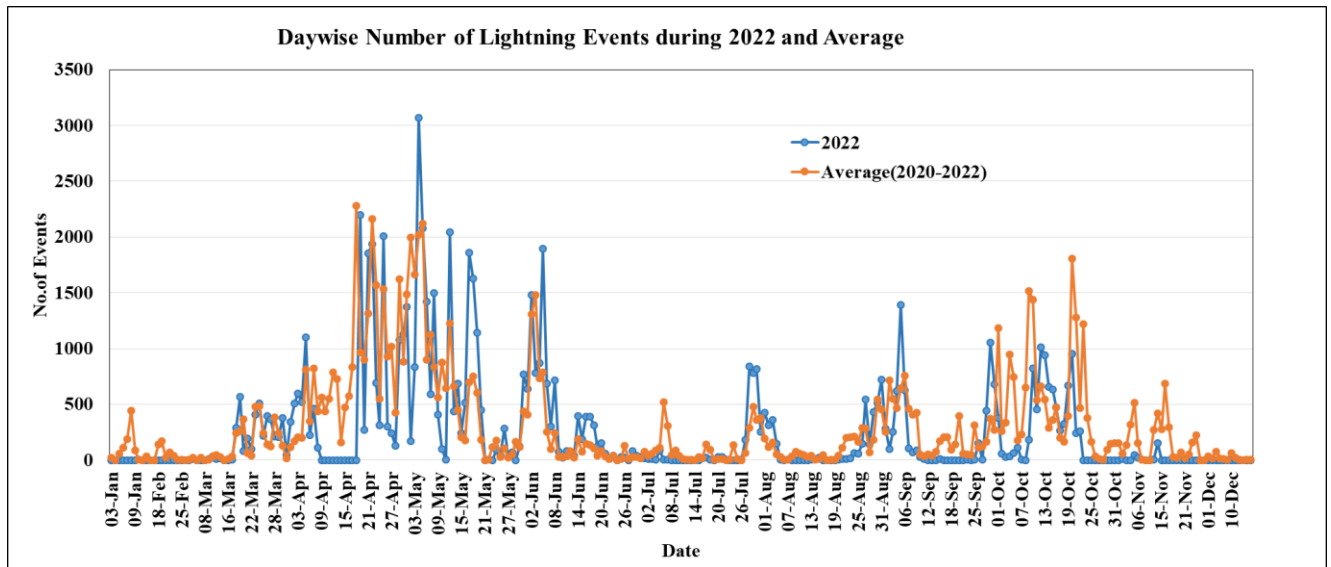


Fig 19: Day wise Lightning observed lightning events (2020 - 2022)

Top Maximum Number of Lightning Events in 2022	Date
3070	04-May
2195	19-Apr
2077	05-May
2043	12-May
2007	25-Apr
1939	22-Apr
1898	05-Jun
1861	17-May
1854	21-Apr
1628	18-May

Table 5: Top Ten Lightning observed dates during 2022 over the State

District-wise Annual Lightning Events (2020 - 2022)					
S. No	District	2020	2021	2022	Total
1	Belagavi	6142	7688	5036	18866
2	Dakshina Kannada	5004	9202	3324	17530
3	Kalaburagi	4431	7765	4796	16992
4	Tumakuru	3094	6528	5481	15103
5	Chikkamagaluru	4372	5722	2038	12132
6	Shivamogga	3768	5842	2505	12115
7	Bellary	3236	5317	3413	11966
8	Vijayapura	2809	4293	4024	11126
9	Hassan	3749	4266	2428	10443
10	Chitradurga	2575	4365	2580	9520
11	Uttara Kannada	2652	5032	1661	9345
12	Dharwad	2833	3762	2723	9318
13	Bidar	2794	4440	2083	9317
14	Haveri	2512	4178	2242	8932
15	Raichur	2152	3243	3230	8625
16	Udupi	1892	4948	1279	8119
17	Mysuru	2511	2896	2461	7868
18	Davanagere	2668	3358	1589	7615
19	Mandya	2075	3148	2130	7353
20	Bagalkote	2038	2707	2335	7080
21	Kolar	2566	2783	1729	7078
22	Yadgir	1481	2780	2711	6972
23	Gadag	1957	2805	2112	6874
24	Chamarajanagara	2004	2453	1685	6142
25	Koppala	1719	2700	1517	5936
26	Chikkaballapura	1362	2593	1687	5642
27	Ramanagara	1354	1972	1805	5131
28	Kodagu	1397	2327	982	4706
29	Bengaluru Urban	2126	1087	912	4125
30	Bengaluru Rural	953	1472	1211	3636
TOTAL		80226	121672	73709	275607

Table 6: District-wise Lightning events (2020 - 2022)

The above analysis shows that lightning events mainly occur during the Pre-Monsoon & North East Monsoon. Lightning events are lesser in the year 2022 compared to the last year.

CHAPTER-VI

PREVENTION, MITIGATION AND PREPAREDNESS MEASURES

CHAPTER 6: PREVENTION, MITIGATION AND PREPAREDNESS MEASURES

6.1. Preventive Measures

Disaster prevention covers measures aimed at impeding the occurrence of a disaster incident and/or preventing such an occurrence from affecting communities. The occurrence of thunderstorms and squalls can't be impeded. However, their harmful effects can be minimized through several measures.

- a) **Hazard and Vulnerability Assessment:** Micro-level hazard zoning and vulnerable areas are marked on a map. The extent of vulnerability (mild, moderate or intensive) and the probable cost of damages to crops due to incidents of varying intensities must be included in the assessment report. Concerning a disaster, the risk is described using relative terms such as High Risk, Average Risk and Low Risk to indicate the degree of probability of the occurrence of the incident. The risk assessment includes an evaluation of all elements that are relevant to the understanding of the existing hazards and their effects on a specific environment. Risk assessment involves several steps based on the related hazard mapping vulnerability analysis processes. They establish the nature, location and scale of risks to society and its assets. This information will assist decision-makers in deciding what can and should be protected and up to which level.
- b) **Sensitization of Disaster Managers, Planners and Decision Makers:** Sensitization of planners and decision-makers can immensely help minimize the harmful effects of these incidents on communities. The first and foremost need is awareness generation among policymakers, administrators, engineers, architects, the general public, and the farming community.
- c) **Awareness generation among the masses:** Public awareness and education help improve the masses' disaster resilience.

6.2. Mitigation and Preparedness Measures

The lessons learnt from previous incidents, particularly regarding gaps in rescue and relief works and the shortcomings experienced in the process, should be dealt with carefully. Disruption of communication and transportation services and undue delays in clearing the fallen trees, electricity poles and hoardings on the roads and/or streets that further delay the immediate transportation of the injured to nearby hospitals remains a significant challenge. The hierarchical structure for execution must be formalized to coordinate all efforts properly. Coordination for relief distribution is equally important to ensure qualitative and timely delivery; the lack of which may lead to duplication of efforts at some locations while leaving others completely starved.

- a. **Enhanced understanding of preparedness and mitigation measures** will help us minimize the losses due to thunderstorms/squalls, etc.
- b. **Hazard Resistant Construction:** United Nations Development Programme (UNDP) and NDMA, Ministry of Home Affairs, Government of India, released a “Manual on Hazard Resistant Construction in India” for non-engineered buildings in July 2008. The popular load-bearing masonry building systems prevalent in different parts of the Country are covered in the manual. Relevant building codes and guidelines of the Bureau of Indian Standards form the basis for this manual. In addition, the two decades of work carried out by the authors focused on promoting suitable building technologies in different parts of the Country, the on-site training of building artisans and engineers, and the post-disaster assessments of damages in various disasters provide the backbone of this manual. It is hoped that this manual will contribute towards ensuring better structural performance in the face of potentially destructive natural hazards and thus bring safety to the people, rich and poor alike, in India.

- c. **Laying underground electricity cables and telephone lines:** These are best suited, particularly for congested townships where thunderstorms/squalls may cause the falling of electricity and telephone poles and snapping of cables.
- d. **Emergency Communication Systems:** Planning, updating and mobilizing existing radio communication resources in emergencies and acquiring satellite phones to make them available at the tehsil level to ensure prompt response during disasters.
- e. **Integrating Development schemes with Disaster Management Schemes:** This would enable the creation of disaster-resilient localities through recommendations by gram pradhan/ gram adhyaksharu that quality raw materials and technology be used in all infrastructure/ construction projects.
- f. **Technical, Social, Organizational and Administrative preparedness:** The most urgent need of the hour is to develop a DSS (Decision Support System) for thunderstorm nowcast, which is currently being done using the existing network of Lightning Detection Network installed by KSNDMC and its observations, radars, satellites and lightning data. To accomplish this, the DWR and lightning network could be expanded over all thunderstorm-prone areas across the Country. The information thus obtained could be merged with satellite observation to generate meaningful insights for different regions with a lead time of 1-2 hours. The nowcast alerts/warnings are accompanied by actionable Information (Do's and Don'ts) and potential impact (expected damage).

Besides SDMAs and DDMA's, a tehsil-level Disaster Management Group (TMG) at the subdivision/ tehsil level should be formed with representatives of various line departments, including Agriculture, Forest, BSNL and other telecom service providers, Electricity Board, Revenue, PWD, Health, Police and Fire Brigade. Village Disaster Management Committees (VDMCs) formed at the village level comprising local villagers. This would undoubtedly strengthen the local response mechanisms to disasters.

- g. **Emergency Plan for Hospitals and Health Centres:** Emergency expansion plan for civil hospitals, community health centres, Primary Health Centres (PHCs) and additional PHCs, including schemes for mobile medical teams for a post-disaster situation, in place. A list of Army hospitals, Govt. Hospitals (Centre and State), private hospitals and nursing homes in each district should be prepared. Phone numbers of all these medical facilities should be available in the District Control Room and the SEOC. Emergency medicines, Operation Theatres and life-saving drugs should be kept ready based on the hazard assessment. Vacant doctors and paramedical staff posts should be filled in all government hospitals to make available the required number of medical workers during an emergency. An Action Plan is considered to train doctors and paramedical staff on handling patient inflow and treating them in case of a disaster.
- h. **Focusing on Research and Establishing a Forecasting Centre for Thunderstorms and Squalls:** Conduct hazard zonation and vulnerability analysis for thunderstorms and squalls using the available lightning data at KSNDMC in Coordination with State-level knowledge institutions.
- i. **Making Disaster Risk Reduction (DRR) a part of school and college curriculum:** Youth and children can be taught about extreme weather incidents and the Do's and Don'ts to be followed before, during and after a disaster. They act as change agents and increase awareness in the neighbourhood and society.

6.3. Structural Mitigation Measures

The most effective structural measures against thunderstorms, Lightning, squall and strong winds are meant to protect against firm high-speed winds and the electric discharge from a lightning strike.

(a) Protection against Strong Winds

Strong winds can reach more than 200 km/hr velocities during cyclonic conditions. Cyclonic winds are also associated with pressure differentials that can cause a huge pressure difference between the outside and the inside of a building resulting in a higher net effect of the wind storm. These high-velocity winds can cause severe damage to structural and non-structural systems such as claddings. Since the arrival of cyclonic storms is accompanied by suitable warnings, people are expected not to be found outdoors during a cyclonic storm. People are, therefore, safe against the most harmful effects of the high wind velocity provided they are inside cyclone shelters or other well-constructed buildings.

During strong winds associated with thunderstorms or squalls, the wind velocity is high but rarely reaches cyclonic levels. Typical wind speeds during thunderstorms are in the range of 50- 80 km/hr. During severe thunderstorms, the wind speeds may reach around 100 km/hr. The wind velocity is highest in storms associated with extensive lightning activities.

Structures do not require any special protection against storms with wind speeds up to 100 km/hr if designed and constructed as per approved standards. Buildings that are constructed informally or those which are made using non-engineered materials may not be able to resist wind forces. These may get damaged even at low wind speeds unless special protection mechanisms are adopted. Components that provide ample areas for applying wind forces are the first to be damaged. They can become loose and pose a threat to humans as flying debris. In buildings that use lightweight sheets for roofing, the panels may collapse on occupants.

Properly securing them with their supporting frames can protect against lightweight panels under such wind speeds. The connection has to ensure that shearing or punching is avoided. Also, it has to be ensured that the panels themselves have the requisite strength to withstand

the wind force. The supporting frames also need adequate strength to transfer the forces imposed on them safely.

(b) Protection against Lightning – Lightning Shields

Installation of lightning arresters and sound earthing for each building is essential. Lightning shields are the most commonly employed structural protection measure for buildings and other structures. A lightning shield involves installing a lightning conductor at a suitably high location at the top of the structure. The conductor is grounded using a metal strip of suitable conductance. The grounding of the conductor is also specially designed to ensure rapid dissipation of the electrical charge of a lightning strike into the ground.

Lightning shields are not foolproof in their effectiveness. The ability of lightning shields to complete the cloud-to-ground circuit depends on several variables, such as the height of the conductor and the shape and size of adjoining structures or natural conductors. The cone of protection is also highly variable, and the angle of the protective cone decreases with the height of the shield's conductor. Very tall buildings may require lightning conductors at intermediate levels of the building and the ones on its roof.

Internationally, lightning shields are not used to protect open areas such as agricultural fields due to their high cost and reliability issues. However, they are very effective for protecting individual structures or groups of structures in an area.

6.4. Action – Before, During and After

(a) Before Thunderstorms and Lightning

To prepare for a thunderstorm, you should do the following:

- I. Remember that vivid and frequent Lightning indicates the probability of a strong thunderstorm.

- II. Build an emergency kit and make a family communication plan.
- III. Remove dead or rotting trees and branches that could fall and cause injury or damage during a severe thunderstorm.
- IV. Postpone outdoor activities.
- V. Remember the 30/30 Lightning Safety Rule: Go indoors if, after seeing Lightning, you cannot count to 30 before hearing thunder. Stay indoors for 30 minutes after hearing the last clap of thunder.
- VI. Secure outdoor objects that could blow away or cause damage.
- VII. Get inside a home, building, or hard-top automobile (not a convertible). Although you may be injured if Lightning strikes your car, you are much safer inside a vehicle than outside.
- VIII. Remember, rubber-soled shoes and rubber tyres do not protect against Lightning. However, the steel frame of a hard-topped vehicle provides increased protection if you are not touching metal.
- IX. Unplug appliances and other electrical items such as computers and turn off air conditioners. Power surges from Lightning can cause severe damage.
- X. Shutter windows and secure outside doors. If shutters are not available, close window blinds, shades or curtains.
- XI. Unplug any electronic equipment well before the storm arrives.

(b) Before/During a Hailstorm

- I. Farmers are advised to use hail nets for orchard crops to protect them from mechanical damage.
- II. Support banana crops, young fruit plants and cropping up in sugarcane crop/staking of vegetables to prevent the crops from lodging.
- III. Keep harvested produces in a safe place.

- IV. Keep cattle/goats indoors during a hailstorm.

(c) During Thunderstorms and Lightning

If thunderstorms and Lightning are occurring in your area, you should:

- I. Use your battery-operated radio/TV for updates from local officials.
- II. Avoid contact with corded phones and devices, including those plugged in for recharging.
- III. Cordless and wireless phones not connected to wall outlets are OK to use.
- IV. Avoid contact with electrical equipment or cords.
- V. Avoid contact with plumbing or pipes. Do not wash your hands, do not take a shower, do not wash dishes, and do not do laundry. Plumbing and bathroom fixtures can conduct electricity.
- VI. Stay away from windows and doors, and stay off porches.
- VII. Do not lie on concrete floors or lean against concrete walls.
- VIII. Avoid natural lightning rods such as tall, isolated trees in an open area.
- IX. Avoid hilltops, open fields, the beach or a boat on the water.
- X. Take shelter in a sturdy building. Avoid isolated sheds or other small structures in open areas.
- XI. Avoid contact with anything metal - tractors, farm equipment, motorcycles, golf carts, golf clubs, and bicycles.
- XII. If you are driving, try to exit the roadway and park safely. Stay in the vehicle and turn on the emergency flashers until the heavy rain ends. Avoid touching metal or other surfaces that conduct electricity in and outside the vehicle.

(d) After Lightning strikes a human being

Call for medical assistance immediately if Lightning strikes you or someone you know. You should check the following when you attempt to give aid to a victim of Lightning:

- I. Breathing – If breathing has stopped, begin mouth-to-mouth resuscitation.
- II. Heartbeat – If the heart has stopped, administer Cardiopulmonary Resuscitation (CPR).
- III. Pulse – If the victim has a pulse and is breathing, look for other possible injuries. Check for burns where the Lightning entered and left the body. Also, be alert for nervous system damage, broken bones and loss of hearing and eyesight.

CHAPTER-VII

CAPACITY BUILDING

CHAPTER 7: CAPACITY BUILDING

7.1 TLSD/HSW Education

To emphasize greater awareness by making TLSD/HSW education a part of educational curricula, covering all the relevant aspects. This would foster a culture of prevention, mitigation and preparedness, as well as effective and rapid response, relief, rehabilitation and recovery. Case studies of previous major incidents may be valuable inputs in the process.

Development of high-quality Information, Education and Communication (IEC) materials, textbooks and field training, including specially designed material for women, the elderly and the differently abled. The State governments/ SDMAAs will encourage their school boards to develop similar content in their curricula.

7.2 Target Groups for Capacity Building

The target groups for capacity building include elected representatives, Government officials concerned with DM functions, media professionals, urban planners, development experts, engineers, architects and builders, NGOs, community-based organizations (CBOs), social activists, social scientists, youth organizations such as National Cadet Corps (NCC), National Service Scheme (NSS), Nehru Yuva Kendra Sangathan (NYKS), Raitha Samparka Kendras (RSK), School Teachers, Anganwadi, Aasha workers and School Children. Besides, the capacity of police personnel, Civil Defense, Home Guards and the SDRFs should also be strengthened. The general public should be aware of the need to keep an emergency kit containing medicines, a torch, identity cards, ration cards and non-perishable food, such as dry fruits, roasted grams, etc., ready. They should also be trained in making and using improvised rescue tools with household articles. The NDRF, the SDRF and the Civil Defense, in Coordination with State government/SDMA/DDMAAs, will conduct these training programmes.

7.3 Capacity Building of Professionals

The KSNDMC will, in consultation with reputed knowledge institutions like the Indian Institutes of Technology (IITs), National Institutes of Technology (NITs) and Indian Institute of Tropical Meteorology (IITM), etc., develop comprehensive programmes and a State level plan for creating a group of mentors from among trained faculty members of engineering and architecture colleges as also from among professionals in the relevant fields. KSDMA/KSNDMC will help identify these potential trainers for introductory, intermediate and advanced training programmes. These training programmes will be pilot tested, evaluated, continuously upgraded based on assessment participant assessment and feedback, documented, and peer-reviewed.

7.4 Training

At the State level, the KSDMA /KSNDMC and Administrative Training Institutes (ATIs) will organize training of elected representatives and administrative personnel from all concerned line State governments departments.

The KSDMA/ KSNDMC will evolve Action Plans and a National Strategy, in association with the ATIs and other technical institutions, to develop comprehensive curricula in the form of training modules for various target groups and initiate the design, development and delivery of the same at the earliest.

7.5 Research and Development

The State government will proactively develop application-oriented research and developmental activities to address contemporary challenges, generate solutions, and develop new techniques to improve resilience against TLS/HSW.

The KSDMA/KSNDMC will arrange for systematic data collection and incorporation into its data bank with an efficient retrieval system. It will encourage the development of standardized methods for TLSD/HSW risk assessment and scenario development. The KSDMA to take up pilot projects in risk assessment and scenario analysis and publish peer-reviewed reports.

The KSNDMC/KSDMA will seek the necessary assistance from the central institutes. The State government will encourage and assist subject matter specialists from academia and industry to prepare technical documents on the concepts of the behaviour of these extreme weather incidents. Fine-tuning the technical specifications for making new and old buildings and structures TLSD/HSW resilient will be a priority. The implementation of these guidelines requires participation from a broad spectrum of professionals. The State and technical institutions like the IITs, NITs and other professional bodies will create and maintain a directory of professionals in India who have experience in related fields, architecture and engineering and also those who are interested in contributing to the national efforts towards improving our resilience for ensuring TLSD/HSW safety in India.

During 2022, KSNDMC has made MoU with the National Centre for Medium-Range Weather Forecasting Centre (NCMRWF), Ministry of Earth Sciences (MoES) - New Delhi, Government of India, with a scope of having high-resolution dynamical weather model downscaling upto 3 days over Karnataka and also Numerical Weather Prediction (NWP) products with one of the main objective in providing the predictions of Thunderstorms & Lightning along with other extreme weather weathers like Heavy rainfall events & urban flooding for the State.

CHAPTER-VIII

ROLES AND RESPONSIBILITY

CHAPTER 8: ROLES AND RESPONSIBILITY

All the stakeholder Departments and agencies are working under a unified command to ensure the effective implementation of prevention, preparedness and mitigation measures.

The Chief of Operations (Chief Secretary) will define the priorities and issue policy guidelines. The Relief Commissioner will coordinate the services of various stakeholders, including national/State and central government agencies.

The SEOC is the nerve centre to support, coordinate and monitor disaster management activities at the State level, including training and research. It will, under normal circumstances, work under the supervision of the Relief Commissioner. During an emergency, it will work as the centre for decision-making as long as the need for emergency relief operations continues or until the long-term plans for rehabilitation are finalized. Respective line departments will manage long-term rehabilitation programmes.

The system and procedures of a SEOC are designed for the rapid dissemination of Information to all stakeholders to enable effective decision-making and quick response during an emergency.

Academic institutions such as the IITs, the private sector and NGOs also complement the Government's efforts and provide necessary inputs/assistance to the concerned Ministry/Department.

8.1 Department-specific measures to prevent lightning-related injury & casualties, and property damage.

Agriculture and Horticulture Department:

- Lightning safety awareness through Raitha Samparka Kendras through posters, skits, etc.

- Extension Officers to educate farmers on identifying early signs of Lightning and do's and don'ts during Lightning.
- Awareness of the protection of livestock. Protection of electrical equipment by installing a lightning protection system as mandated in National Building codes.
- Popularizing Sidilu and Damini Applications.
- Training field staff on lightning safety measures

Animal Husbandry Department:

- Lightning safety awareness to protect livestock. Awareness generation programs at Veterinary Hospitals, marketplaces etc.
- Karnataka Sheep and Wool Development Corporation to create awareness of Lightning among shepherds. Awareness of do's and don'ts through posters, skits and innovative methods to bring behavioural changes. Dissemination of lightning alerts within their network.
- Popularizing Sidilu and Damini Applications.
- Training field staff on lightning safety measures

Rural Development and Panchayat Raj:

- Lightning safety awareness at village levels. MGNREGA workers to be oriented on do's and don'ts during lightning strikes. Posting of posters/banners in PDO/Secretary's office, market places etc.
- Identifying villages most vulnerable to lightning strikes based on historical data in Coordination with KSNDMC. Circulation of lightning safety videos of NDMA and SDMA.
- Dissemination of lightning alerts received from IMD/KSNDMC to the vulnerable population.

- Awareness of installing lightning protection systems as mandated in National Building codes in rural areas. Ensuring all GP infrastructure is protected using a lightning protection system as mandated in NBC.
- Popularizing Sidilu and Damini Applications.
- Training field staff on lightning safety measures.
- Create a network of volunteers and NGOs to ensure Lightning Safety Programme.

Health and Family Welfare Department:

- Training of doctors and paramedics in Health Care Facilities (PHC to tertiary care) on treating lightning-related injuries.
- Awareness of do's and don'ts during Lightning. Display of posters in PHCs and CHCs on lightning protection measures.
- Training field staff on lightning safety measures.
- Ensuring all Health Care Facilities' infrastructure is protected using a lightning protection system as mandated in the NBC.

Urban Development Department:

- Conduct awareness on lightning safety through posters, videos, etc.
- Strict implementation of lightning protection system as mandated in NBC in their jurisdiction.
- Training field staff on lightning safety measures.
- Create a network of volunteers, NGOs and the Community to ensure Lightning Safety Programme.

Public Works Department:

- Strict implementation of lightning protection system as mandated in the NBC in all infrastructure projects.

- Display Lightning Do's and Don'ts posters prominently in their offices.
- Training field staff on lightning safety measures.

Energy Department:

- Strict implementation of lightning protection system as mandated in the NBC in all electrical projects.
- Awareness of protection of electrical infrastructure during Lightning.
- Training field staff on lightning safety measures.
- Lightning alerts dissemination to field staff.

Forest Department:

- Dissemination of lightning alerts received from IMD and KSNDMC. Popularize Sidilu and Damini Applications.
- Training field staff, forest dwellers and tourists on lightning safety measures.
- Create a network of volunteers, NGOs, and the community to ensure a lightning safety programme.
- Monitoring lightning-induced forest fires and quick response to extinguish a forest fire.
- Ensuring lightning protection system as mandated in the NBC in all forest infrastructure.

Housing Department:

- Ensuring lightning protection system as mandated in the NBC in all Housing infrastructure projects.
- Training field staff on lightning safety.

Revenue Department (DM) through KSNDMC:

- Identify Hotspots of Lightning based on historical data (Parameters: number of clouds to ground strike, human and livestock loss, property loss and geography).

- Development of lightning vulnerability atlas for the State.
- Dissemination of lightning alerts through CAP and DEWS. Evolve mechanism to reach out to local Revenue Officers and PDOs directly.
- The cause of each human loss and livestock to Lightning will be studied and documented. Learning from this to be incorporated in the Plan to reduce lightning causality.
- Coordinate and facilitate lightning safety programmes with concerned departments, NGOs and SHGs.

DIPR (Department of Information and Public Relations):

- Dissemination of lightning awareness and do's and don'ts during Lightning in various media.
- Creating innovative messaging on lightning safety measures through KSNDMC.

A detailed matrix laying down the roles/responsibilities of all stakeholders is given in Sections 8.2 & 8.3.

8.2 Matrix of Karnataka State Action plans for Thunderstorms & Lightning:

Thunderstorm, Lightning			
State and their Responsibilities			
Sl. No	Sub-Thematic Area for DRR	State	Responsibility
1	Understanding Risk & Documentation	KSDMA KSNDMC IMD, Bangalore	- Preparing State Action Plan and its implementation. - Prepare detailed departmental SoPs by the concerned department. - Documentation of incidents that occurred in the State of Thunderstorm, Lightning, Squall/Hailstorms & Strong Winds
2	Inter-Agency Coordination	KSNDMC	- To disseminate the Information received from KSNDMC Lightning detection Network and IMD nowcast bulletins to the public. - Promote installations of lightning arresters and Doppler Radars. - Information, Alerts and Early Warnings, Reports, Weather forecasts and related Advisories are being made available through SMS to mobile phones, e-mail, Social Media and Web Portal to all DCs, CEOs, HQAs, ACs, Tahsildars, JDs (Agri), AD's (Agri), Agri Officers, SP's, Raitha Samparka Kendras, Farmers facilitators under Bhoochethana Program, Krishi Vigyana Kendras (KVKs), Agriculture Universities, Civil Defense, Home guards, Print and Electronic Media.
		Information & Public relations	- Ensure specific messages and information dissemination to the public through print/electronic/social and other mass media at all levels. - Create a network of community-based early warning systems.
		KPTCL	- To ensure power cuts and restoration of power supply and also provide emergency power supply to critical facilities. - Activate all concerned ESCOM office/officers.
		Education department	Institutionalized multi-agency Coordination with clear roles and responsibilities.
		SDRF	Rescue and evacuation operations in Coordination with the administration, NGOs and volunteers.

Thunderstorm, Lightning			
State and their Responsibilities			
Sl. No	Sub-Thematic Area for DRR	State	Responsibility
3	Investing in DRR – Non-structural measures	PWD	• Ensure road connectivity and access to vulnerable areas.
		KPTCL	• To ensure the functional State of all electrical equipment and maintain the service or replace equipment from time to time. • Assessment of damage from weather events.
		Department of Animal Husbandry	• Treatment of animals. • Provision of vaccination. • Disposal of dead animals. • Arrange for timely care and treatment of animals during a thunderstorm.
4	Capacity Development	ATI-CDM and ANSSIRD	• Training programme for all concerned department officials/volunteers. • Conduct training programmes and drills on the usage of various protection equipment and preventive systems.
		Information and Public Relations	• Creation of public awareness. • Extensive IEC campaigns to generate public awareness through Print, Electronic and Social Media. • Ensure Push SMS by various telecom service operators to all active mobile connections.
5	Climate Change Risk Management	KSDMA	Recurring/ Continuous • Sensitization and awareness creation. • Support national CCA efforts. • Coordination with central agencies. • Sponsor and promote state-specific and local efforts for GACC mitigation and adaptation. Short-Term (T1) • Develop local adaptation strategies and pilot projects. Medium-Term (T2) • Sponsor and promote state-specific efforts and local efforts. • Implementation of GACC adaptation programs. • Integrate adaptive measures in social protection programmes for vulnerable groups.

8.3 Roles and Responsibilities Matrix for Management of Thunderstorms, Lightning, Dust/Hailstorm, Squall and Strong Winds

Thunderstorm, Lightning					
Sl. No	Tasks/Activities	State/ District agencies and their responsibilities			
		State	Responsibility	DDMA	Responsibility
Understanding Task					
1	Preparation of policy, guidelines and action plans	Revenue Department (DM)/ KSNDMA	Prepare Guidelines for preparation for State Action Plan	DDMAs consultation with concerned dept.,	. Prepare State Action Plan and ensure its implementation . Prepare detailed department-wise SOPs
Interagency Coordination					
2	Early Warning and Communication	Nodal Agency: KSNDMC & IMD with Information and Broadcasting (PIB, AIR, Doordarshan)	Issue area-specific warnings/ alerts and weather forecasts to all the concerned dept., DDMA/KPTCL/RDPR /Health/ULBs and other line dept.,	DDMAs consultation with concerned departments	. Disseminate Information received from KSNDMC and IMD to the public . Promote the Installation of lightning arresters and Doppler Radars . Create a network of community-based early warning systems

3	Relief & Response	Revenue Dept. (DM)/ KSDMA	· Coordination with concerned agencies and stakeholders with clear roles and responsibilities · Deployment of NDRF/SDRF as per requirement	DDMAs consultation with concerned departments COR (to coordinate with other concerned Departments/Agencies)	· Designate a nodal officer for emergency response · Coordination among all stakeholder agencies with clearly defined roles and responsibilities · Rescue and evacuation operations in Coordination with the administration, NGOs and volunteers · Emergency medical response · Other necessary actions
---	-------------------	---------------------------	---	---	---

Investing in DRR – Non-structural measures					
4	Prevention, Mitigation and Preparedness measures	Nodal Agency: KSDMA with other	- Inter-agency Coordination - Issue relevant advisories - Give directions to concerned	Nodal agency: DDMA's consultation with concerned departments	- Inter-agency Coordination and implementation of State directions - Implement assessment, preparedness and mitigation measures and implementing - Review and update preventive measures and procedures - Public awareness and education for early warning response - Identify vulnerable places - Follow alerts/warnings, advisories - Disseminate Do's and Don'ts for the general public and enable them to access safe places - Protect property/infrastructure and environment from damage from a fire - Ensure strict adherence to fire safety
		RDPR	Disseminate Information to the public on structural mitigation measures		
		Housing and Urban Development	Conduct drives to check the structural strength of trees, old structures, etc.		
		Department of Telecommunications	Set up alternative or emergency communication systems	DDMA's consultation with concerned departments	- Establish public information facilities. - Set up alternative or emergency communication systems
		Energy Department	- Deal with power cuts and ensure emergency power supply whenever needed - Start a drive to check and maintain/replace old electrical	DDMA's with concerned Power corporations	- Ensure early restoration of electricity supply to essential services during emergencies and restoration of electric supply at the earliest - Ensure the functional State of all electrical equipment and maintain the service or
		PWD & RDPR	Ensure road connectivity and access to vulnerable	PWD & RDPR	Ensure quick restoration of road connectivity and access to vulnerable areas

		Health & Family Welfare	• Create posts for medical staff for emergencies • Hospital preparedness, including training in human resources	DDMAs consultation with concerned departments	• Ensure appropriate medical staff and facilities at the place of incident • Strengthen health centres with a network of paramedical
		8. Department of Agriculture & Horticulture	• Ensure adherence to crop safety norms • Construction of safe crop storage shelters for farmers	DDMAs consultation with concerned departments	• Promote crop/animal insurance • Construct thunderstorm-safe crop storage shelters for farmers
		9. Forests and Environment	• Set up awareness programmes	DDMAs consultation with concerned departments	• Ensure adherence to fire safety norms • Protect
5	Record of data & Documentation	Nodal agency: Revenue department (DM)	Collect post-disaster data from districts and maintain a District-level database.	DDMAs consultation with concerned departments	• assessment of damage from weather-related incidents • Collect post-disaster data from the field and report to State/national level

Investing in DRR – Structural measures					
6	Structural Mitigation Measures	Nodal Agency: - PWD/ RDPR/ Energy/ Road Transport -	- Inter-agency Coordination and review and update preventive measures and procedures to be followed - Develop and update relevant Indian standards - Comply with Building Bye Laws while installing conductors /arresters atop buildings - Promote the installation of lightning arresters - Start a drive to check the structural strength of hoardings and similar old structures - Start a drive for sample	DDMAs consultation with concerned departments	- Inter-agency Coordination and review and update preventive measures and procedures to be followed - Ensure Building Bye Laws are complied with and make it mandatory for all G+2 and above buildings to install lightning conductors /arresters - Promote installation of lightning conductors/arresters in schools, industries, Government and private buildings - Undertaken drives to check the structural strength of hoardings and old structures
Capacity Development					
7	Capacity Building and Training	Nodal agency: KSDMA/ATI/KSN DMC/ Fire & Emergency	Training programmes for all concerned functionaries/stakeholders	Nodal agency: DDMA, ATI, Fire and Emergency	- Conduct a training programme for all concerned officials/ volunteers - Conduct training programmes and drills on the usage of various fire protection
8	Mass awareness campaigns and IEC activities	Nodal agency: KSDMA and Information Dept.,	- Extensive IEC campaigns to generate awareness through print, electronic and social media - Push SMS by various telecom service operators to all active mobile connections	Nodal agency: DDMAs	- Extensive IEC campaigns to generate public awareness through print, electronic and social media - Ensure Push SMS by various telecom service operators to all active mobile connections

THUNDERSTORM & LIGHTNING: DO'S AND DON'TS

If at home or work

Preparation

- Look for darkening skies and increased wind.
- If you hear thunder, you are close enough to be struck by Lightning.
- Keep monitoring local media for updates and warning instructions.
- Stay indoors and avoid travel if possible.
- Close windows and doors, and secure objects outside your home (e.g. furniture, bins, etc.).
- Ensure that children and animals are inside.
- Unplug unnecessary electrical appliances (to isolate them from the main power supply, which may conduct a power surge during a lightning storm).
- Remove tree timber or any other debris that may cause a flying accident.

Response

- Avoid bathing or showering, and stay away from running water. This is because Lightning can travel along metal pipes.
- Keep away from doors, windows, fireplaces, stoves, bathtubs, or other electrical conductors.
- Avoid using corded phones and other electrical equipment that can conduct Lightning.
-

If Outdoor

Response

- Go to a safe shelter immediately – avoid metal structures and constructions with metal sheeting.
- Ideally, find shelter in a low-lying area and ensure the chosen spot is not likely to flood.
- Crouch down with your feet together and head down to make yourself a smaller target.
- Hair standing up on the back of your neck could indicate that Lightning is imminent.
- Do not lie flat on the ground; this will make a bigger target.
- Keep away from all utility lines (phone, power, etc.), metal fences, trees, and hilltops.
- Do not take shelter under trees as these conduct electricity.
- Rubber-soled shoes and car tyres do not offer protection from Lightning.

If travelling

Response

- Get off bicycles, motorcycles or farm vehicles that may attract Lightning.
- Get to a safe shelter.
- If boating or swimming, get to land as quickly as possible and take shelter.
- During a storm, remain in your vehicle until help arrives or the storm has passed (the metal roof will protect if you are not touching metal inside); windows should be up; park away from trees and power lines.

Treatment

- Take the person who is struck by Lightning to a hospital.
- If possible, give basic First Aid.
- People struck by Lightning carry no electrical charge and can be handled safely.
- Check for broken bones, loss of hearing and eyesight.
- A victim of a lightning strike can suffer varying degrees of burn. Check the impact point and where the electricity left the body for injury marks.



**What will you do ?
when lightning strikes ?**

When you are Indoors

-  Unplug all electrical equipment before the storm arrives. Don't use corded telephones
- Stay away from window and doors and stay off verandas 
-  Don't touch plumbing and metal pipes. Do not use running water

When you are Outdoors

-  Don't take shelter near/under trees. Spread out; don't stand in a crowd
- Get inside a home, building. Stay away from structures with tin roofs/ metal sheeting 
-  Don't use metallic objects; stay away from power/telephone lines
- Get out of water - pools, lakes, small boats on water bodies 
-  If caught under open sky, crouch. Don't lie down or place your hands on the ground
- Stay put if you are inside a car/bus/ covered vehicle 

What to do after a Lightning Strikes

-  Administer CPR (Cardio Pulmonary Resuscitation), if needed. Seek medical attention immediately.

**Be Smart
Be Prepared !**

 **National Disaster Management Authority**
Government of India 

Caught in a storm outside ? Crouch to Survive a Lightning strike

Lightning likes to strike the tallest object around. Get as low as you can.

Do not lie down. This increases your surface area and chances of getting struck. Also, the electric current can move along the ground surface after striking at a point.

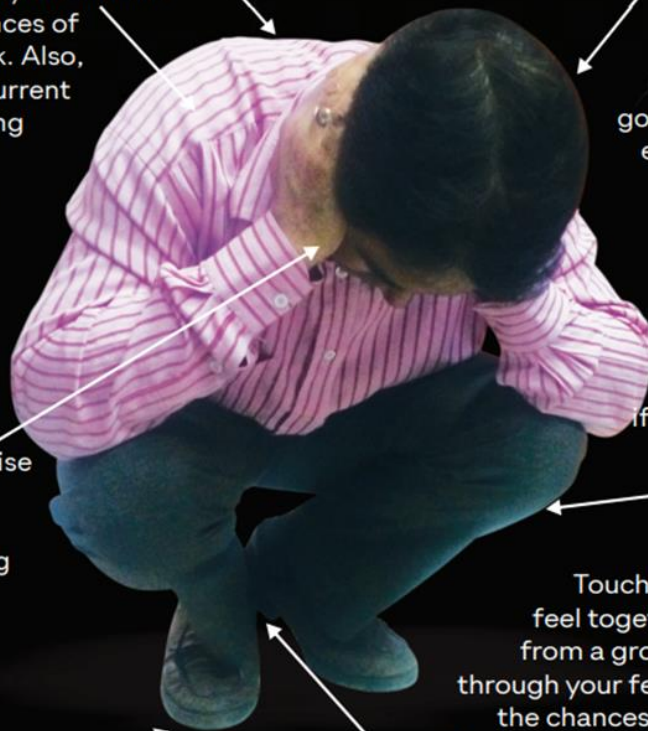
Put your hands over ears to minimise hearing loss from the accompanying thunder.

The only thing touching the ground should be the balls of your feet. Lesser your contact with the ground, lesser are the chances of current entering your body.

If your hair begins to stand on end or your skin starts to tingle, a lightning strike is imminent. However, lightning may strike without this warning.

Do not touch good conductors of electricity such as metals, metallic pipes, electrical systems, TV, wires, cables, water, etc. as it can give you an electric shock if lightning strikes.

Touch the heels of your feet together. If electricity from a ground strike enters through your feet, this increases the chances of the electricity going in one foot and out the other, rather than into the rest of your body.





Dos & Donts of Lightning





If at Home or Work- Preparation

Look for darkening skies and increased wind;

If you hear thunder then you are close enough to be struck by lightning



If at Home or Work- Preparation

Keep on monitoring local media for updates and warnings



During Lightning





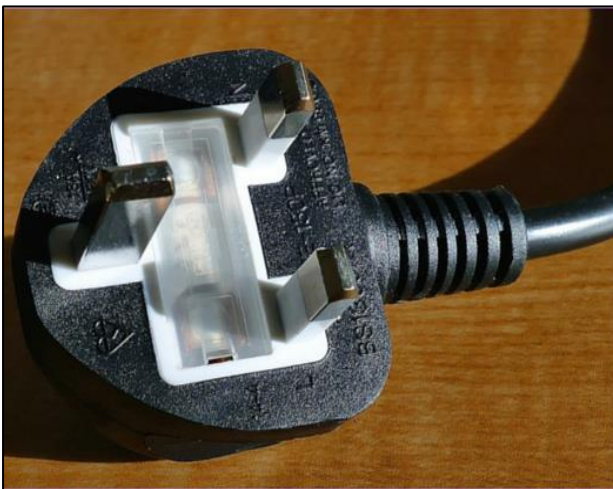
If at Home or Work- Preparation

Stay indoors and avoid travel if possible



If at Home or Work- Preparation

**Ensure that children
and animals are inside**



If at Home or Work- Preparation

**Unplug unnecessary electrical
appliances
(to isolate them from the
main power supply which may
conduct a power surge during
a lightning storm)**



If at Home - Response

**Avoid taking a bath or shower
or running water for any
purpose;**

**This is because lightning
can travel along pipes**



If at Home - Response

**Keep away from doors,
windows, fire places,
stoves, bath-tubs, or any
other electrical charge
conductors**



If at Home - Response

**Avoid using corded phones
and other electrical
equipment (mobile or
cordless phones are safe)**



If on Foot - Response

**Go to safe shelter
immediately - avoid metal
structures and or
constructions with
metal sheeting**



If on Foot - Response

Crouch down with feet together and head down to make yourself a smaller target



If on Foot - Response

Ideally find shelter in a low lying area and make sure that the spot chosen is not likely to flood



If on Foot - Response

Hairs standing up on the back of your neck could indicate that a lightning is imminent



If on Foot - Response

Do not lie flat on the ground; this will make a bigger target



If on Foot - Response

Keep away from all utility lines (phone, power, etc., metal fences, trees, and hill tops).



If on Foot - Response

Do not shelter under trees as these conduct electricity