



Karnataka State Disaster Management Authority

Revenue Department (Disaster Management)

Government of Karnataka



Karnataka State Thunderstorm & Lightning Action Plan - 2025-26



Karnataka State Thunderstorm & Lightning Action Plan - 2025-26

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

CONTENTS

CONTENTS

CHAPTER 1: INTRODUCTION.....	3
1.1. Definitions & Classification of Thunderstorms and associated weather phenomena.7	
A. Thunderstorms.....	7
B. Squall.....	8
C. Hailstorm.....	8
D. Lightning.....	9
CHAPTER 2: THUNDERSTORMS & LIGHTNING VULNERABILITY - KARNATAKA.....	11
2.1. Lightning Vulnerability in Karnataka.....	11
2.2. Lightning causalities in Karnataka.....	11
CHAPTER 3: LIGHTNING MONITORING & EARLY WARNING SYSTEM (LEWS) - KARNATAKA	19
3.1. Early Warning & Dissemination	20
3.2. Sidilu Mobile App.....	21
3.4. 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	31
4.4. Steps to Develop an Action Plan.....	32
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	36
CHAPTER 5: LIGHTNING DATA ANALYSIS – KARNATAKA	37
5.1. Spatial Lightning Density:.....	37
5.2. District-wise observed cloud to ground Lightning events for the last 5 years (2020 - 2024)	37
5.3. Top ten date's highest cloud to ground lightning events observed – 2024	37
5.4. District-wise Cloud to ground lightning events recorded during 2020 – 2024.....	39
5.5. District-wise graphical representation of Cloud to ground lightning events recorded during 2021 – 2024 for Seasons and annual.....	40
5.6. Lightning causalities in Karnataka in the last 14 years.....	42

CHAPTER 6: PREVENTION, MITIGATION AND PREPAREDNESS MEASURES.....	43
6.1. Preventive Measures	43
6.2. Mitigation and Preparedness Measures	44
6.3. Structural Mitigation Measures	44
6.4. Action – Before, During and After.....	47
CHAPTER 7: CAPACITY BUILDING.....	50
7.1 TLSD/HSW Education	50
7.2 Target Groups for Capacity Building.....	50
7.3 Capacity Building of Professionals	51
7.4 Training.....	51
7.5 Research and Development	51
CHAPTER 8: ROLES AND RESPONSIBILITY.....	53
8.1 Department-specific measures to prevent lightning-related injury & casualties, and property damage.....	53
8.2 Matrix of Karnataka State Action plans for Thunderstorms & Lightning:.....	65
8.3 Roles and Responsibilities Matrix for Management of Thunderstorms, Lightning, Dust/Hailstorm, Squall and Strong Winds.....	67
THUNDERSTORM & LIGHTNING: DO'S AND DON'TS.....	74

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. Recent trends have evidenced a notable surge in lightning occurrences and so the fatalities. As per the observations by Lightning Detection Network (LDN) of Indian Institute of Tropical Meteorology (IITM)/ Ministry of Earth Science (MoES) and National Remote Sensing Centre (NRSC)/ Indian Space Research Organisation (ISRO), India has witnessed continuous rise in lightning strikes. Annual Lightning Report 2023 highlights the overall rise in lightning Cloud to Ground (CG) flashes to 53% from 2019 to 2023. 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 kutchu 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 for the period 1981 -2010 indicated in **Figure 1**.

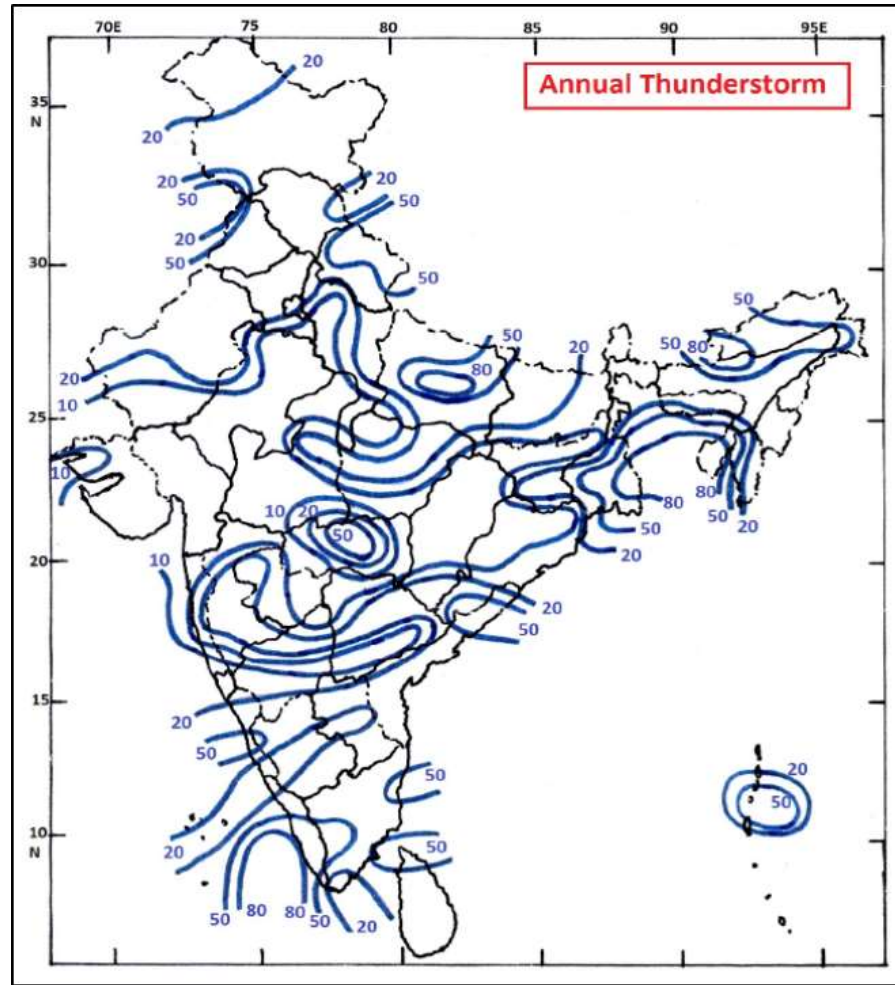


Figure 1: Average annual frequency of thunderstorms in India 1981 -2010 (IMD)

The Cloud-Ground (C-G) lightning strikes distribution was mapped for India from April 2021 to March 2022. The below Figure-2 reveals lightning-prone zones, also called lightning hotspots.

1.1 Definitions & Classification of Thunderstorms and associated 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.

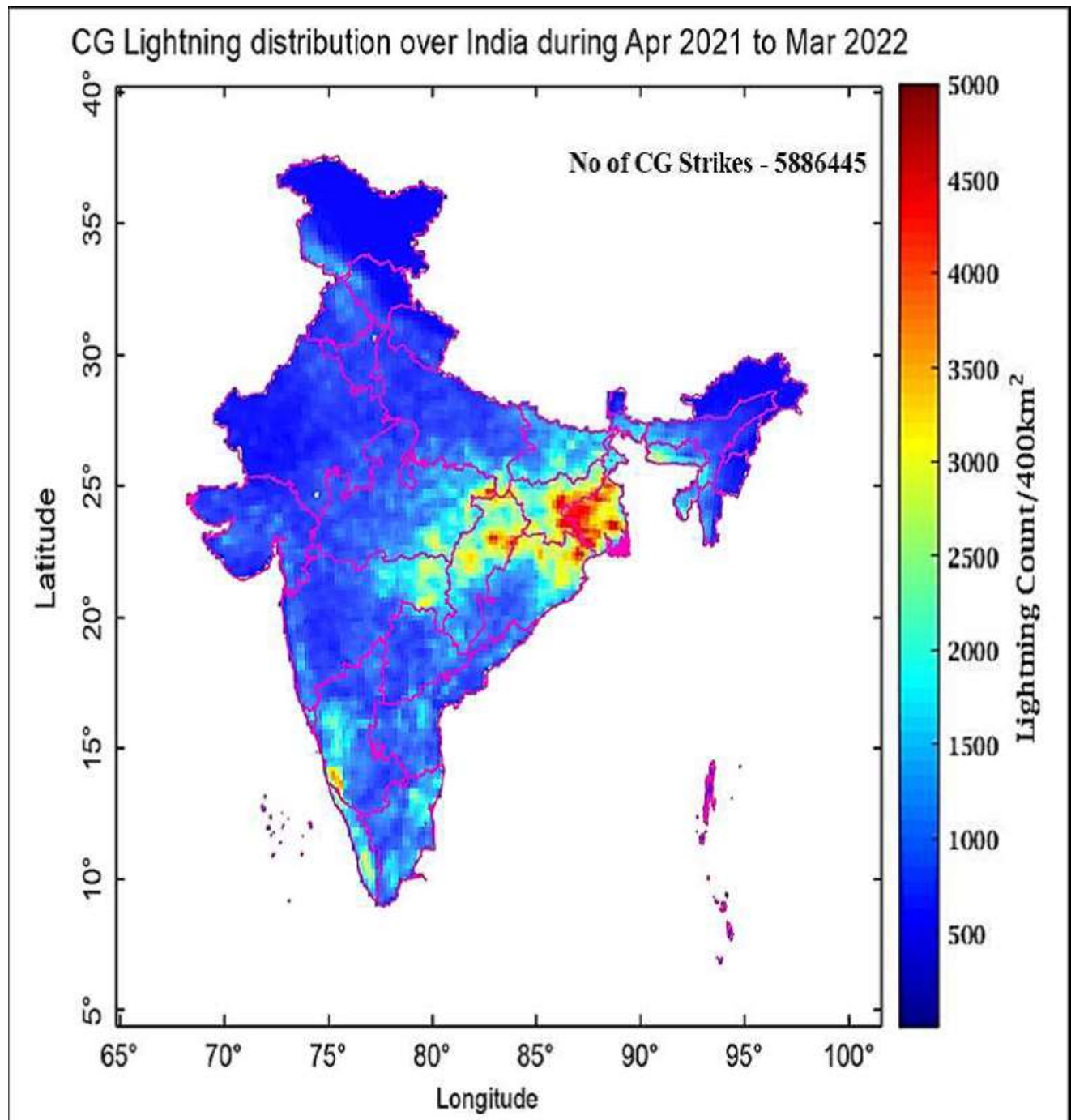


Figure 2: C-G Lightning strikes distribution over India from Apr 2021 to Mar 2022

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 1026 people have lost their lives due to lightning strikes in the Karnataka State during 2011-2024. 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 11 years are more than 50, as shown in (Table -1 & Figure 3 below).

2.2. Lightning casualties in Karnataka

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.

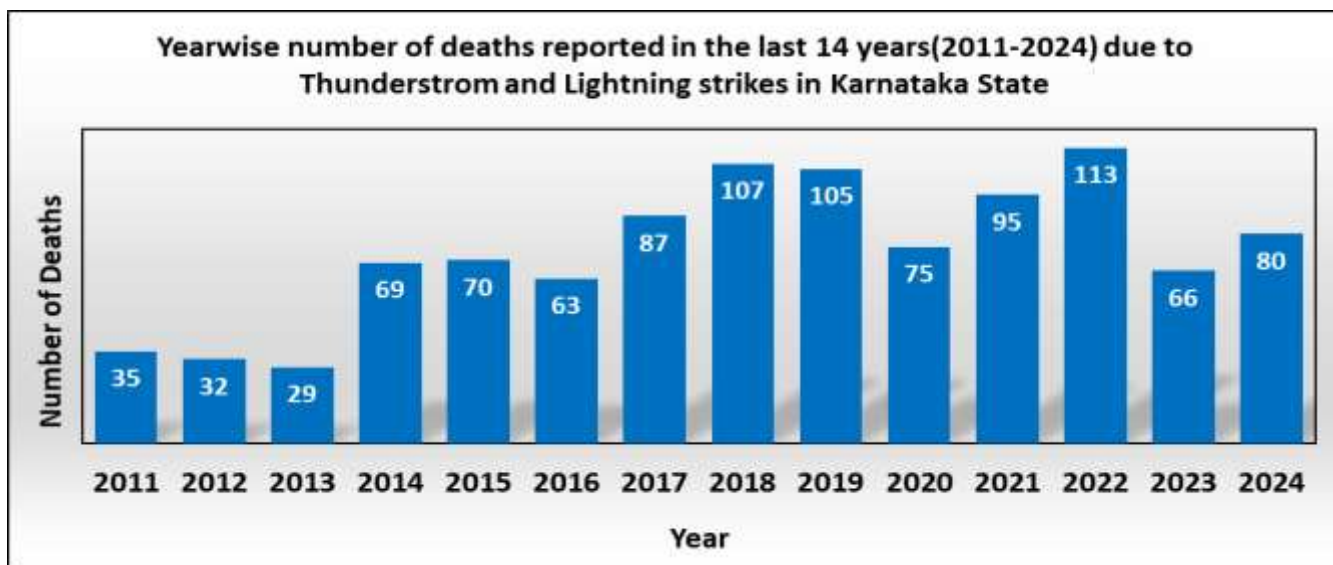


Figure 3: Year-wise No. of deaths due to Thunderstorm & Lightning in the State

Table. 1: Year - wise Lightning death reported details from 2011 to 2024

Year	Number of Deaths
2011	35
2012	32
2013	29
2014	69
2015	70
2016	63
2017	87
2018	107
2019	105
2020	75
2021	95
2022	113
2023	66
2024	80
Total	1026

Lightning deaths were spread across all the districts of the State. Belagavi district observed the No. of deaths are high during 2011-2024. District wise human deaths in 2024 are spatially presented in the Figure – 4. District wise human deaths during the last 14 years from 2011 to 2024 have been provided in the below Table-2 and Figure – 5.

Table. 2: District-wise human deaths details due to Lightning during 2011-2024

S.No	District	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
1	Belagavi	5	6	6	1	9	7	7	10	11	9	5	6	4	4	86
2	Kalaburagi	0	0	0	4	7	2	12	6	17	7	10	9	6	11	80
3	Vijayapura	8	8	3	4	0	5	5	6	5	4	13	9	9	5	79
4	Bidar	0	2	4	15	2	4	10	9	7	5	6	9	2	6	75
5	Hassan	4	1	2	4	8	6	7	14	2	1	1	6	0	3	56
6	Koppala	5	2	3	9	3	3	1	5	1	1	4	7	5	6	49
7	Haveri	1	4	2	2	4	5	3	8	3	2	0	6	3	2	43
8	Yadgir	0	1	0	0	3	2	0	5	11	6	4	10	0	6	42
9	Tumakuru	0	0	0	3	3	1	5	5	8	2	6	5	2	2	40
10	Gadag	0	0	3	0	3	1	8	2	4	3	4	7	2	2	37
11	Raichur	2	2	0	3	2	1	1	1	3	7	7	3	3	5	35
12	Bagalkote	0	3	1	6	0	5	1	2	2	4	3	5	2	3	34
13	Ballari	0	0	1	5	1	3	5	1	7	2	0	1	7	0	33
14	Chitradurga	0	0	0	0	6	4	4	3	3	3	2	5	2	2	32
15	Davanagere	3	0	2	8	2	1	0	5	3	0	4	1	3	0	32
16	Shivamogga	3	0	0	2	5	6	2	3	1	1	2	0	3	2	28
17	Dharwad	0	2	1	0	1	0	4	7	4	2	1	4	1	3	27
18	Mandya	1	1	0	0	2	0	3	1	1	1	2	4	2	0	18
19	Mysuru	0	0	0	0	3	1	4	2	2	0	0	2	2	0	16
20	Dakshina Kannada	0	0	0	0	2	1	0	2	0	1	6	3	0	4	15
21	Udupi	3	0	1	0	0	0	0	2	0	3	2	1	3	3	15
22	Chikkaballapura	0	0	0	0	0	0	2	3	1	0	6	1	1	1	14
23	Vijayanagara	0	0	0	0	0	0	0	0	0	4	4	4	2	6	14
24	Chikkamagaluru	0	0	0	1	1	1	2	1	3	3	1	0	1	2	14
25	Uttara Kannada	0	0	0	0	2	0	0	2	1	2	0	0	0	0	7
26	Chamarajanagara	0	0	0	0	0	0	1	0	1	2	0	2	0	0	6
27	Kodagu	0	0	0	2	1	2	0	0	0	0	0	0	1	1	6
28	Bengaluru Rural	0	0	0	0	0	1	0	1	2	0	1	0	0	1	5
29	Bengaluru Urban	0	0	0	0	0	1	0	0	1	0	1	1	0	0	4
30	Kolar	0	0	0	0	0	0	0	0	1	0	0	2	0	0	3
31	Ramanagara	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Total		35	32	29	69	70	63	87	107	105	75	95	113	66	80	1026

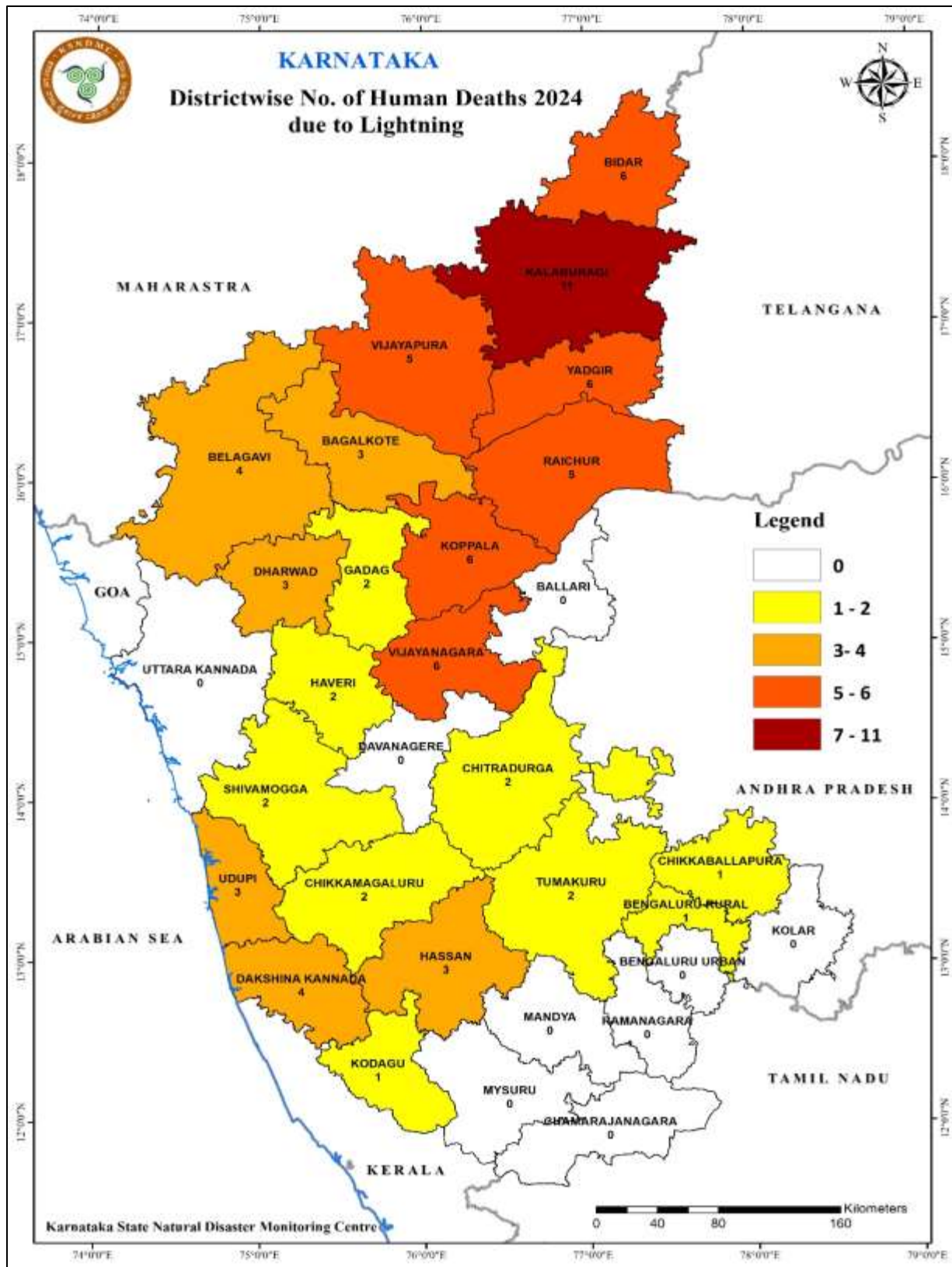


Figure 4: District-wise number of deaths due to lightning during the year 2024

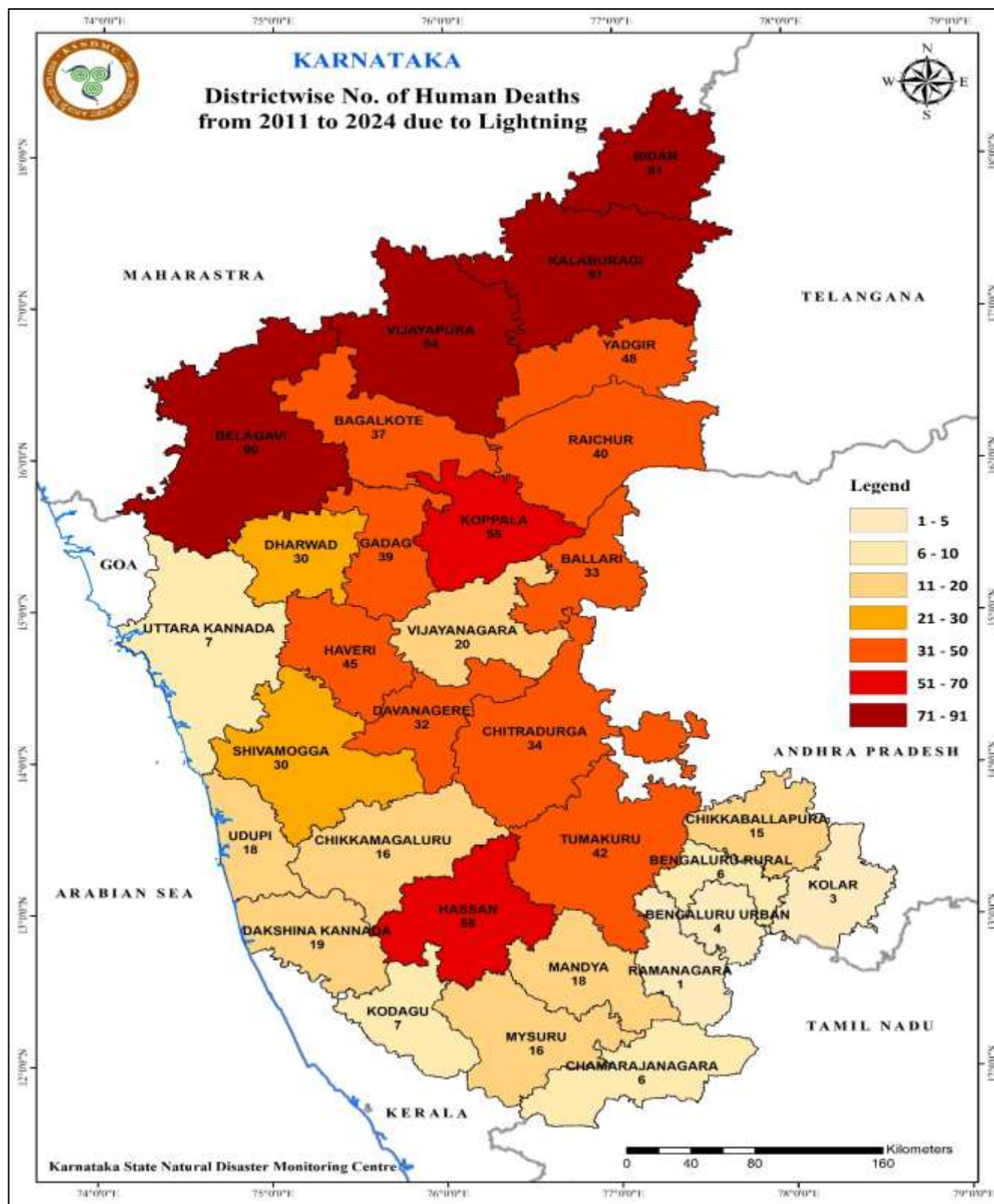


Figure 5: District-wise No. of deaths due to Thunderstorm & Lightning for last 14 years (2011-2024).

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. 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 number of Cloud to Ground (C-G) events were mapped district-wise from January - 2020 to Dec - 2024 (Figure – 6 & 7). 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.

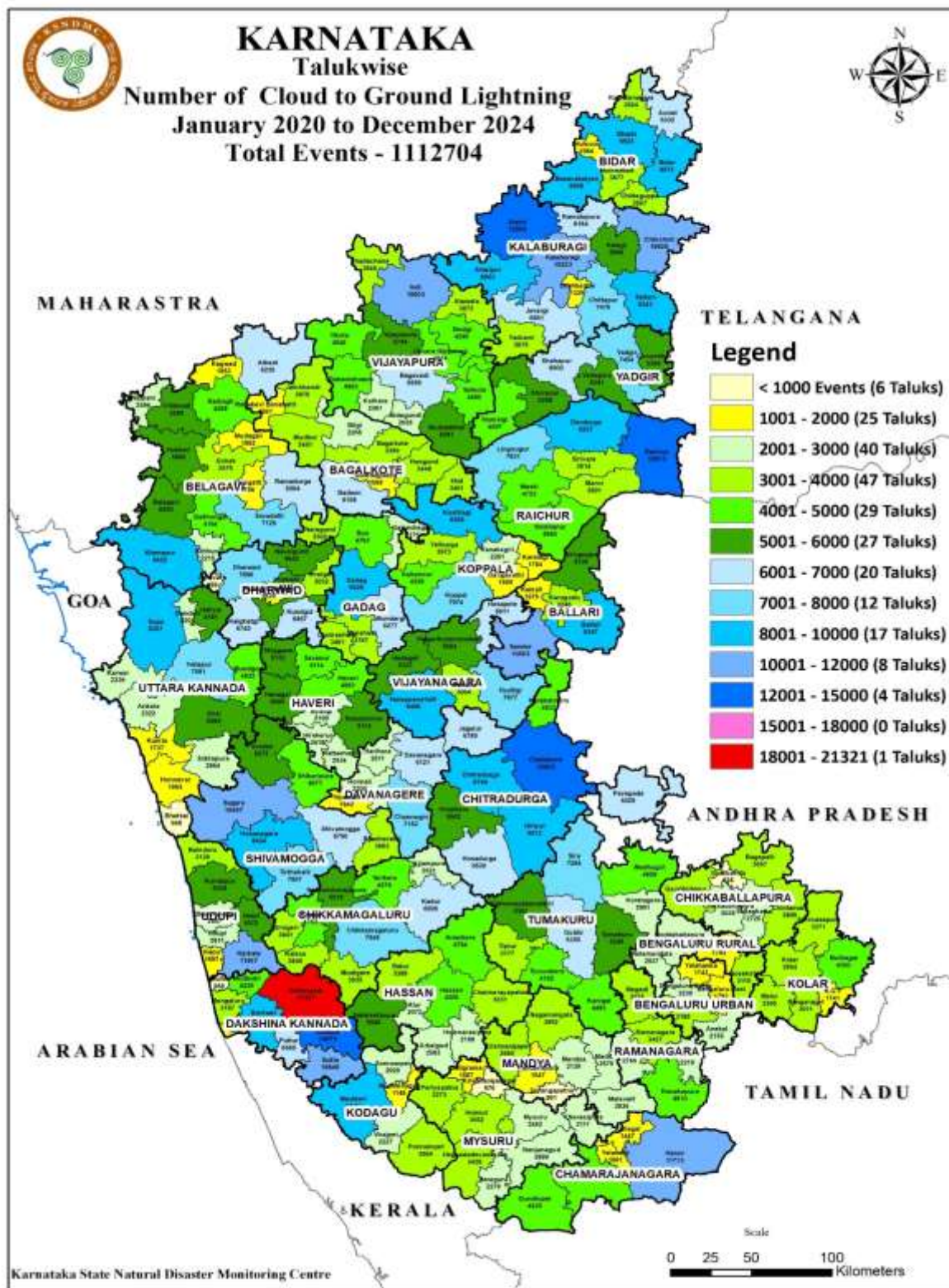


Figure 6: Cloud to Ground (C-G) Total No. of lightning events from January 2020 to Dec 2024

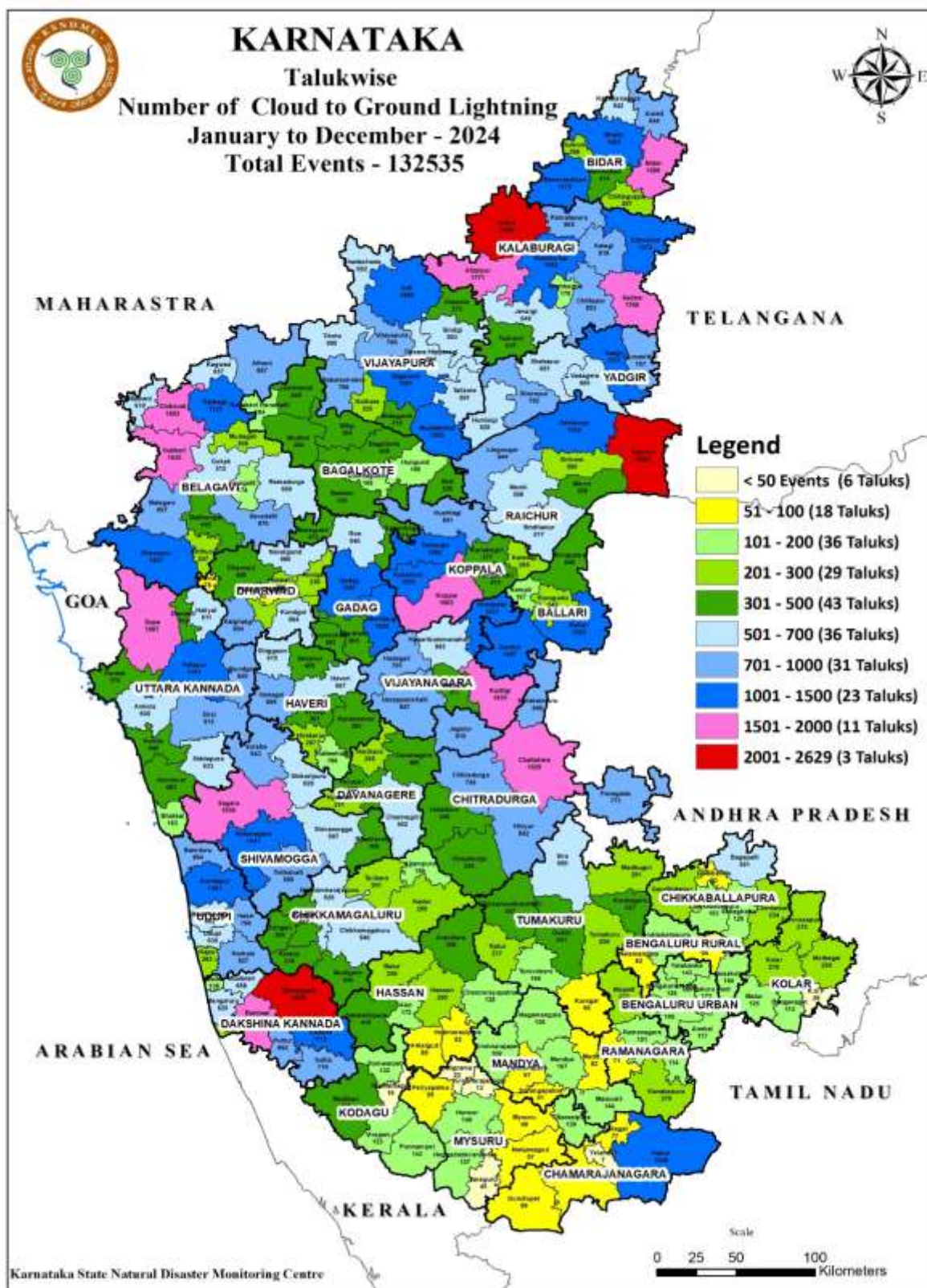


Figure 7: Taluk wise Cloud to Ground (C-G) Total No. of Lightning events during the year 2024

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 11 Lightning Detection Sensor stations are installed in the State. Thunderstorms and Lightning (Cloud to Cloud and Cloud to Ground) real time data is being collected from the above said network at KSNDMC. 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, 2022 and 2023, 2024 the No. of lightning alerts issued are 4.8 crore, 3.5, 2.01 and 2.14 crore respectively. Lightning events are lesser in the year 2024 compared with last year.

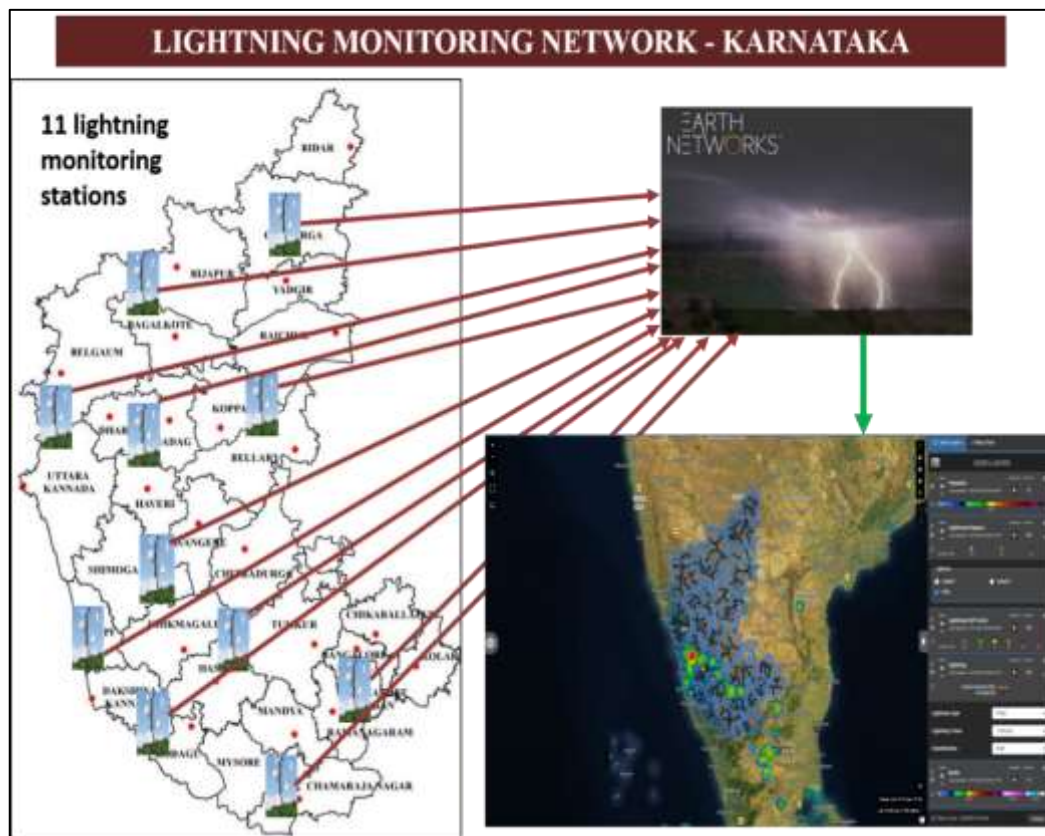


Figure 8: Lightning Network in Karnataka State

A dedicated interactive web platform of 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 to 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 location specific early warnings. 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.



Figure 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, VARUNA MITRA 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.

The live applications also developed in 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 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 colors. 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.

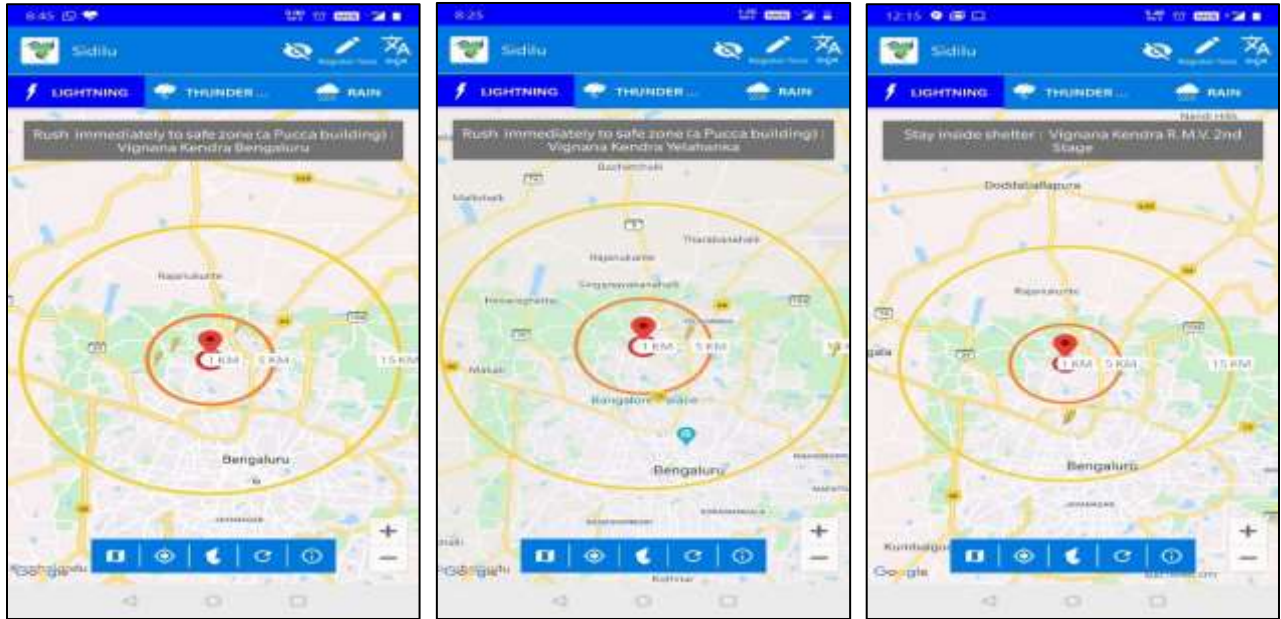


Figure 10: Screenshots of the App SIDILU

3.3. Alert Dissemination through CAP Platform:

National Disaster Management Authority (NDMA), under Ministry of Home Affairs (MHA) has implemented Common Alerting Protocol (CAP) Integrated Alert System for geo targeted dissemination of disaster alerts through various media. Centre for Development of Telematics (C-DOT) is the technical executor of this Project. Under this project, the Cell Broadcast (CB) technology also explored and geo-targeted alerts can be delivered to citizens in a short span of time and in case of severe heat wave conditions CB can be used for dissemination of alerts clarified by NDMA.

Karnataka State DMA disseminated 501 lightning alerts using CAP platform during the year 2024 generated by Alert Generating Agency (IMD-Bengaluru) for the State. These warning/alerts were issued mainly through web browser and sachet mobile app notifications to the vulnerable communities across the State.

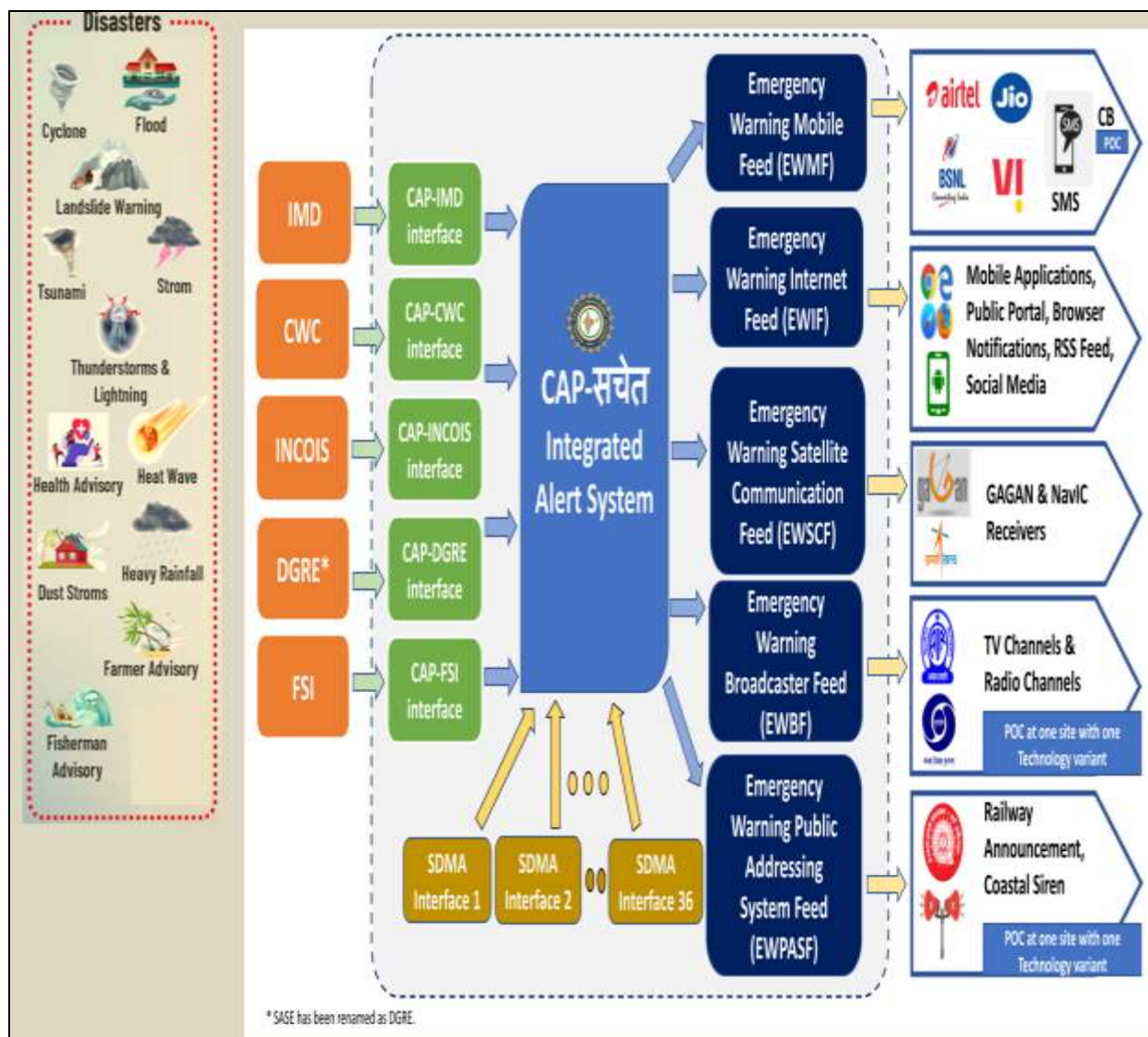
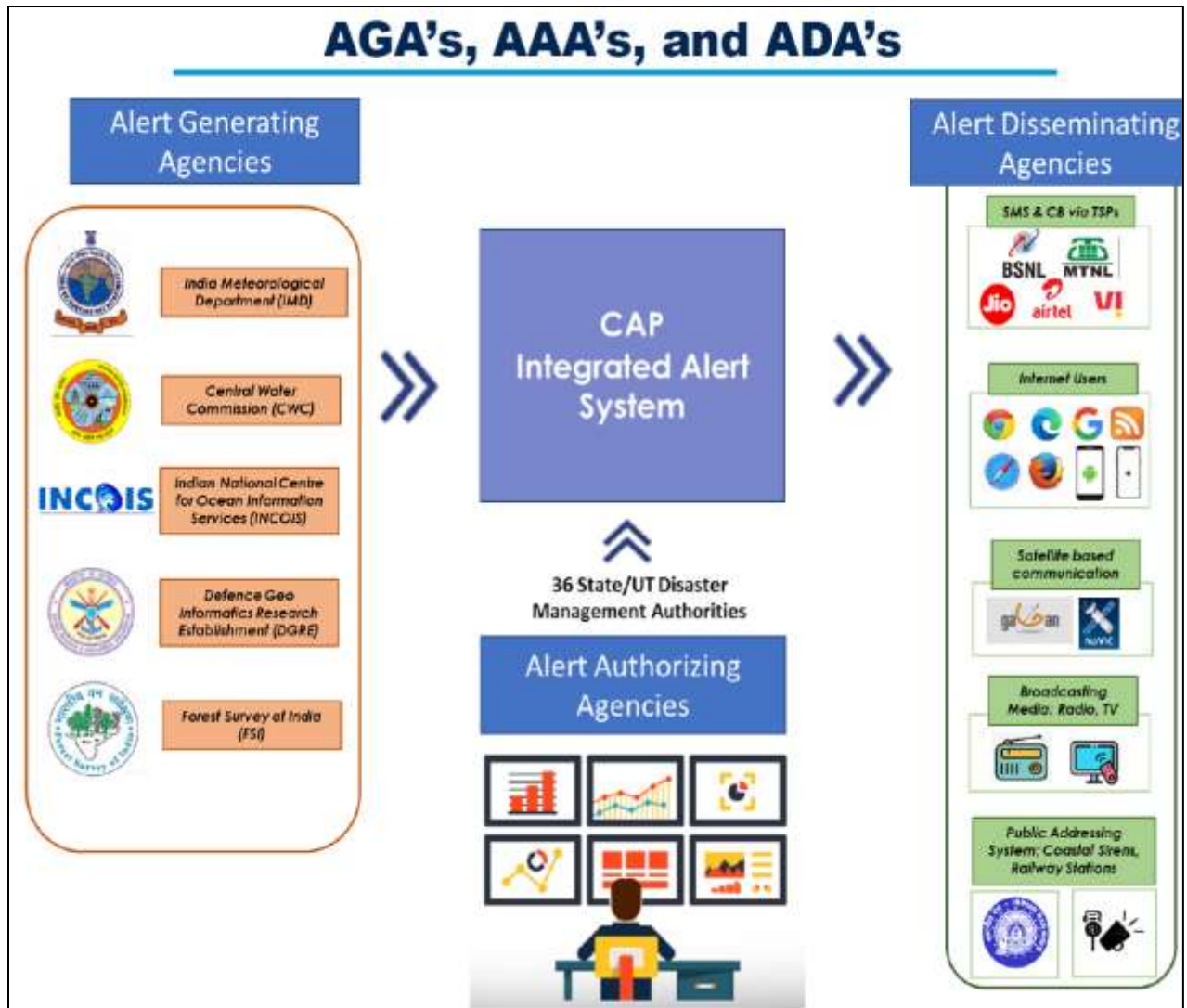


Figure 11: Implementation of CAP platform

The platform will facilitate to Alert Authorizing Agencies (AAA's) , the Alert Generating Agencies (AGA's) and the Alert Dissemination Agencies (ADA's) to give flexible geo-targeted alert dissemination in English or in vernacular language over one or multiple media to the targeted public, based upon Alert Category (i.e., severity type, vulnerable areas and lead time). CAP based Integrated Alert System has developed Standard Operating Procedures (SOP's) to AGA's and general guidelines to all project implementing agencies & AAA's by NDMA and C-DOT.

CAP platform enables near – real time dissemination of early warnings through multiple means of technology including SMS, Cell Broadcast, Radio, TV, Siren, Social Media, Web Portals and Mobile Applications using geo-intelligence. This one-stop solution is a concrete step towards realizing Hon'ble Prime Minister's 10 point Agenda for Disaster Risk Reduction.



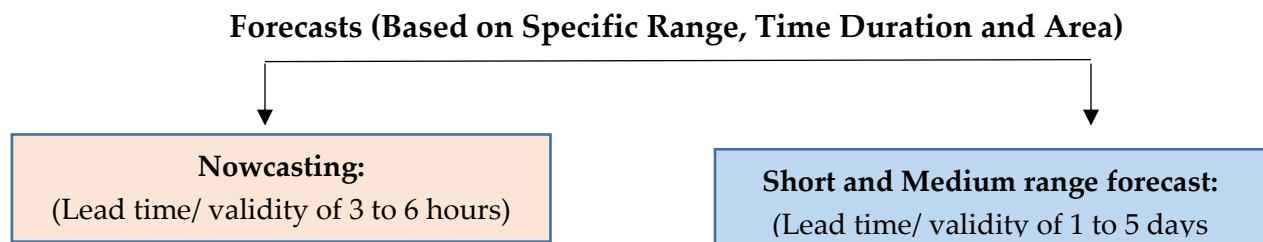
Flow chart of CAP Integrated Alert System to AGA's, AAA's & ADA's

DAMINI MOBILE APP BY IMD: Thunderstorms and lightning being the quickly evolving meteorological phenomenon, the exact forecast of these events is a challenge. Indian Institute of Tropical Meteorology, Pune an autonomous Institute under the Ministry of Earth Sciences has installed a Lightning Location Network with about 48 sensors over various parts of the

country and are connected to central processing unit at IITM, Pune. This network provides exact information about lightning strikes and movement of thunderstorm path. The network is being expanded with addition of more sensors to increase accuracy and reliability. Using this network, by ESSO-IITM has developed an Mobile App, DAMINI LIGHTNING. This App gives exact location of current lightning strikes, probable locations of impending lightning around area of 40 sq.km and movement and direction of thunderstorm. DAMINI also lists precautionary steps to be taken during lightning and some general information on lightning DAMINI-App would indeed help in getting advance information about impending lightning activity.

3.4. 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.



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 2025-2026 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

- Prevention of danger or threat of any disaster
- Mitigation or reduction of risk of any disaster or its severity or consequences
- Capacity building
- Preparedness to deal with any disaster
- Prompt response to any threatening disaster situation or disaster
- Assessing the severity or magnitude of effects of any disaster
- Evacuation, rescue and relief and
- 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. Safety: Ensuring the safety of individuals and property during thunderstorms and lightning strikes.
- B. Awareness: Educating the public about the risks associated with thunderstorms and lightning, including how to recognize dangerous weather conditions and how to respond appropriately.
- C. Preparedness: Developing protocols and procedures for emergency response teams, shelter-in-place guidelines, and communication strategies.
- D. Mitigation: Implementing measures to minimize the impact of thunderstorms and lightning strikes, strict implementation of National Building Code pertaining to lightning and thunderstorm, such as lightning protection systems for buildings and infrastructure and also other measures including , tree maintenance, and stormwater management.
- E. Monitoring and Early Warning: Establishing systems for monitoring weather conditions and issuing timely warnings to the public, allowing people to take necessary precautions.
- F. Coordination: Facilitating collaboration among government agencies, emergency responders, meteorological services, community organizations, and the public to ensure a coordinated response to thunderstorm and lightning events.

These objectives aim to reduce the risk of injury, loss of life, and damage to property caused by thunderstorms and lightning strikes.

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, 2023 & 2024 KSNDMC has issued Lightning Early Warnings to both the urban & rural communities of the State as nowcast alerts are 4.8, 3.5, 2.01 & 2.14 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 Government 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 will appoint a nodal officers at the State and district levels, and at the State level, KSDMA 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 5 years (2020-2024) 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. The following points are important while preparing Early Warnings/ Alerts:

- a. Dissemination of alerts through CAP:** National Disaster Management Authority (NDMA), under Ministry of Home Affairs (MHA) has implemented Common Alerting Protocol (CAP) Integrated Alert System for geo targeted dissemination of disaster alerts through various media.

- b. The warning messages from Alert Generating Agencies (AGA's) like IMD and State level DM authority (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;
- c. The message is short, clear, in simple language and action-oriented;
- d. Greater emphasis is placed on inter-agency Coordination while dissemination of warning messages, including public and private media; and
- e. 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 / SMS 's 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.

4.7 Public Awareness, Community Outreach & IEC

Public awareness, community outreach, and Information, Education, and Communication (IEC) efforts regarding thunderstorms and lightning are crucial for safety. These initiatives could include disseminating digital informational materials, and leveraging social media to educate people on safety measures during thunderstorms, such as seeking shelter indoors and avoiding open areas.

At district level:

1. Dissemination of customized (digital and posters) do's and don'ts during thunderstorm and lightning to vulnerable population such as outdoor workers, farm workers, shepherds, children, women and elderly people through concerned departments.
2. Dissemination of Do's and don'ts related to animal and livestock safety during thunderstorm and lightning through concerned departments.
3. Campaign on enforcement of National Building code pertaining to lightning safety by concerned departments.

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 5 years (2020 - 2024). District-wise comparison of lightning events for the different years and seasons are presented graphically. Top ten highest events that occurred on the date and the top ten districts' highest lightning events observed are identified and presented in Tables 3 & 4.

5.1. District-wise observed cloud to ground Lightning events for the last 4 years (2020 - 2024)

District-wise lightning events details for all the seasons and annually are given in Figure - 13. The Figures show that lesser lightning events were observed during 2024 compared to the last two years. Kalaburagi, Dakshina Kannada and Belagavi districts have observed Maximum number of lightning events for all the seasons and annually (Figure- 13 to 16).

5.2. Top ten date's highest cloud to ground lightning events observed – 2024

- The highest number of **6013** lightning events were observed in one day on 23rd May 2024 (Table - 3).
- Single day Maximum lightning events recorded in the months of April and May 2024.
- Top ten highest lightning events observed during 2020 – 2024 in Kalaburagi, Dakshina Kannada, Belagavi, Vijayapura, Tumakuru, Shivamogga, Chitradurga, Bidar, Raichur and Uttara Kannada districts (Table-4 & Figure-12)

The top ten observed lightning events with observed dates are given below

Table 3: Top Ten Lightning observed dates during 2024 over the State

Sl. No.	Top 10 number lightning events recorded during 2024 in a single day	Date
1	6013	23-May
2	5010	20-Apr
3	4326	18-Apr
4	4186	16-Aug
5	4137	12-May
6	3878	19-Apr
7	3700	30-Sep
8	3679	02-Oct
9	3565	20-May
10	3463	11-May

5.3. District-wise Cloud to Ground lightning events recorded during 2020 – 2024

Table 4: District-wise cloud to ground Lightning events (2020 – 2024)

S. No	District	2020	2021	2022	2023	2024	Total
1	Kalaburagi	12930	25572	13410	17701	11997	81610
2	Dakshina Kannada	7993	30098	11053	14103	8763	72010
3	Belagavi	8054	23594	12265	11356	12157	67426
4	Vijayapura	7712	19416	12230	13559	9207	62124
5	Tumakuru	8897	13146	15808	8375	3532	49758
6	Shivamogga	3484	20377	8856	8699	6054	47470
7	Chitradurga	9756	14693	10783	7033	4747	47012
8	Bidar	7328	13162	5196	14158	6643	46487
9	Raichur	10442	11152	9626	9154	5740	46114
10	Uttara Kannada	4197	17981	5866	8365	8428	44837
11	Chikkamagaluru	3977	19402	6722	9526	3517	43144
12	Dharwad	3141	15905	10382	4771	3417	37616
13	Vijayanagara	7028	14443	5844	4462	5544	37321
14	Yadgir	5874	8014	9224	6573	4761	34446
15	Gadag	4648	12779	7360	3552	4492	32831
16	Haveri	3392	13226	6692	5543	3641	32494
17	Udupi	3639	14083	3939	5174	5354	32189
18	Koppal	4752	10433	4429	4946	5676	30236
19	Bagalkote	5473	9776	5670	5198	2828	28945
20	Ballari	5695	9825	6166	3285	3666	28637
21	Hassan	4323	9679	5976	6559	1706	28243
22	Davanagere	3804	9957	5607	4621	2618	26607
23	Chamarajanagar	3559	6695	5709	5436	1285	22684
24	Mysuru	3847	5291	6656	5575	697	22066
25	Kolar	5955	5386	4146	3232	1008	19727
26	Kodagu	1878	8616	3758	3917	842	19011
27	Mandya	3873	4952	5031	3028	750	17634
28	Ramanagara	4377	4455	4440	2313	802	16387
29	Chikballapur	3573	4432	4469	2295	1391	16160
30	Bengaluru Urban	2931	2822	3161	1433	753	11100
31	Bengaluru Rural	2618	2591	3220	1430	519	10378
Total		169150	381953	223694	205372	132535	1112704

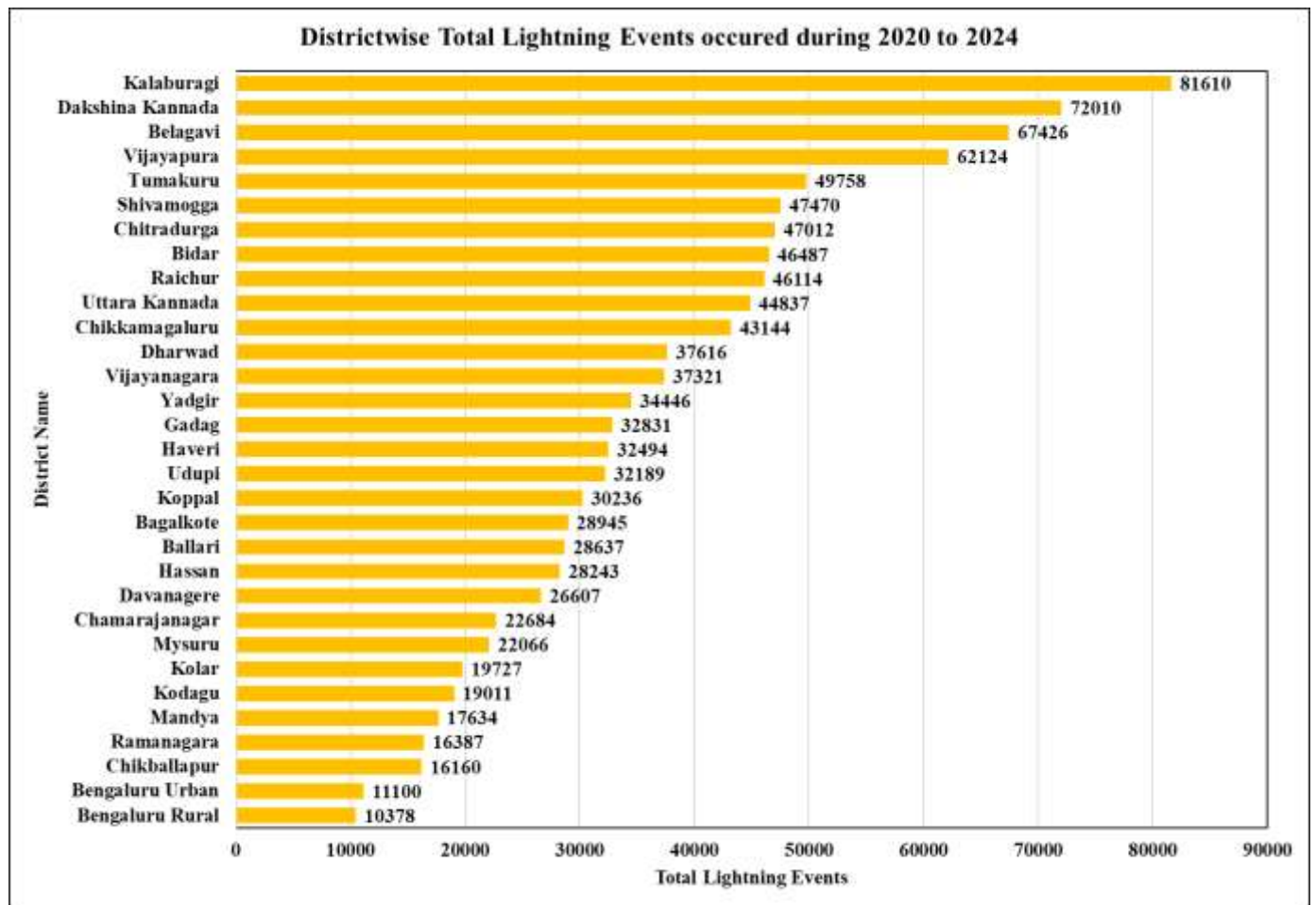


Figure - 12: District-wise observed lightning events from 2020 to 2024.

5.4. District-wise graphical representation of Cloud to ground lightning events recorded during 2021 – 2024 for seasons and annual.

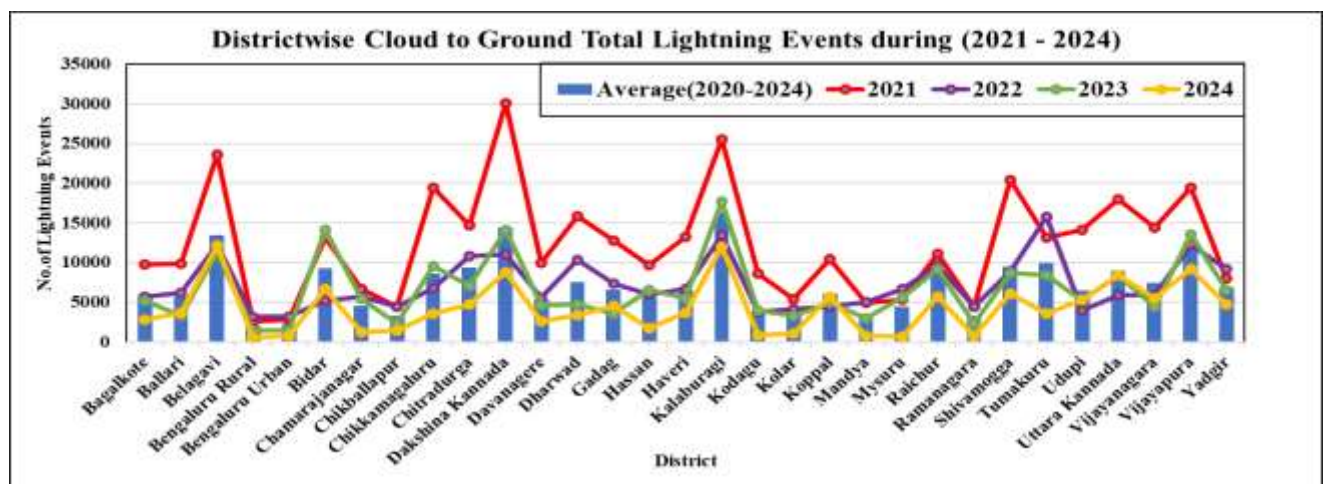


Figure - 13: Annual district-wise observed lightning C-G events (2021 - 2024)

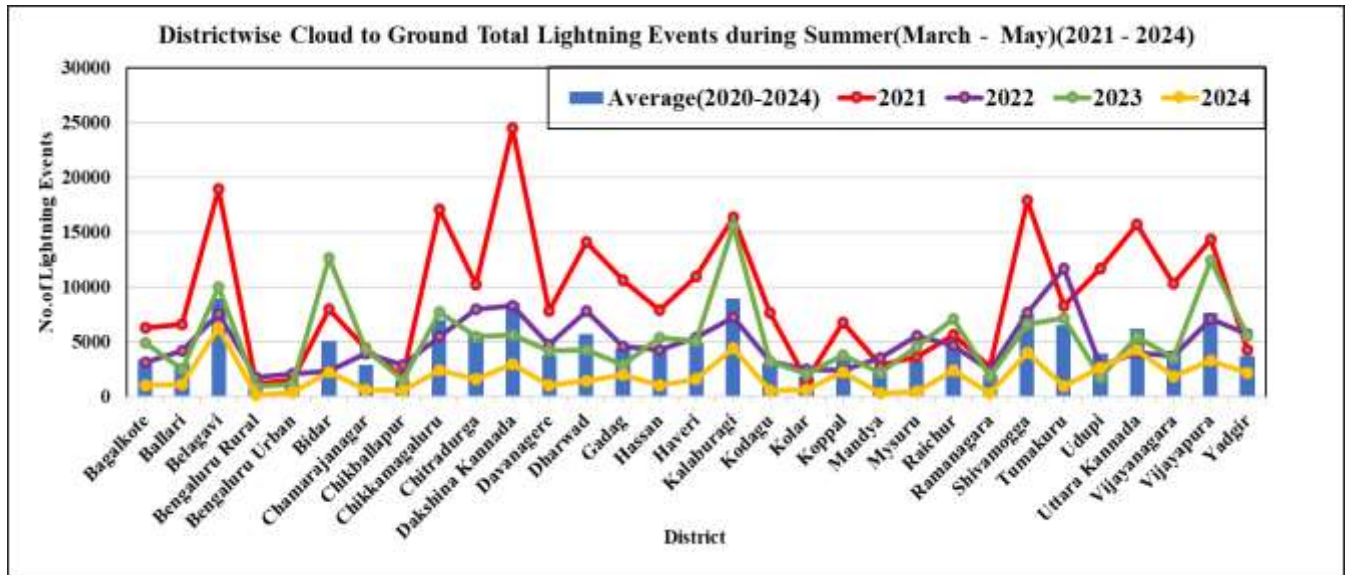


Figure - 14: Summer (March-May) season district-wise observed lightning C-G events (2021 - 2024)

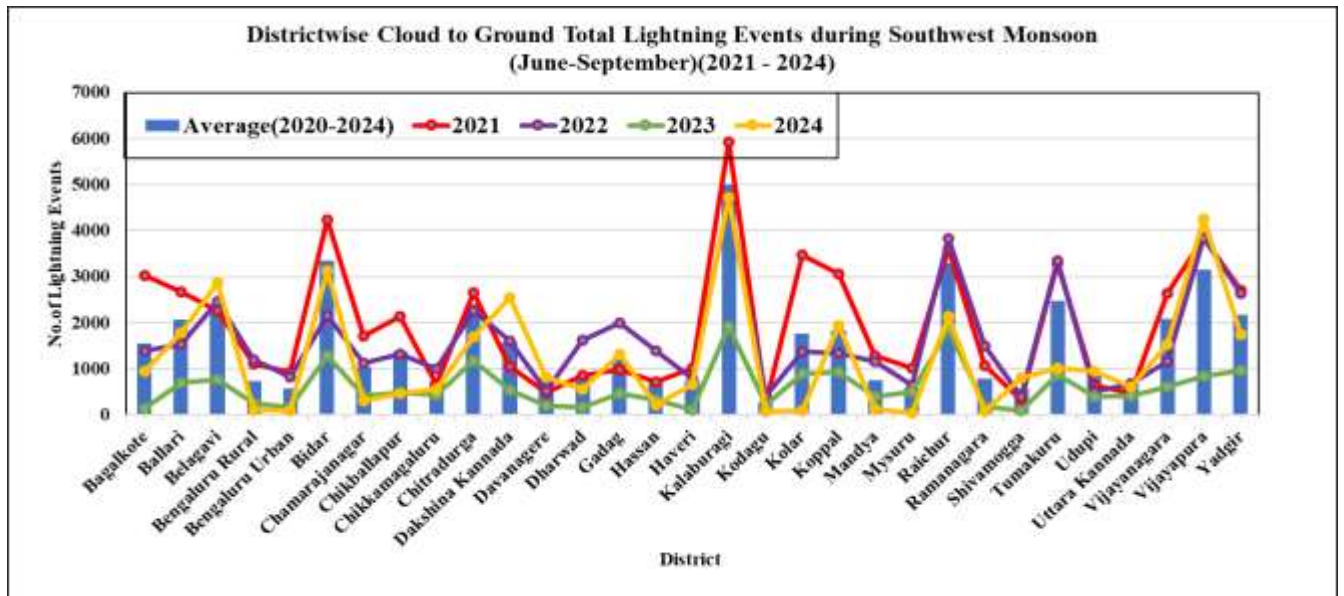


Figure - 15: Southwest monsoon (June - September) season district-wise observed lightning events (2021 - 2024)

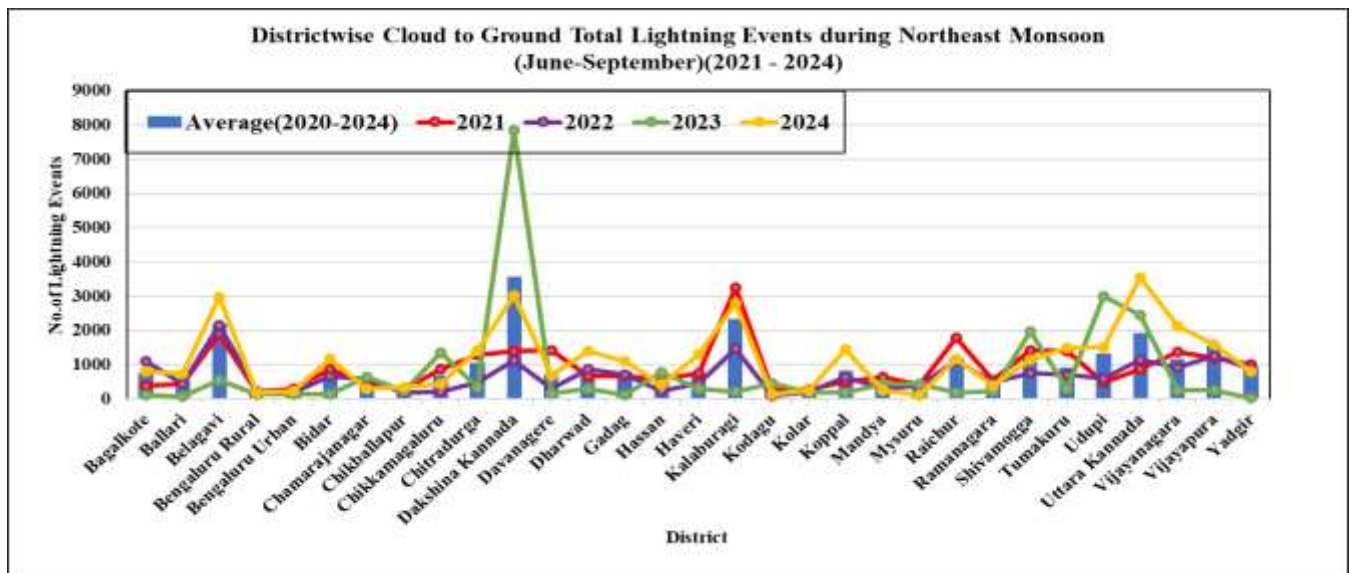


Figure - 16: Northeast monsoon (October - December) season district-wise observed lightning events (2021 - 2024)

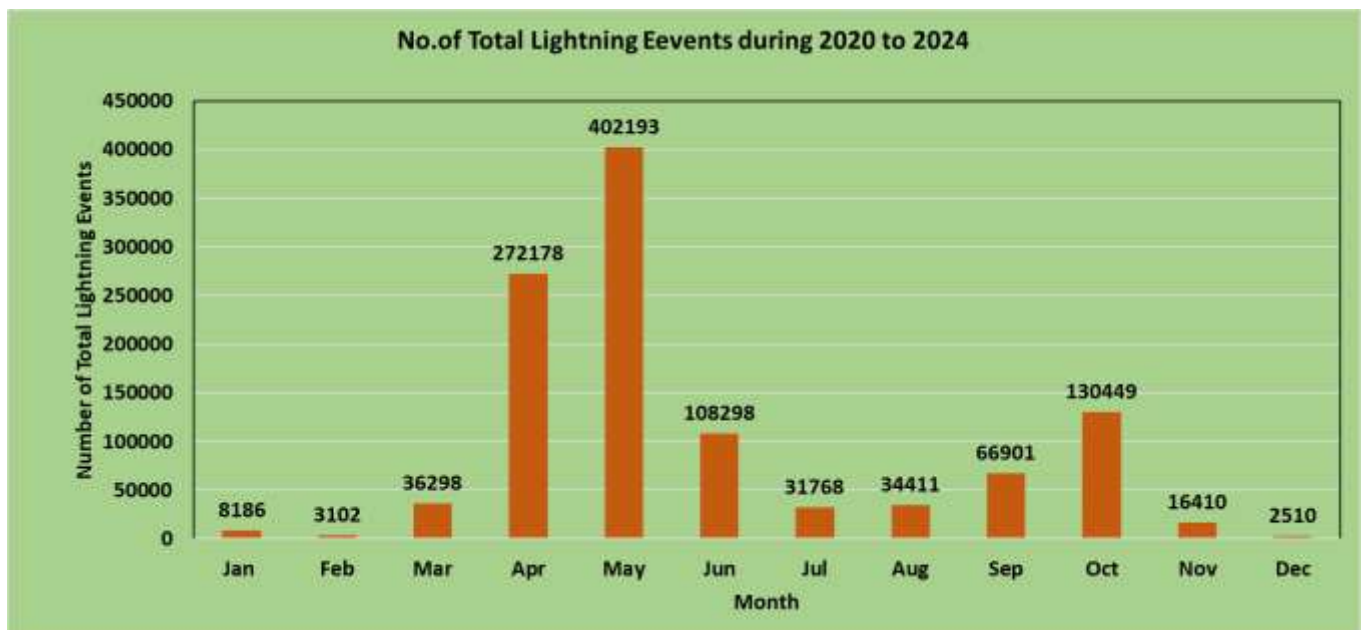


Figure - 17: Month-wise total lightning events observed from 2020 to 2024

The above analysis shows that occurrence of the lightning events during the Pre-Monsoon & North East Monsoon period is high. Lightning events are lesser in the year 2024 compared to the last 2 years (Figure-17).

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:** Assessing thunderstorm and lightning hazards involves evaluating factors such as frequency and severity of thunderstorms, lightning occurrence, and associated risks to people, infrastructure, and the environment. Vulnerability assessment considers the susceptibility of communities, infrastructure, and ecosystems to the impacts of thunderstorms and lightning, taking into account factors like population density, building codes, emergency response capabilities, and natural features that may exacerbate risks. By understanding both the hazards and vulnerabilities, local authorities can develop targeted mitigation strategies and emergency preparedness plans to reduce the impacts of thunderstorms and lightning events.
- 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

- a. **Enhanced understanding of preparedness and mitigation measures** will help us minimize the losses due to thunderstorms/squalls, etc.
- b. Building mass awareness on Do's and don'ts during lightning and thunderstorm. Strict implementation of National Building Codes pertaining to lightning protection. Integration of Disaster Risk Reduction strategies into development projects by the concerned departments.
- c. Technical, Social, Organizational and Administrative preparedness: KSNDMC has developed a DSS (Decision Support System) for thunderstorm nowcast, The nowcast alerts/warnings are accompanied by actionable Information (Do's and Don'ts) and potential impact (expected damage). The concerned department may based on the DSS will disseminate actionable inputs to the field staff.
- d. **Emergency Plan for Hospitals and Health Centres:** Capacity building of Doctors and para-medical staff on treatment related to lightning injuries. To follow treatment protocol as outlined by the Health Department. Phone numbers of all medical facilities should be available in the District Control Room. Emergency medicines, Stocking of essential medicine.
- e. **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.
- f. **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 neighborhood 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 light weight 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:

- Remember that vivid and frequent Lightning indicates the probability of a strong thunderstorm.
- Build an emergency kit and make a family communication plan.
- Remove dead or rotting trees and branches that could fall and cause injury or damage during a severe thunderstorm.
- Postpone outdoor activities.
- 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.
- Secure outdoor objects that could blow away or cause damage.
- 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.
- 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.
- Unplug appliances and other electrical items such as computers and turn off air conditioners. Power surges from Lightning can cause severe damage.
- Shutter windows and secure outside doors. If shutters are not available, close window blinds, shades or curtains.
- Unplug any electronic equipment well before the storm arrives.

(b) During Thunderstorms and Lightning

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

- Use your battery-operated radio/TV for updates from local officials.
- Avoid contact with corded phones and devices, including those plugged in for recharging.
- Cordless and wireless phones not connected to wall outlets are OK to use.
- Avoid contact with electrical equipment or cords.
- 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.
- Stay away from windows and doors, and stay off porches.
- Do not lie on concrete floors or lean against concrete walls.
- Avoid natural lightning rods such as tall, isolated trees in an open area.
- Avoid hilltops, open fields, the beach or a boat on the water.
- Take shelter in a sturdy building. Avoid isolated sheds or other small structures in open areas.
- Avoid contact with anything metal - tractors, farm equipment, motorcycles, golf carts, golf clubs, and bicycles.
- 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.

(c) 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:

- Breathing – If breathing has stopped, begin mouth-to-mouth resuscitation.
- Heartbeat – If the heart has stopped, administer Cardiopulmonary Resuscitation (CPR).
- 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 Thunderstorm & Lightning Education

To emphasize greater awareness by making Thunderstorm & Lightning education a part of educational curricula, covering all the relevant aspects. This would foster a culture of prevention, mitigation and preparedness, Information, Education and Communication (IEC) materials, textbooks and field training are critical in building capacity. Education Department will be encouraged to include chapters on lightning and thunderstorm safety 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/DDMAs, 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.

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 Thunderstorm & Lightning.

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 Thunderstorm & Lightning 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 Thunderstorm & Lightning 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 Thunderstorm & Lightning safety in India.

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 & 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 center to support, coordinate and monitor disaster management activities at the State level, including inter department co-ordination, training and research. It will, under normal circumstances, work under the supervision of the Relief Commissioner. During an emergency, it will work as the center 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.

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

1. Agriculture and Horticulture Department:

- Lightning safety awareness through Raitha Samparka Kendras (RSKs) 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

2. 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 behavioral changes. Dissemination of lightning alerts within their network.
- Popularizing Sidilu and Damini Applications.
- Training field staff on lightning safety measures

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. Housing Department:

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

10. 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.

11. 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.

Advisory to the Districts / Taluks for Thunderstorm & Lightning – 2025

Lightning in State starts during the Pre-monsoon season and during the South West monsoon with intense thunderstorm and lightning. It is also relevant to mention that lightning generally takes place during second half of the day particularly in the late afternoon or evening and all the districts in the State are vulnerable to for Lightning Strikes. It is advised to take appropriate measures as below:

Mitigation and Preparedness for Thunderstorm & Lightning

- Action Plan of the State may be circulated to all district Collectors & HoDs instructions may be issued to all concerned line Departments and the District Collectors for implementation.
- District Administration should update and customize the District Action Plan and ensure its implementation.
- Undertake assessment, preparedness and mitigation measures for effective response, prepare detailed department wise Standard operating Procedures.
- Identify vulnerable places and protect public property / infrastructure from Thunderstorm and Lightning.
- Promote installation of lightning conductors / arresters or local innovative techniques in schools, industries, public and private buildings including rural area.
- Create a network or community-based early warning systems.
- Dissemination of specific early warning information to public through print / electronic / social and other mass media like SMS, WhatsApp at local level.
- Ensure installation of lightning arresters in school building and government buildings.
- Ensure installation of hooters, siren on school, community building to alert people.
- Set up alternative or emergency communication systems and ensure early restoration of electricity to ensure functioning of essential services during emergencies and restore of electric supply at the earliest.

- Disseminate Do's and Don'ts and conduct IEC campaigns to generate public awareness through print, electronic and social media.

Awareness generation Activities

Awareness campaigns should be carried out based on a well-planned communication strategy. IEC activities should be planned at State/District and local levels.

A. State level:

- Mass awareness campaigns involving Print, TV, Radio, Social Media, etc in local languages;
- Promote lightning early warning Mobile Apps like 'Damini' & Sidilu.
- Special awareness campaigns to ensure people access and understand updates / advisories issued about the local weather conditions.
- Special list of Do's and Don'ts and safety tips for weaker and vulnerable sections of society (e.g. Agriculture workers, women, children, poor elderly and differently-abled);
- Separate list of Do's and Don'ts for animal and livestock safety;
- Encourage the line departments of the State Governments and local authorities to widely disseminate Do's and Don'ts.
- Develop media and communication strategies and plans considering local socio-economic and behavioural factors;
- Conduct regular awareness programmes in all districts;
- Conduct regular training programmes for inter-personal communication activities.

B. District and local level:

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

- Conduct regular inter-personal communication activities;
- Demonstrate safety tips to the vulnerable population in their local language;
- Use of IEC tools and materials (such as flyers, calendars, comic books, etc.) extensively

- Strengthen and involve local communities such as RWAs, Municipal bodies, Panchayati Raj Institutions, Anganwadis and NGOs etc.,
- Carry out of Home campaigns using banners, posters, billboards, etc.
- Carry out special awareness programmes for the differently-abled.
- Keep first aid material needs for lightning victims and made arrangements to send victims to the hospital if needed.

Thunderstorm & Lightning: Do's and Don'ts

If Outdoor

Do's

To avoid the exposure of lightning while outdoors, some tips for safety and to reduce the risk are:

- Check the weather forecast before participating in outdoor activities. If you see thunderstorm & lightning, stay indoor for 30 minutes.
- Do not go out of house during adverse weather especially for working in agriculture field, grazing cattle, fishing and plying boats or general travel.
- When thunder roars, be inside safe shelter. Avoid metal structures and constructions with metal sheeting. Safe shelters include homes, offices shopping centers, and hard-top vehicles with windows rolled up.
- If you are caught outside with no safe shelter nearby, immediately get off elevated areas such as hills, mountain ridges, or peaks.
- If you are caught in an open area, act quickly to remove yourself from danger.
- Ideally, find a shelter in a low-lying area and make sure that the spot chosen is not likely to be flooded.
- Hair standing up on the back of your neck with tingling could indicate that lightning is imminent.
- Immediately get out of and away from ponds, lakes, and other water bodies.
- Keep away from all utility lines and objects that conduct electricity (telephone, power, metal fences, overhead wire, rail-road tracks, wind mills, etc.), trees and hilltops.
- Rubber-soled shoes and car tyres do not offer protection from lightning.
- If you are in a group during thunderstorm, than keep adequate distance to reduce risk.

Don'ts

- Do not go outside during adverse weather especially for working in agriculture field, grazing cattle, fishing and plying boats.
- If you are in forest area, take shelter under small and dwarf trees.
- Do not take shelter under electric or telephone poles or trees. These attract lightning
- Do not use metallic items and stay away from bikes, electric or telephone poles, wire fence, machines etc.
- If you are working in an open field / outdoor and do not have enough time to take shelter in a safe place, crouch down in a ball-like position with your head tucked and hands over your ears with minimal contact with the ground and make yourself a smaller target.
- Never use mobile phones during lightning.
- Do not use umbrellas with iron rods.

If at home or Indoor

Even though shelters like your homes, offices, shopping centers are considered safe during a lightning storm, a person may still be at risk. Here are some tips to keep yourself safe:

Do's

- Keep monitoring local media for updates and warning instructions by various modes of communication.
- Stay indoors and avoid travel if possible.
- Keep away from doors, windows, porches, and concrete floors, fireplaces stoves, bathtubs, or any other electrical conductors during a thunderstorm.
- Unplug electrical / electronic appliances like computers, laptops, game systems, washers, dryers, stoves, or anything connected to an electrical outlet, as the main power supply may conduct a power surge during a lightning storm.

- Close windows and doors, and secure objects outside your home (e.g. furniture, bins, etc.)
- Ensure that children and pet animals are inside.
- Remove tree timber or any other debris that may fly and cause an accident.

Don'ts

- Do not take a bath or a shower, wash dishes, or have any other contact with stagnant or running water. This is because lightning can travel through a building's plumbing and metal pipes.
- Do not use electric / electronic appliances including corded phone and any metal wire or bars.
- Avoid using corded phones and other electrical equipment that can conduct lightning. However, it is safe to use cordless phones during a storm.
- Avoid open vehicles such as convertibles, motorcycles, and golf carts, etc. Avoid open structures / spaces such as porches, sports arenas (such as golf courses, parks, and playgrounds), ponds, lakes, swimming pools, and beaches.

Do's and Don'ts on travel

- Check the weather forecast before outdoor activities. If there is a forecast or warning for thunderstorm, postpone travel or outdoor activities.
- During a thunderstorm, avoid open vehicles such as convertibles, motorcycles, and golf carts. Be sure to avoid open structures such as porches, baseball dugouts, and sports arenas. And stay away from open spaces such as golf courses, parks, playgrounds, ponds, lakes, swimming pools, and beaches.
- Get off bicycles, motorcycles or farm vehicles that may attract lightning.
- If boating or swimming, get to land as quickly as possible and take shelter in a safe place.

- During a storm, remain in your vehicle until help arrives or the storm has passed (the metal roof will provide protection if you are not touching metal inside); windows should be up and the vehicle must be parked away from trees and power lines.
- Move out of forested area (especially pine forest / tall trees) towards clear ground. There is possibility of forest fire due to lightning strike.

Lightning: First Aid treatment

- First aid to lightning struck victims while waiting for professional medical attention can save their lives.
- It is safe to touch a lightning strike victim.
- Check to see if the victim is breathing and has heartbeat. The best place to check for pulse is the carotid artery which is found on your neck directly below your jaw.
- If the victim is not breathing, immediately begin mouth-to mouth resuscitation. If the victim does not have pulse beat, start cardiac compressions as well (CPR).
- Check whether the person who survived from a lightning strike has broken bones that can cause paralysis or major bleeding complications.
- Be aware of the continuing lightning danger to both the victim and rescuer. If the area where the victim is located in a high risk area, then move the victim immediately to a safer location,
- 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, Shock, and sometimes blunt trauma. Check the injury, if necessary move the person to hospital for treatment.
- Call helpline number 112 / 1070 at State level and 1077 is at District level give correct directions to reach the exact location and information about the condition of the strike victim(s). Take the person who is struck by lightning to a hospital, if possible.

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 Defence, 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

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
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	DDMA's consultation with concerned departments COR (to coordinate with other concerned Departments/Age ncies)	· 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 concerned Departments	· Inter-agency Coordination · Issue relevant advisories · Give directions to concerned ministries/departments.	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

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
					Protect property/ infrastructure and environment from damage from a fire · Ensure strict adherence to fire safety norms · Ensure essential services and facilities at vulnerable places
		RDPR	· Disseminate Information to the public on structural mitigation measures · Conduct drives to check the structural strength of trees, old structures, etc.		
		Housing and Urban Development			
		Department of Telecommunications	· Set up alternative or emergency communication systems	DDMAs 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 equipment/cables	DDMAs 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 replace equipment from time to time

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
		PWD & RDPR	· Ensure road connectivity and access to vulnerable areas	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 professionals · Ensure stockpiling of life-saving drugs, detoxicants, anaesthesia, and availability of Halogen tablets in vulnerable areas
		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

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
		9. Forests and Environment	· Set up awareness programmes	DDMAs consultation with concerned departments	· Ensure adherence to fire safety norms · Protect property/ infrastructure and environment from damage by a fire
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					

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
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

Sl. No.	Tasks	State/ District agencies and their responsibilities			
	Activities	State	Responsibility	DDMA	Responsibility
7	Capacity Building and Training	Nodal agency: KSDMA/ATI/K SNDMC/ 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 equipment and preventive systems
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



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 & Dents 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

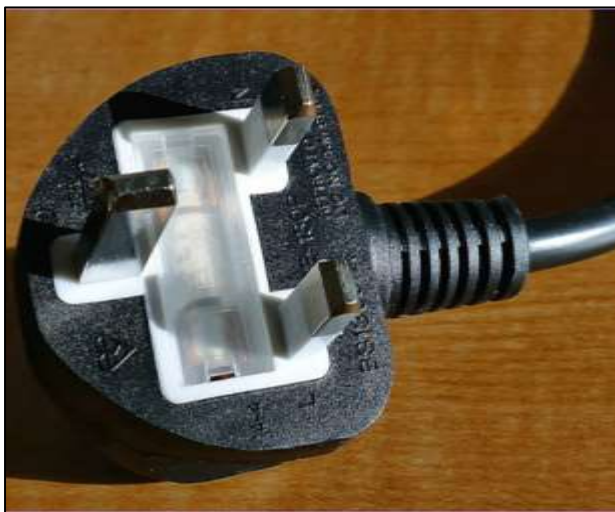
If at Home or Work- Preparation

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



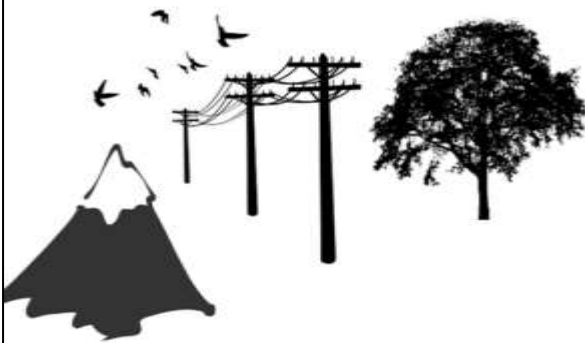
If on Foot - Response

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

Lightning Safety Dos & Don'ts

Dos

Outdoors

- Seek refuge in a car or grounded building
- Avoid tall objects like trees



- Suspend activities for at least 30 minutes after the last sound of thunder

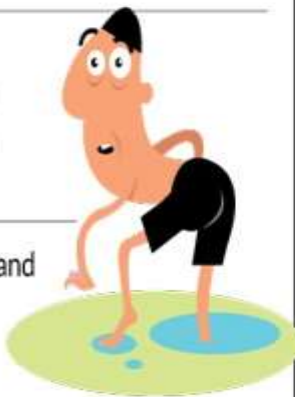
- Leave elevated

areas such as hills, mountain ridges or peaks

- Get out from ponds, lakes and any other water entities

Indoors

- Avoid plumbing, including sinks, baths and faucets.



Don'ts

Outdoors

- Don't lie down on the ground
- Don't use a cliff or rocky overhang for shelter
- Don't seek refuge under an isolated tree



Indoors

- Don't take baths or showers.
- Don't wash dishes
- Don't use landline phones, switch on televisions or any other electrical appliance.
- Stay away from concrete floors or walls
- Stay away from windows, doors, and porches



Source: National Geographic, US Centers for Disease Control and Prevention, and the US National Weather Service

TIPS FOR SURVIVING LIGHTNING

1. Avoid being outdoors.

Lightning is nothing but a large spark of electricity that is trying to find the easiest and

Shortest path to the ground. Logically, it could hit the highest point, typically an isolated tall tree, telephone pole or a person who is standing up.

For example, if we are walking in an open field without trees during a thundershower, we are the tallest structure and could become a target for lightning.

It is therefore unwise to be outdoors when there is lightning.



2. Do not take shelter under a tall tree.

Taking shelter under an isolated tall tree is unsafe, as it could attract lightning and pass it on to us. If caught in a forest, it is better to be either in a clearing or near the shortest trees—these are less likely to attract lightning.

3. Avoid being at high altitudes.

For the same reason, being at a hilltop or rooftop at such a time is considered risky. If caught in such a situation, we should quickly move to low-lying areas whenever possible. Lightning travels along vertical surfaces to seek the ground, hence standing just below the overhanging edge of a cliff is also considered dangerous.

That being said, for a lightning bolt that is traveling to the ground at extreme speed from a height of several thousand feet, it is unlikely that small heights such as five

or fifteen feet will make any difference on *where exactly* it hits the ground. Experts say that the bolt can hit *anywhere* on the ground, not necessarily at the tallest point.



4. Know the types of lightning strikes.

Lightning can strike in various ways. While outdoors in an open area or on high ground, it can deliver a direct '*vertical strike*' from above on to our body. Although this is the most lethal, it is uncommon.

More commonly, lightning spreads *horizontally* to our body after it hits the ground nearby. If we are within 200 m of the strike, then we are at risk. This type is also called '*ground current*' or '*step potential*' and accounts for about half of the fatalities.

A '*side flash*' occurs when we are standing next to a tall object such as a tree and the electric current jumps across *through the air* to our body.

5. Do not lie down on the ground.

It is dangerous to lie down on the ground in an attempt to escape from lightning, as the electric charge from a nearby strike will spread horizontally along the ground.

6. Avoid fences and wires.

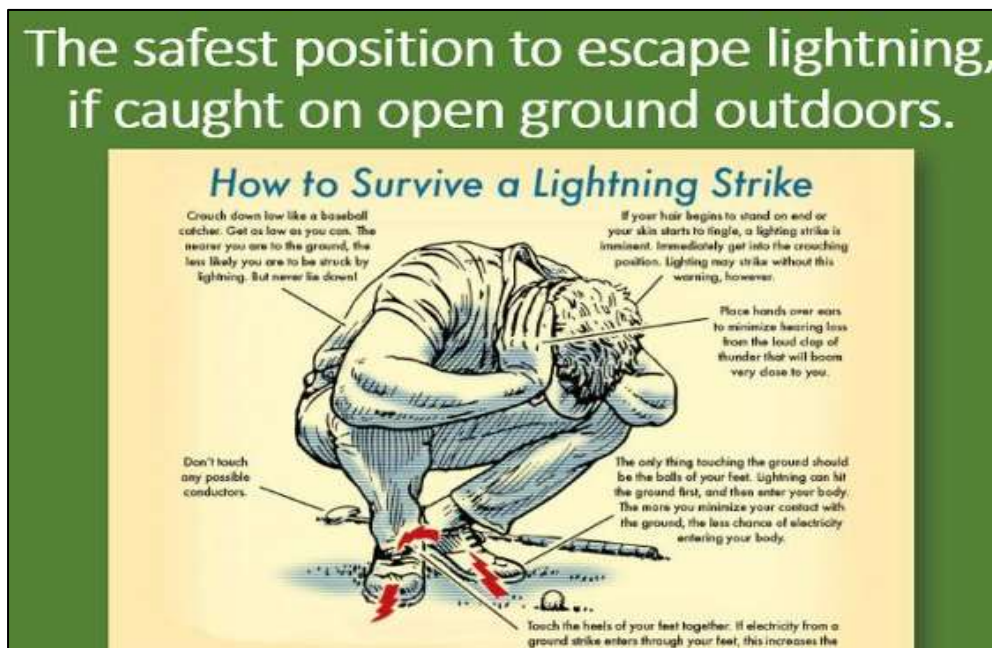
Lightning can also reach us through '*conduction*', which is from contact with metallic objects such as a wire fence, plumbing or landline that is connected to the telephone pole. Staying away from such objects is therefore important.

7. Keep those feet together.

Ground current affects cattle and deer the most. This is because their feet are wide apart, creating a voltage gradient as lightning travels horizontally along the ground

after a strike. The flow of current damages the heart as it enters through one leg and exits by the other, causing death.

When there is threat of ground current, keeping our feet close together will reduce injury. This is because the shorter the distance is between our feet, the smaller will be the voltage difference, and the less likely that our heart will be electrocuted.



8. What to do if a strike is imminent?

When the thundercloud is directly overhead, just before lightning strikes our body, we

may experience a tingling on our skin, and our hair will stand up. The best thing to do if a strike is imminent and there is no way to get indoors, is to crouch down with only the tips of our feet touching the ground, while the heels are raised off the ground and touching each other.

By doing so we are making ourselves as small as possible, while minimising contact with the ground. This reduces the chance of both direct and ground lightning strike.

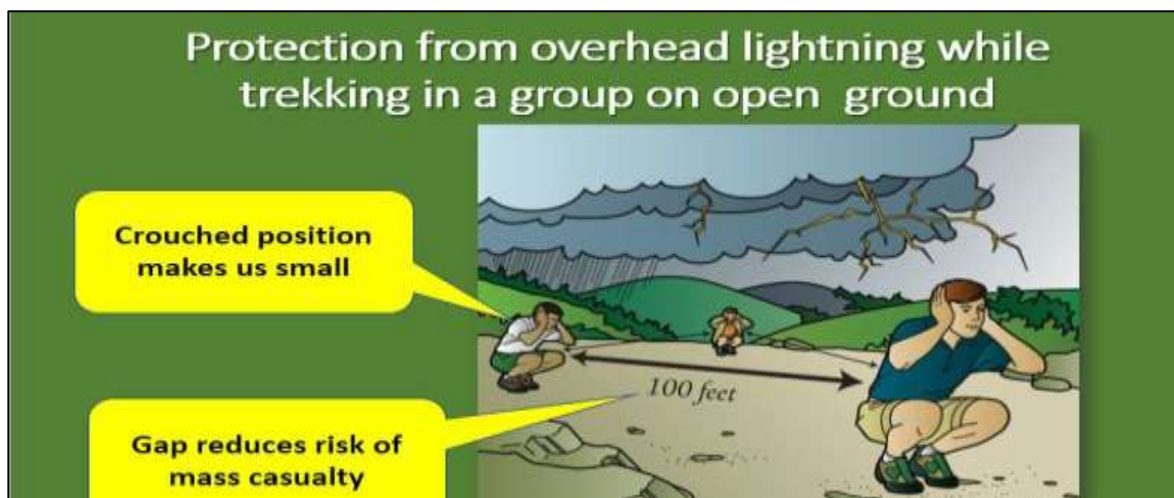
While crouching, if we can sit on a backpack or jacket, it serves as a potential electrical insulator. Once the overhead threat passes, we must run indoors to the safety of a building.

9. Avoid huddling together. Spread out.

If we are part of an outdoor group while the storm hits, instruct everyone to spread out at least 100 feet to minimise the risk of a *mass casualty*. This is because lightning can strike one person and then spread along the ground to hit people close by.

On the other hand, when people are spread out, even if one person gets struck, others will be able to come to the rescue.

It is worth noting in this context that lightning occurring as *ground current* instantly kills large numbers of animals that travel in herds. Two years ago in Norway, over 300 reindeer in a herd were killed during a single thunderstorm.



10. How to save a life.

If a person is found unconscious immediately following a lightning strike, CPR must be started without delay, and the victim must be shifted to hospital quickly. Doing CPR can save a life, because the heart would have stopped due to an electrical failure in its conducting system, and any time lost waiting for an ambulance can kill the person.

11. The metal myth.

Contrary to popular belief, there is no need to remove metallic objects from our body. Getting rid of items such as jewelry and watches does not protect us from lightning strike. At best, doing so might reduce the risk of skin burns in the unlikely event of our being hit. Considering the big picture, this advantage is therefore of questionable value.

12. Stay inside the car.

If we happen to be driving while the thunderstorm hits, the safest place to be is *inside* the vehicle with windows rolled up. That is because of the *Farraday cage effect*, where the

metal shell of the car, a good conductor of electricity, takes the hit while the occupants are protected. *It is important not to touch any of the metal parts of the vehicle* till the storm passes. The best place for our hands is in our lap.

If lightning hits a moving car, it is usually not damaged. However, occasionally electrical failure is known to occur, which can include sudden and unexpected deployment of airbags. The car must therefore be parked safely, windows shut and ignition turned off while we wait out the storm.

Being inside a bus or a truck is also considered safe due to the protective metal frame. However, the protective effect does not extend to cyclists, bike riders, tractors or convertible cars due to the lack of a metal shell.



13. Planes are safe.

Those who fly regularly might wonder about the risk of the plane being hit by lightning while in the sky. Though strikes do occur, the hard shell of the aircraft essentially works like a *flying Farraday cage*, protecting its occupants as well as internal circuitry. No aviation accidents have occurred in the past 50 years from

lightning strikes.

14. How far away was the strike?

At only 343 metres per second, sound travels much slower than light. This is why we get to see the lightning first, and then hear the thunder. The longer it takes for us to hear thunder after a flash of lightning, the farther away the strike is.

In fact, we can easily calculate how far away the lightning occurred simply by counting the number of seconds of delay between the flash and the sound. If we divide the delay in seconds by 3, we can calculate the distance in kilometers. For example, if there is a 30 second delay after seeing the lightning flash to hear the sound of thunder, it means that the incident occurred 10 km away; that is 30 divided by 3. When the delay is 15 seconds or less, it generally means that the next strike could be really close by. Until a few years ago, the teaching was that if the delay was less than 30 seconds, it was time to get indoors to safety because lightning was within striking distance. However, that recommendation has now been replaced by the slogan: *"When thunder roars, it is time to get indoors"*. This means that one has to get to the safety of indoors *as soon as* the first clap of thunder is heard.

Besides, many experts now believe that it is futile to make such a calculation, because lightning can strike us even from 15 km away from the area of rainfall. This is due to its ability to travel long distances across the sky before descending to the ground.



15. The safest place is indoors.

Fortunately, most thunderstorms last 30 minutes or less, and the safest place to be at that time is deep inside a solid, fully enclosed building. It is wise to stay away from windows, avoid touching any metallic objects or wires and avoid leaning on concrete walls. Bus shelters, open sheds and tents are unsafe options.

16. Be careful immediately after the rain.

Studies have shown that up to half of lightning strikes occur immediately following the thunderstorm. Hence, it is important to wait a full 30 minutes indoors after the last clap of thunder, before venturing outdoors.

17. Bolt from the Blue.

Lightning can strike even when the weather is sunny. Aptly called '*bolt from the blue*' this involves a positively charged lightning streak originating from a thundercloud, traveling long distances across the clear blue sky and finally striking ground that could be as far as 25 miles away.

18. No landlines, please.

It is foolish to talk on a wired telephone (landline) during a thunderstorm, as they are directly connected to outdoor posts that might easily be struck by lightning. Mobile phones must be unplugged from their chargers. Using mobile phones is safe during lightning as they are not connected to telephone posts by a wire.

19. Unplug electrical devices.

If lightning strikes an electric post outside, the current can travel through the wires and hit us if we are using an appliance that is plugged into the electrical outlet. Hence, it is unsafe to operate equipment such as the electric iron during thunderstorms.

At least a few people would be hopeful that surge protectors will prevent damage to electrical equipment during a lightning strike. Unfortunately, this is false. In fact, the huge blast of electricity from a lightning strike effortlessly jumps air gaps and gets past fuses and circuit breakers—almost as though they did not exist.

Therefore, *unplugging* is the only certain way to prevent damage to expensive equipmentsuch as TV or computers during a thunderstorm.

20. The shower and the dishes can wait.

It is safer not to take a shower or wash hands or dishes under a tap during a thunderstorm. This is because running water is a good conductor of electricity; and we stand the risk of being electrocuted if there is a lightning strike nearby.

21. Get out of the water.

Lightning can hit boats or swimmers in the water, hence it is safer to come to the shore and stay indoors during a thunderstorm.

Although reported fatalities are exceedingly rare, swimming pools are considered unsafe during thunderstorms because they are connected to a larger area of the ground by wiring and plumbing. A lightning strike anywhere nearby can potentially spread to the pool. It is recommended not to use the pool till at least 30 minutes after the last clap of thunder.

In summary, lightning strikes can be lethal or severely disabling. Almost having a mind of its own, it is impossible to predict *exactly* when and where a strike will occur. However,

we do know that nearly all the fatalities have occurred outdoors—a case of being in the *wrong place at the wrong time*. It is better to avoid being outdoors if there is a thunderstorm warning.

The survival tips listed are only meant to reduce the risk of a strike if we are caught outdoors when a thunderstorm occurs unexpectedly. Being indoors is always the safe.

Source:

<https://ndma.gov.in/Resources/awareness/lightning>

FAQs from IMD pertaining to thunderstorm and lightning:

FAQ

Frequently Asked Questions

Know your weather



What are negative and positive cloud to ground (CG) lightning?

When discharge occurs between negative charges in cloud and positive charges at earth's surface it is termed as negative cloud to ground lightning. On the other hand if discharge takes place between positive charges in cloud and negative charges at earth's surface it is termed as positive cloud to ground lightning.



 @Indiametdept

FAQ

Frequently Asked Questions

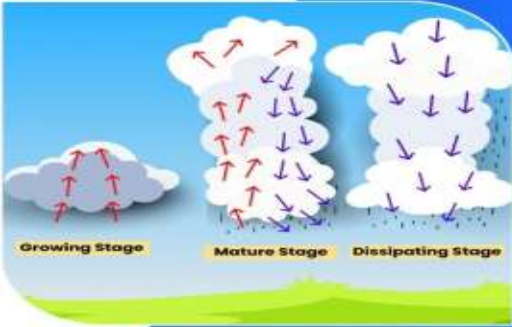
Know your weather



What are various stages of thunderstorm life cycle.

The life cycle of thunderstorm cloud has three stages:

1. Growing Stage
2. Mature Stage
3. Dissipating Stage



 @Indiametdept



Figure : Types of lightning

FAQ

Frequently Asked Questions

Know your weather




What is Lightning?

Lightning is an electrical discharge caused when static electricity builds up between thunderclouds, or thunderclouds and the ground.




@Indiametdept

FAQ

Frequently Asked Questions

Know your weather

How do I recognize that a thunderstorm is approaching my location?

- Rush of cool air towards you.
- Appearance of huge greyish-black tall cylindrical cauliflower like clouds in the sky.
- Thunder sound produced by a cloud and lightning in the sky.
- Hair standing up on the back of your neck could indicate that lightning is imminent very close to you.



    @Indiametdept

FAQ

Frequently Asked Questions

Know your weather

What is a thunder cloud?

The cloud which produces thunder and lightning is called a thunder cloud. Scientifically, it is known as cumulonimbus (Cb) cloud.



    @Indiametdept

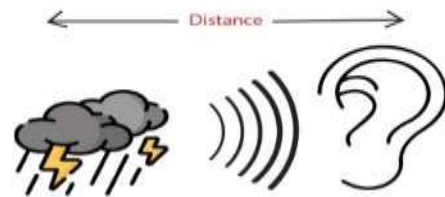
FAQ

Frequently Asked Questions

Know your weather

What is the audible range of thunderstorm?

The audibility of thunderstorm is normally about 20km i.e. you can hear a thunder if it occurs with a distance of upto 20km around you. Sometimes, it can be heard 40 km away.



 @Indiametdept



FAQ

Frequently Asked Questions

Know your weather

Is thunder cloud dangerous?

Thunder cloud is the most dangerous cloud as this is the only cloud that gives thunder, lightning, strong winds, flash floods etc. which are highly destructive in nature and are associated with huge loss of life and property.



 @Indiametdept



FAQ

Frequently Asked Questions

Know your weather

How much volts of electricity does a lightning stroke carries?

Lightning strokes carry up to 100 million volts of electricity and leap from cloud to cloud, or cloud to ground and vice versa.



    @Indiametdept



FAQ

Frequently Asked Questions

Know your weather

What instruments detect thunderstorms?

In addition to visual detection, thunderstorms can be detected by

- (a) Weather Radar
- (b) Satellites
- (c) Lightning Sensors



    @Indiametdept



FAQ

Frequently Asked Questions

Know your weather

Where is lightning more likely to strike?

The lightning is more likely to strike raised places over earth's surface like tall buildings or structures, trees, metallic objects, electric wires, standing animals and humans, water bodies etc. as these objects provide easy conduction path for discharging process and hence lightning strike.



    @Indiametdept



FAQ

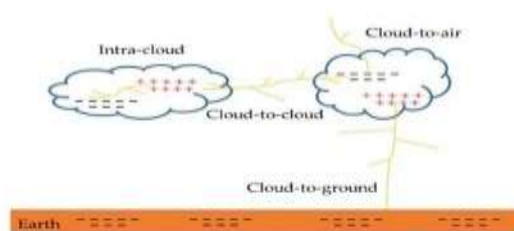
Frequently Asked Questions

Know your weather

What are the types of lightning?

Based on whether the discharge process is between clouds or cloud and earth, the lightning is of three types:

- Intra cloud (IC) Lightning
- Cloud to cloud (CC) Lightning
- Cloud to ground (CG) Lightning



    @Indiametdept



FAQ

Frequently Asked Questions

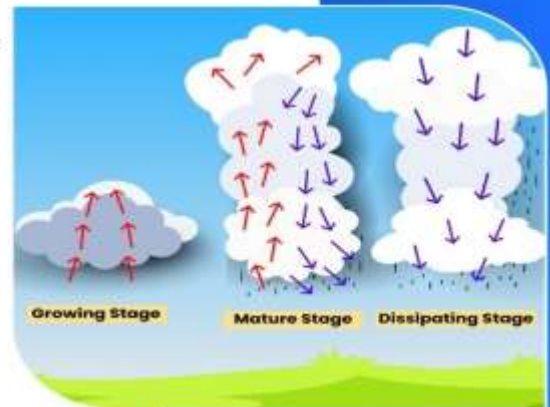
Know your weather



What are various stages of thunderstorm life cycle.

The life cycle of thunderstorm cloud has three stages:

1. Growing Stage
2. Mature Stage
3. Dissipating Stage



    @Indiametdept



Karnataka State Natural Disaster Monitoring Centre (KSNDMC)
Revenue Department (Disaster Management)
Government of Karnataka