Lightning Resilient India Campaign- a Citizen Science Approach to Save Life

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ABSTRACT

Lightning had been the biggest killer and a mysterious disaster. Till the year 2018, there was apparent rise in lightning fatalities mainly due to rising frequency and intensity of lightning strikes. There were frequent deaths of farmers, rural masses specially during Kalbaishakhi and monsoons. Deaths were sporadic but collectively they accounted 33% of total fatalities due to natural hazards. To address this hazard, India Meteorological Department (IMD) started lightning forecasts from 1st April 2019. To enhance outreach of IMD's forecasts and comprehensive solutions to Lightning, Climate Resilient Observing Systems Promotion Council (CROPC) in collaboration with IMD, IMS and World Vision India and Red Cross, launched Lightning Resilient India Campaign on 26 March 2019 with an aim to reduce lightning deaths by 80% in three years. The campaign, through multi-stakeholders' engagement at the national and state levels with government departments, academia, NGOs and communities, has been successful in bringing down deaths by more than 50% within a year. In addition, the scientific mapping of lightning in the whole of India as country as well as in all of its 37 states and union territories and in-depth analysis of data with citizen centric approach have been the key factors in effectively addressing the lightning hazard. Mapping of lightning in time and space brings out the hotspots and critical communities and assets to be saved. The scientific products of Ministry of Earth Science (MoES) institutions and ISRO's observations packed up in a citizen science format have yielded encouraging results. The outcome of Lightning Resilient India Campaign is tribute to the scientific community and an exemplary practice to seed science amongst the stakeholders in saving life, livestock and livelihood.

Keywords: Lightning Fatalities, Multi-Stakeholders, Scientific Mapping and Citizen Science.

1. Introduction

Lightning has been fascinating event since the evolution of our ecosystem. 3000 years back, Indian Vedic science had exhaustive mentions about lightning and its relation to wind, cloud and rains. In fact, lightning was accredited as a blessing from nature by process called nitrogen fixation where in lightning facilitates mixing of atmospheric nitrogen into soil before any cropping season. However, it remained a mystery. Recently, it was realised that Lightning is the biggest killer as compared to other natural hazards. One out of every third casualty is due to lightning. As per available data from national Crime Records Bureau (NSRB), more than 1.02 lakhs people have died due to lightning.

Lightning is a global phenomenon and at any given time more than 2 billion strikes keep taking place. Lightning is the occurrence of a natural electrical discharge of very short duration and high voltage between a cloud and the ground or within a cloud, accompanied by a bright flash and typically also thunder. it occurs in flash of seconds and hence impact is sudden unlike other disasters. The science of lightning is called fulminology and the fear of lightning is called astraphobia (Dwyer and Uman, 2013). Lightning has been extreme promulgation of climate change extremities, mainly due to environmental degradation because of deforestation, depletion of water bodies, pollution, concretization and global warming etc. The reason behind these deaths were mainly lack of early warning and ignorance towards various safety measures against lightning.

Off late, Lightning has been rising in intensity and frequency and hence the fatalities. Prior to 2019, every year, there were 2500-3000 deaths being recorded due to lightning. These deaths due to deaths were sporadic in nature, it didn't draw attention locally. Once taken cumulatively, it amounted to 33% of total human fatalities. There

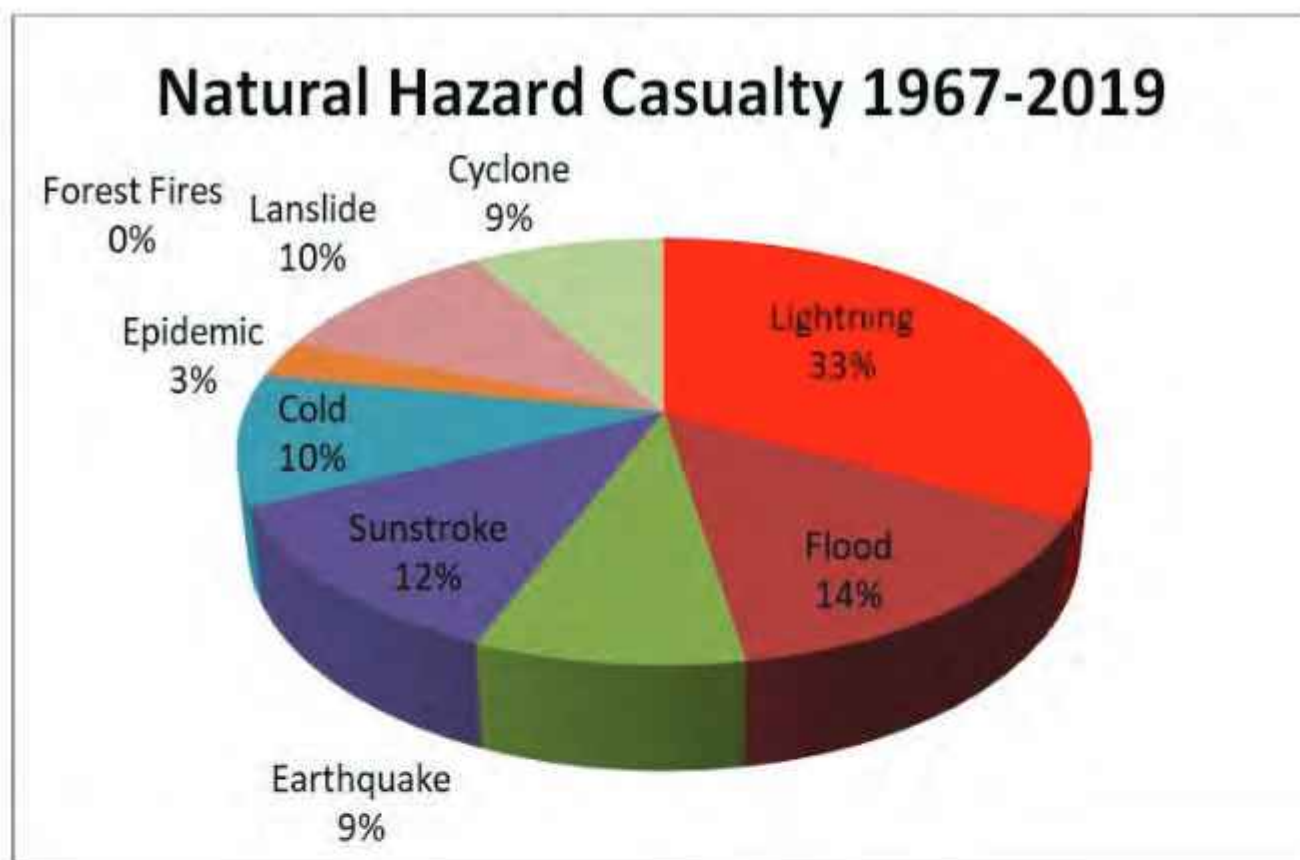# Natural Hazard Casualty 1967-2019

Figure 1: Details of natural hazards casualties during 1967-2019.

are large number of cases which go unreported too. A diagnostic study of cloud physics and lightning flashes versus deaths in the North East corroborates it (Choudhury et al., 2020). Economic losses to animals and critical infrastructures to household goods are yet to be ascertained. Thus, lightning becomes the biggest killer as compared to other natural disasters. Yet it is not notified as a natural disaster by Ministry of Home Affairs. Few states have declared it as state specific disaster.

To stop lightning deaths immediately, lightning Resilient India Campaign was launched on 26 March 2019 in synchrony with India Met Department lightning forecast with effect from 01 April 2019. The campaign is a join initiative of Climate Resilient Observing Systems Promotion Council (CROPC) and India Meteorological Department (IMD) supported by Indian Meteorological Society (IMS), National Disaster Management Authority (NDMA), State Governments, academia and NGOs etc. This being a thermo-hydro-electric phenomenon, needed scientific approach focused towards the ultimate

safety of community. The aim is to reduce lightning deaths of human beings, livestock and wild animals by 80% in next 3 years. It is a two pronged approach to; i) stop deaths of life, livestock and livelihood and ii) undertake long term climate change adaptation at grass root level. Lightning Resilient India Campaign adopted a citizen science approach focused towards the community. The campaign has been able to reduce deaths by more than 50% and the increasing awareness and comprehensive measures is expected to achieve zero avoidable deaths due to Lightning.

2. The Campaign: A Collaborative Effort

IMD's Lightning Early Warning (EW) products launched on 1st April 2019 were required to be taken to the stakeholders such as State Disaster Management Authorities (SDMAs) and ultimately to the community. This being a short term phenomenon, the EW to reach to community on time was real challenge. In addition, responsibility to generate the community education and awareness on understanding the risk and Dos and Don'ts was a herculean task. The paper by Antunes et al.

(2020) on time line distance estimation of lightning is significant in this aspect.

Climate Resilient Observing Systems Promotion Council (CROPC), a non-profit organization has taken up the responsibility to function as interface between IMD and other Government and non-government agencies to reach the last mile. The mission has reduced the rising casualties and also has initiate wide spread measures for intimate climate change adaptation by community and prevent human deaths. Accordingly, the Lightning Resilient India Campaign was launched on 26 March 2019 at IIT Delhi jointly by CROPC, IMD, MoES, IMS and World Vision India (WVI) supported NDMA, National Remote Sensing Center (NRSC), Indian Space Research Organization (ISRO) North Eastern Space Application Center (NESAC), Indian Red Cross Society (IRCS), UNICEF, Association of Agro Meteorologists (AAM) and many central and state Government agencies, INGOs/local NGOs. This campaign created a network and started awareness programmes in all states. A number of regional and state level multi stakeholders' consultations, seminars, workshops, school, panchayat and village level programmes were conducted. Academia was entrusted with major responsibility of research, awareness amongst school children. Farmers, tribal and vulnerable sections were given due importance along with ongoing research and development. Lightning protection was a big gap, especially at grass root level. A number on innovative practices also commenced and the campaign picked up in many sectors. IMS played a great role in sensitizing stakeholders and the community towards generating awareness about early warnings, precautionary & preventive measures and ultimately lightning protection. IMS along with CROPC has been instrumental in educating state authorities about the lightning early warnings, dissemination of warnings to community, awareness and training about lightning safety, research and development and thereby enhance outreach lightning products of IMD. EW credibility on extreme weather events has been established and there has been phenomenal reduction in deaths by more than 50%. The major scientific outcomes are as summarized in the next section.

3. Mapping of Lightning Flashes

India has had the first ever mapping of complete lightning strikes for that is total lightning, Intra or Inter Cloud (IC) lightning and Cloud to Ground (CG) lightning due to this campaign. During the period of 1st April 2019 to 31st March 2020, the details of lightning strikes are as given in Figure 2.

Lightning strikes were mapped for the entire country and individually for all 37 states and union territories. The lightning strikes map of CG lightning for India prepared is given in Figure 3. This map reveals lightning prone zones, also called as lightning hotspots. This is going to be important map for strategizing lightning risk management by both national and state governments. It has critical bearing on land use pattern and development of infrastructures.

4. Climatology of IC and CG Lightning Strikes

The strikes recorded during the campaign period have been collated with an aim to develop climatology of IC and CG clouds. The first ever such plot also (Figure 4) reveals the intensity of CG clouds during various months. The monthly variations and the seasonality of CG clouds is going to be the most critical aspect in planning the lightning safety prevention and mitigations at local level.

In Figure 5, the lightning strikes were plotted for each quarter. It was found that the lightning strikes was different for different quarters. The same has been depicted in Figure 5.

5. Impacts of Lightning Strikes with Special Reference to Deaths

There was extensive mapping of deaths and data collection of fatalities through the volunteers' network. This gave out the impact of lightning strikes in various states. It shows the preparedness of states and the particular areas and time interval where they need to work to prevent the losses. Odisha with the highest strikes of 14.20 lac plus has recorded 207 deaths whereas states like Uttar Pradesh and Bihar incur double the losses with half the strikes. The comparative analysis of lightning strikes vis-a-vis deaths in states has been depicted in Figure 6.

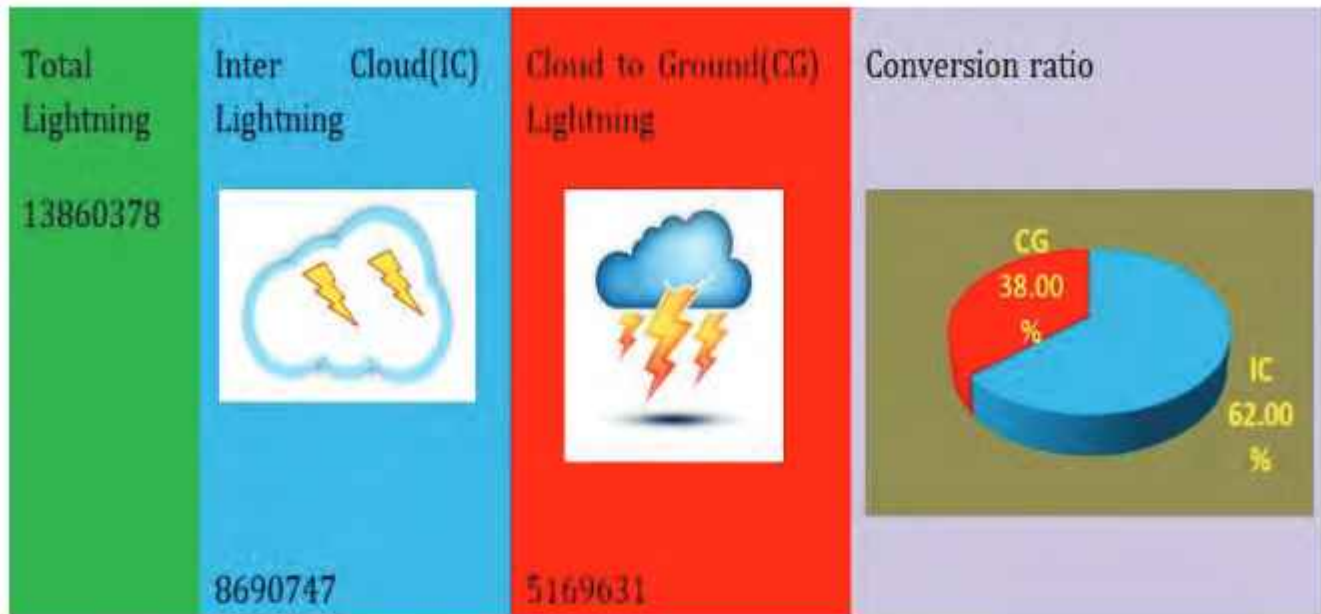| Total Lightning	Inter Cloud(IC) Lightning	Cloud to Ground(CG) Lightning	Conversion ratio
13860378			
	8690747	5169631	

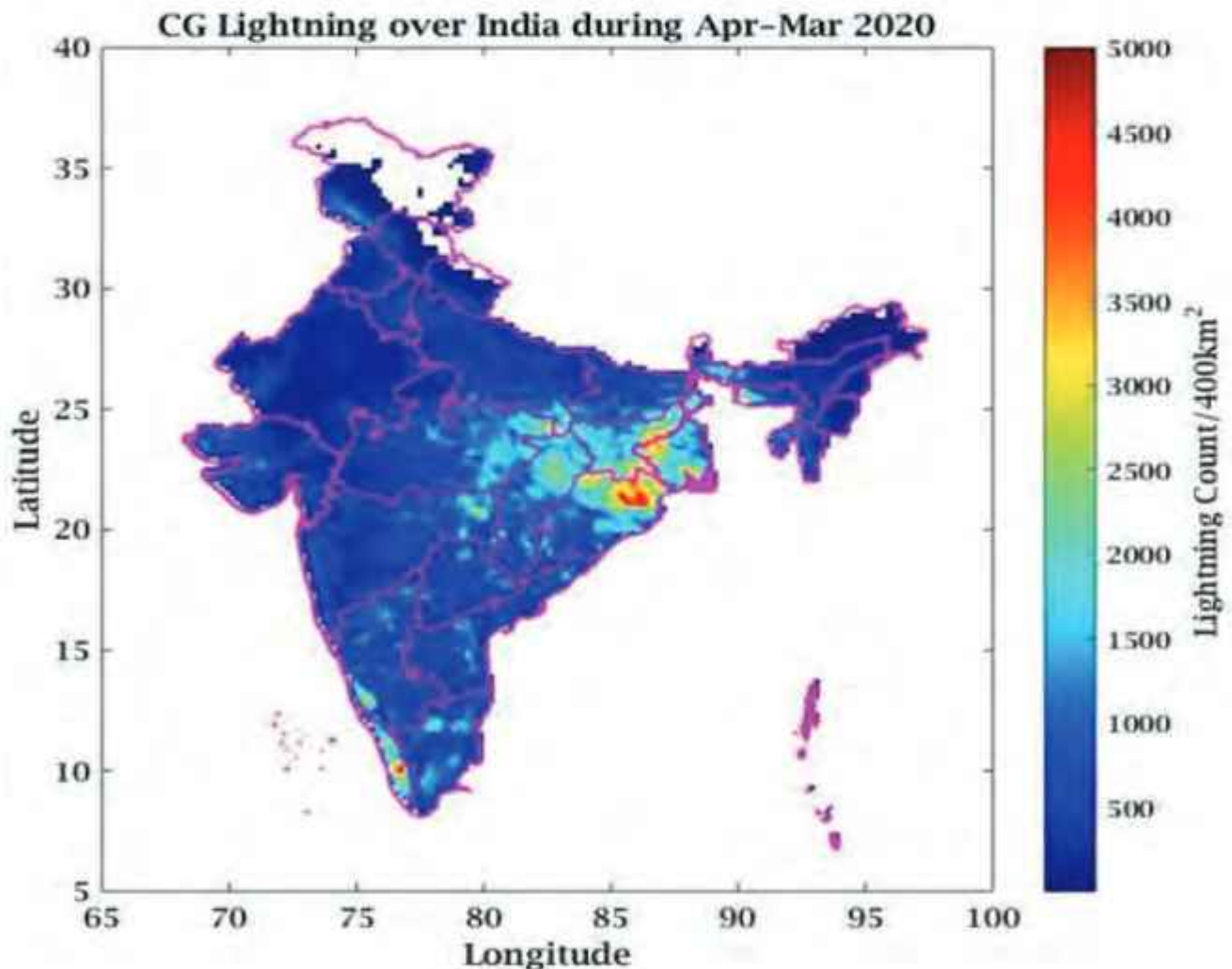Figure 2: Lightning strikes counts recorded over India from 1 April 2019 to 31 March 2020.

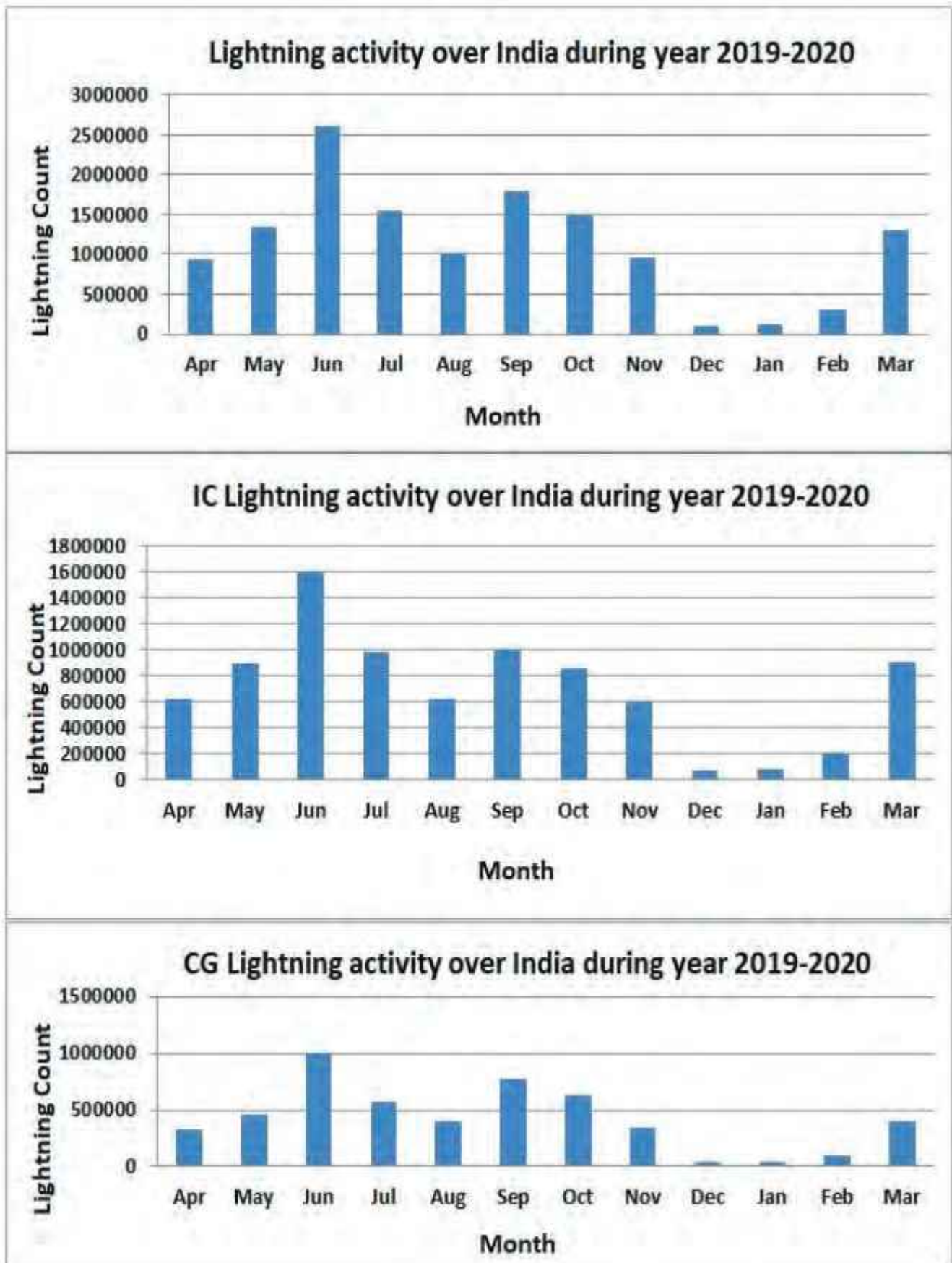Figure 3: Lightning strike flashes for the period 1 April 2019 to 31 March 2020.

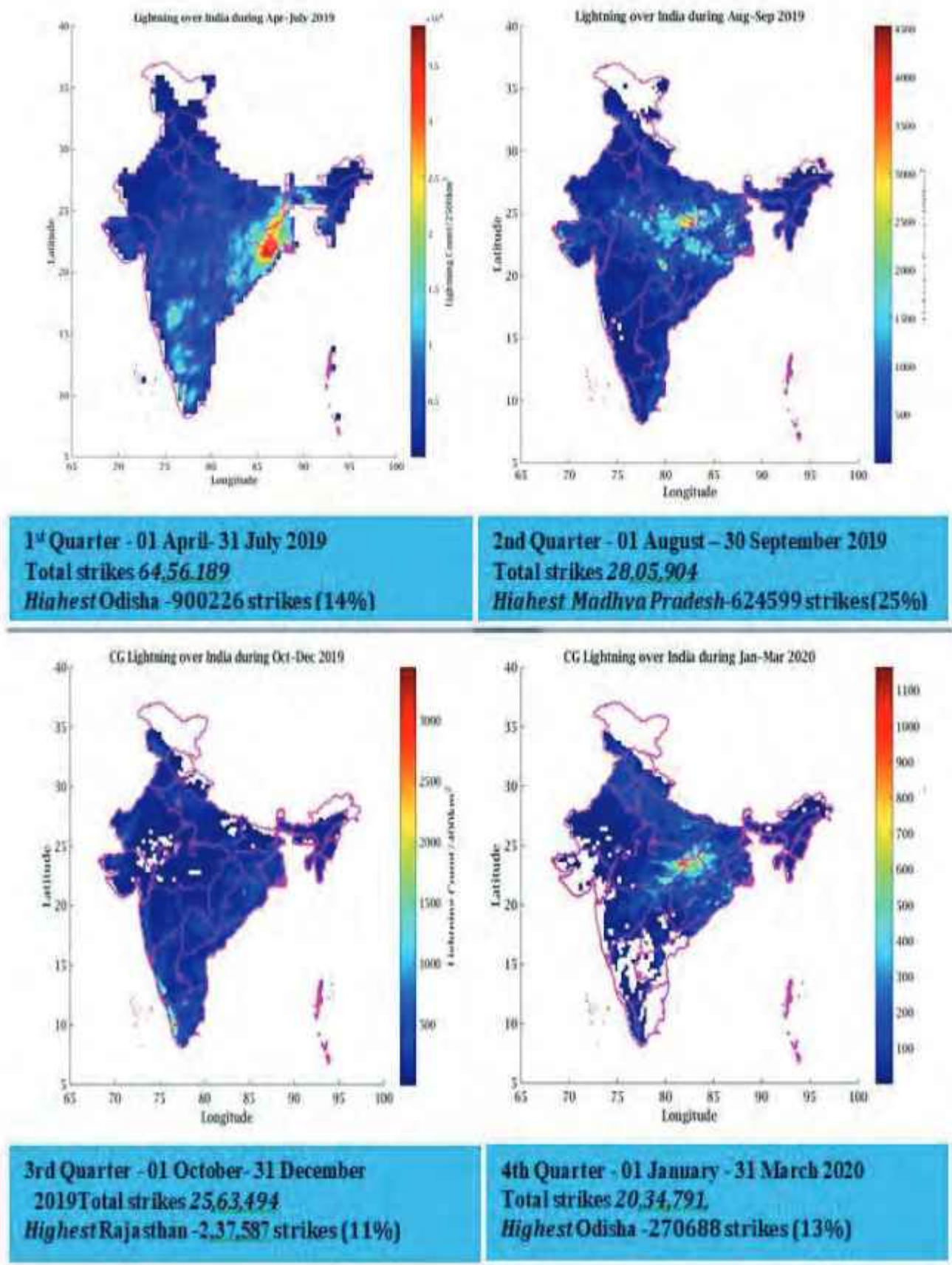Figure 4: Monthly variation of IC and CG clouds during 2019-2020.

1st Quarter - 01 April- 31 July 2019
Total strikes *64,56,189*
Highest Odisha -900226 strikes (14%)

2nd Quarter - 01 August – 30 September 2019
Total strikes *28,05,904*
Highest Madhya Pradesh-624599 strikes(25%)

3rd Quarter - 01 October- 31 December
2019Total strikes *25,63,494*
Highest Rajasthan -2,37,587 strikes (11%)

4th Quarter - 01 January - 31 March 2020
Total strikes *20,34,791,*
Highest Odisha -270688 strikes (13%)

Figure 5: CG Lightning variability observed during four quarters of the year 2019-2020.
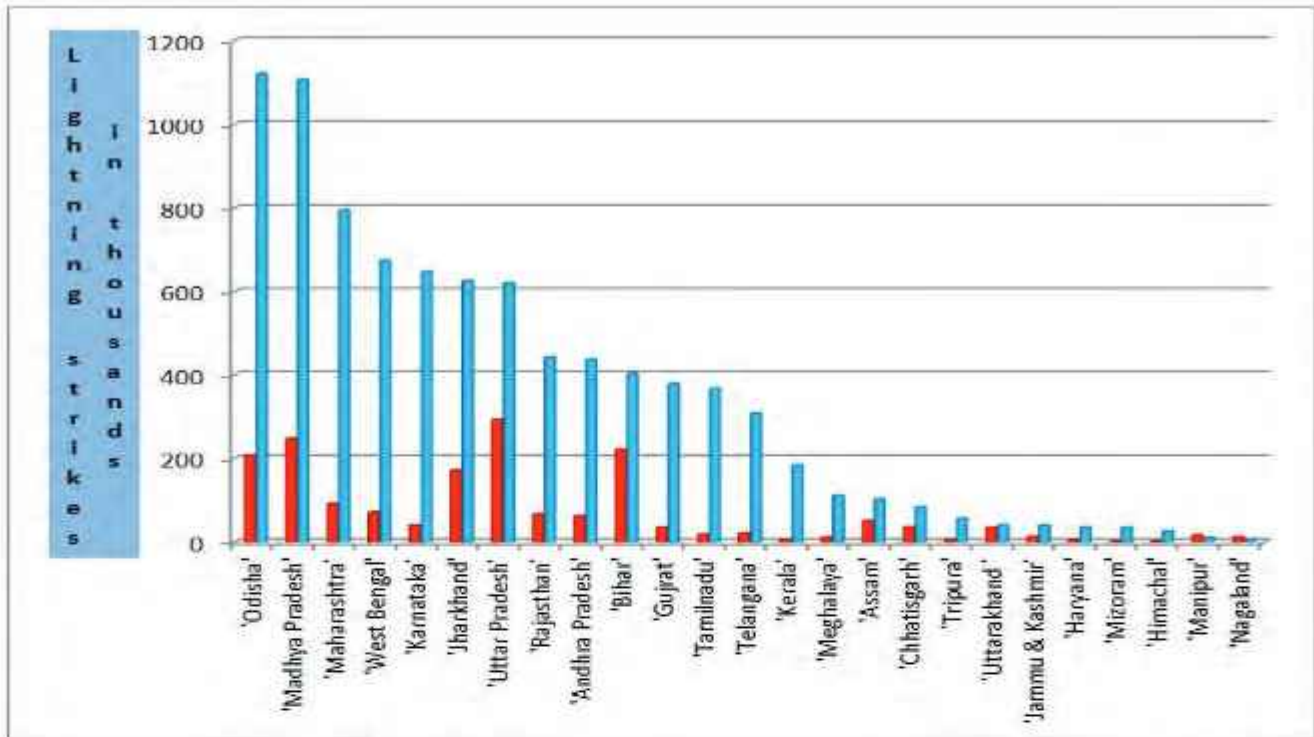
Figure 6: Comparative analysis of lightning strikes vs deaths.
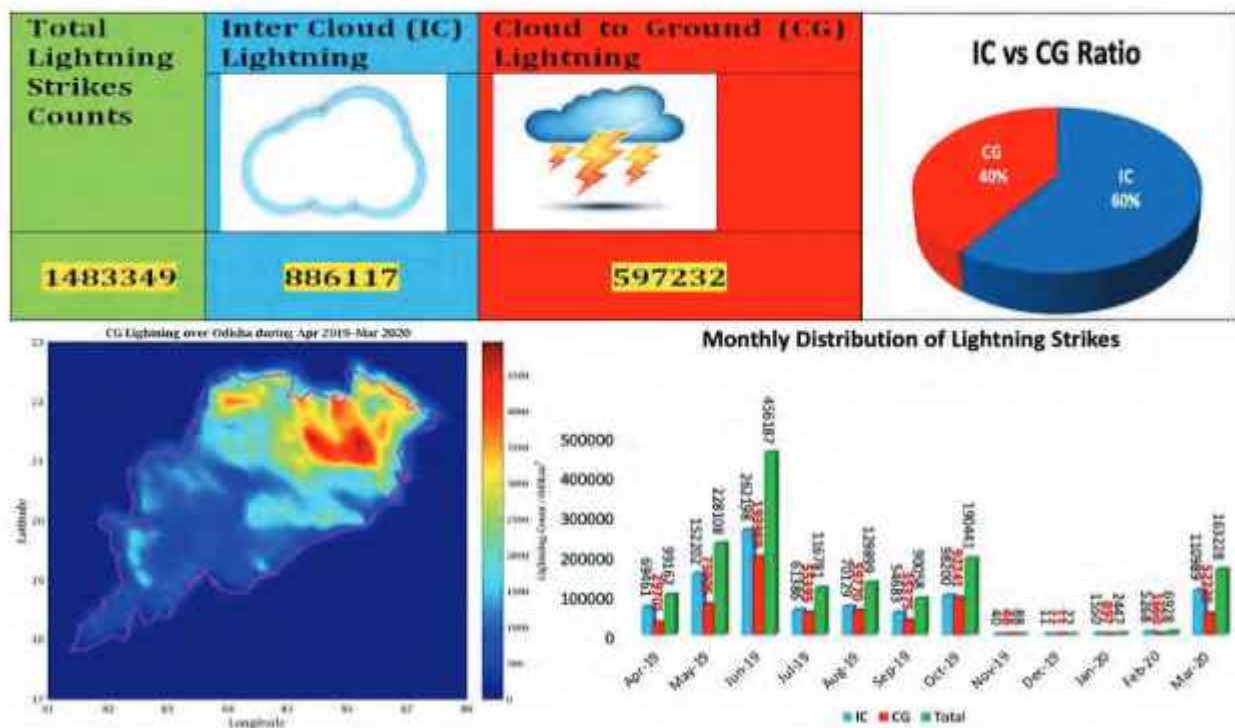
Figure 7: Precise view of lightning strikes in Odisha during year 2019-2020 and its seasonality.

6. Lightning Risk Management Analysis of States

A comprehensive mapping of lightning phenomena in states along with the vulnerability of population including special groups like tribal, PVTG, children, women, industries, economic assets was assessed and shared. This assisted states in proper identification of risks. States like Odisha and Andhra Pradesh could bring down deaths by almost 70% within a short period. A sample of Odisha is depicted in Figure 7.

Andhra Pradesh

Assam

Bihar

Uttarakhand

Gujarat

Jharkhand
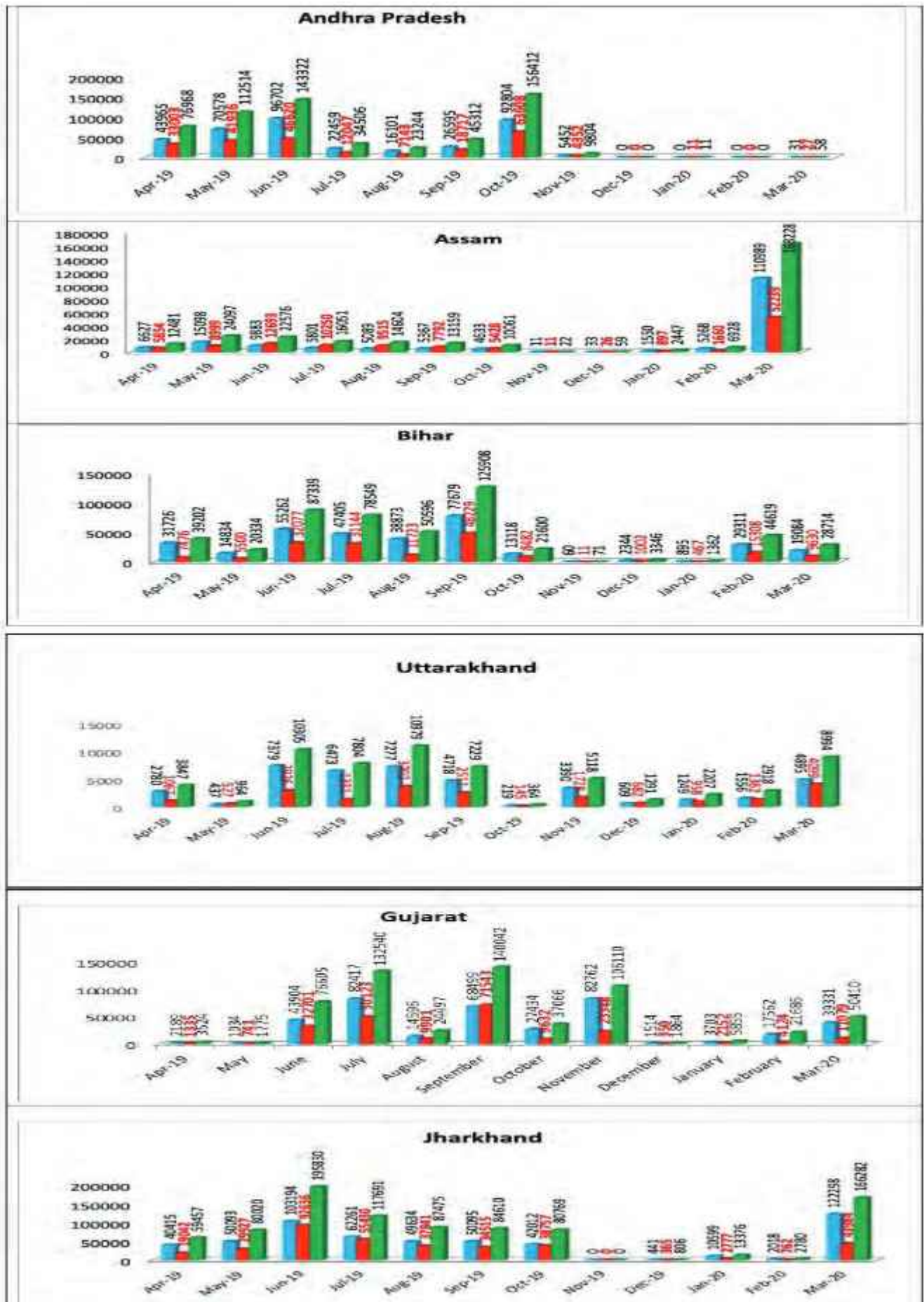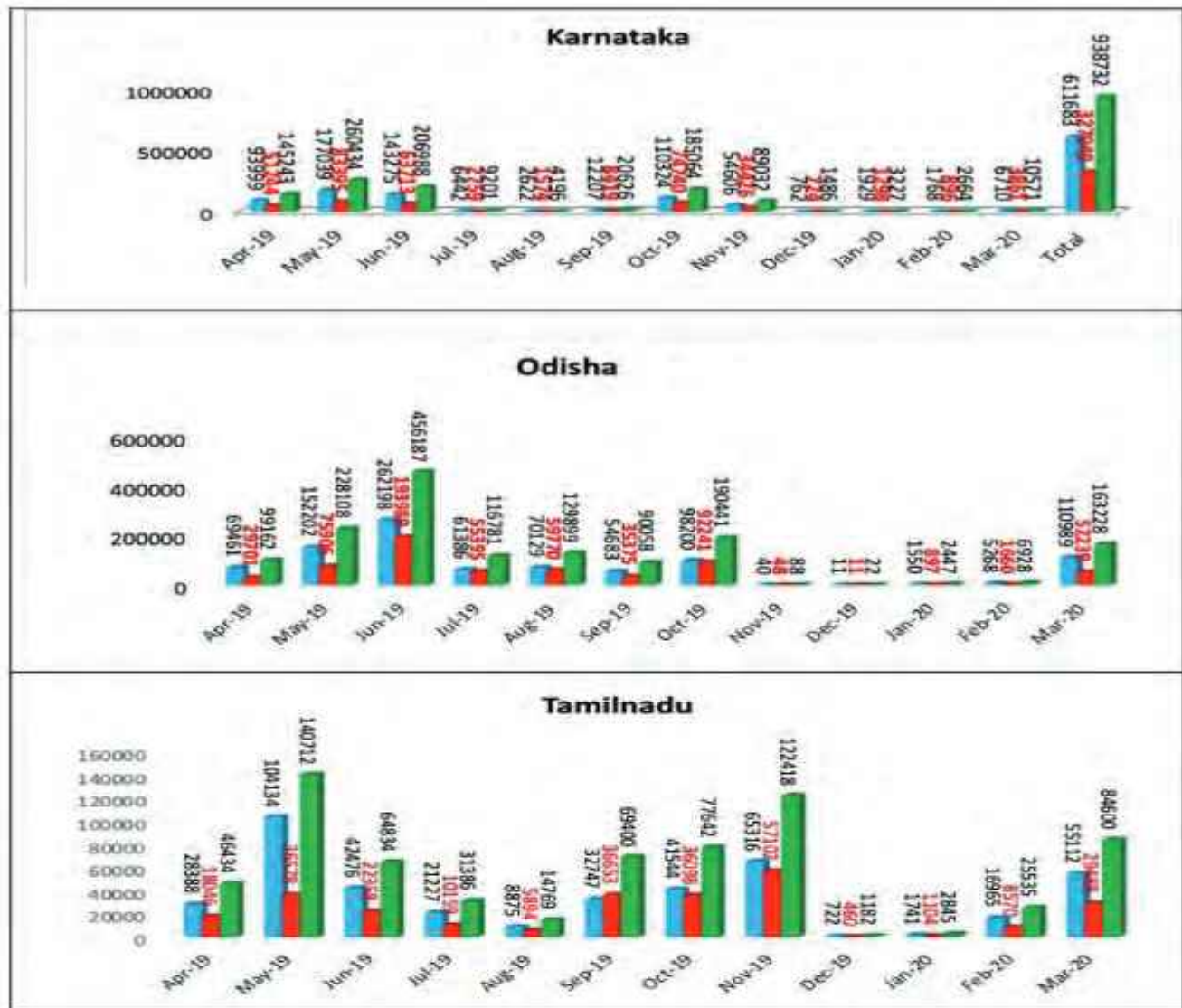
Figure 8: State wise seasonality of lightning strikes during year 2019-2020.

7. Seasonality of Lightning among States

The lightning recorded during the period reveals that seasonality of lightning is different for different states. Figure 8 shows month wise lightning strikes in some of the states. It makes amply clear that the Lightning Risk Management programme for each state has to be customised as per seasonality, intensity and frequency of lightning. It has also revealed that lightning is highly localised phenomena and it varies at different geographical areas. Thus within a state, the seasonality and severity may vary for different areas viz. coastal, hilly, river basin, urban and industrial areas. , It is recommended that states should undertake lightning micro zonation for geographical region wise precise handling of the risk .

Lightning has been generally observed during the second half of the day. However, during intense cloud movement with high wind speed, especially during monsoon and cyclonic activities, lightning may occur anytime. Lightning also depends on local geographical conditions like its different in coastal region, hilly areas and river basins. Recent lightning strikes in Bihar and UP on 25-26 June 2020 as the cloud moved from north Bihar to south Bihar, the lightning started from morning till late evening as per the movement of the cloud and so was the fatal impact felt on ground. Similarly, vulnerability of population and geographical area was deduced out the scientific mapping. This has given a scientific strategy to states and hence there was sudden fall in the number of fatalities in many sincere states.
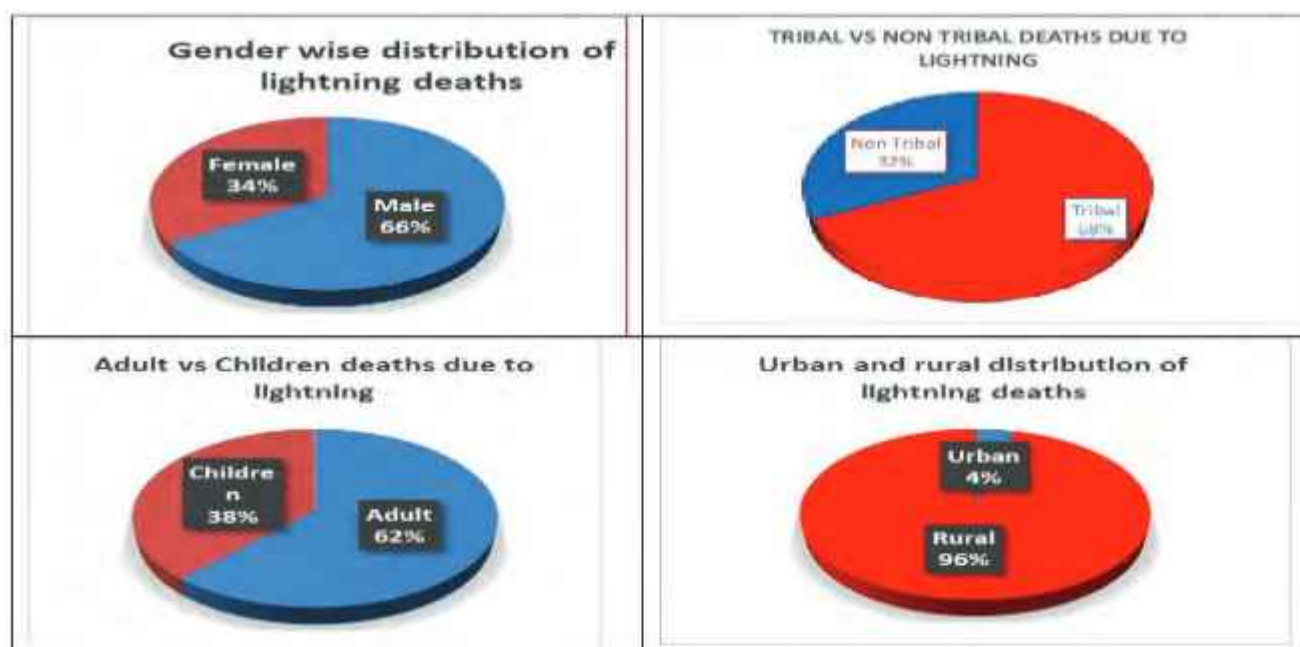
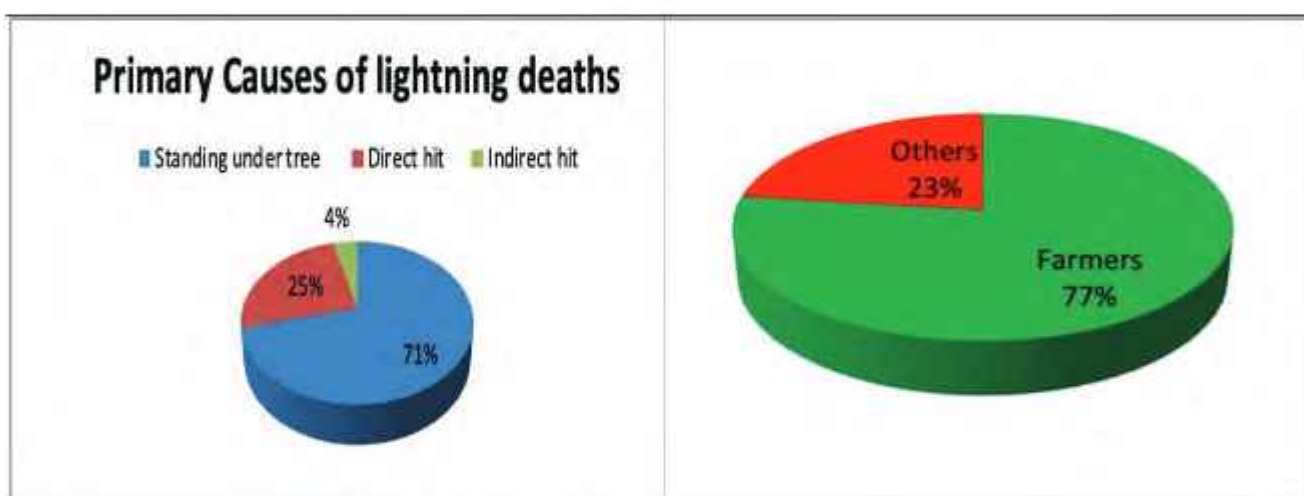Figure 9: Identification of vulnerable groups.

Figure 10: Primary causes of deaths due to lightning.

8. Identification of Vulnerable Groups and Circumstances of Lightning Victims

The mapping of lightning strike based hotspots and the analysis of its impact, revealed the circumstances of deaths and cross sections of population loosing life. This was immensely helpful in focused approach towards targeted vulnerable community. Interestingly, it was revealed that the lightning strikes map matched with the tribal map of India. There used to be 60-70% deaths of tribal due to lightning in Jharkhand, Odisha, Madhya Pradesh, West Bengal and others. The lightning strikes based mapping for tribal area could diagnose the reasons for their fatalities in terms of tinned

housing pattern and their nature of livelihood that is living off the land. These findings have been depicted in Figure 9.

Based on the recent fatalities and during previous year, it has been observed that fatalities during pre-monsoon to initial monsoon are more due to farmers being in agriculture fields or in orchards. Strikes also occur over their huts. In the later part of the year, i.e. in September, majority die due to their standing under tall trees or inside their huts. Lightning deaths categorised circumstances wise are given in Figure 10. It reveals the fact that capacity needs to be built in terms of awareness, education and training.

9. Summary

Lightning Resilient India Campaign was launched on 26 March 2019 with an objective to reduce lightning deaths by 80% in three years. This campaign was executed through multi-stakeholders' engagement at the national and state levels by including government departments, academia, NGOs and communities at large. This combined effort has been able in bringing down deaths by more than 50% within a year. In addition, the scientific mapping of lightning in the whole of India as a country, as well as in all of its 37 states and union territories and in-depth analysis of data with citizen centric approach have been the key factors in effectively addressing the lightning hazard. Mapping of lightning in time and space brings out the hotspots and critical communities and assets to be saved. Citizens' science approach towards lightning resilience has effected governments at national and state levels, decision makers, academia and community. The findings establish the fact that although lightning varies from state to state, it is a national disaster. The paper by Kumarasinghe (2008) gives good insight to similar challenges in Srilanka. The recommendation of the campaign has brought in significant policy level interventions by most of the states. Various tools envisaged for dissemination of IMD's lightning forecast have been adopted greatly. The high level of awareness generated towards lightning resilience, policy and community level interventions have enhanced aspirations of Lightning Resilient India Campaign to ambitious goal of zero lightning deaths. The journey continues and it is aimed at utilising science for the good of humanity.

Acknowledgements

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