Disaster and Disaster Management in India : PYQs

Various disasters, Zonation mapping their Vulnerability, Guidelines, Management strategies and Dos and Don't s

0DM related mains questions:

1. 2011- Composition and functions of the National Executive Committee of the National Disaster Management Authority.(2011/5 Marks)

2. 2013 -1. How important are vulnerability and risk assessment for pre-disaster management? As an administrator, what are key areas that you would focus on in a Disaster Management System? 10

2014-

3.

14. सूखे को उसके स्थानिक विस्तार, कालिक अवधि, मंथर प्रारम्भ और कमज़ोर वर्गों पर स्थायी प्रभावों की दृष्टि से आपदा के रूप में मान्यता दी गई है। राष्ट्रीय आपदा प्रबन्धन प्राधिकरण (एन० डी० एम० ए०) के सितम्बर 2010 मार्गदर्शी सिद्धान्तों पर ध्यान केन्द्रित करते हुए भारत में एल नीनो और ला नीना के सम्भावित दुष्प्रभावों से निपटने के लिए तैयारी की कार्यविधियों पर चर्चा कीजिए।

Drought has been recognized as a disaster in view of its spatial expanse, temporal duration, slow onset and lasting effects on vulnerable sections. With a focus on the September 2010 guidelines from the National Disaster Management Authority (NDMA), discuss the mechanisms for preparedness to deal with likely El Niño and La Niña fallouts in India.

2015-

4.

1. The frequency of earthquakes appears to have increased in the Indian subcontinent. However, India's preparedness for mitigating their impact has significant gaps. Discuss various aspects.

2016.

5.

1. The frequency of urban floods due to high intensity rainfall is increasing over the years. Discussing the reasons for urban floods, highlight the mechanisms for preparedness to reduce the risk during such events.
2. 6.
3.
4. With reference to National Disaster Management Authority (NDMA) guidelines, discuss the measures to be adopted to mitigate the impact of recent incidents of cloudbursts in many places of Uttarakhand.

2017

2017

1. On December 2004, tsumani brought havoc on 14 countries including India. Discuss the factors responsible for occurrence of Tsunami and its effects on life and economy. In the light of guidelines of NDMA (2010) describe the mechanisms for preparedness to reduce the risk during such events.

2018

Describe various measures taken in India for Disaster Risk Reduction (DRR) before and after signing 'Sendai Framework for DRR (2015-2030)'. How is this framework different from 'Hyogo Framework for Action, 2005'? (250 Words, 15 Marks)

2019

1. Vulnerability is an essential element for defining disaster impacts and its threat to people. How and in what ways can vulnerability to disasters be characterized? Discuss different types of vulnerability with reference to disasters. **(Answer in 150 words) 10**

2. 1. Disaster preparedness is the first step in any disaster management process. Explain how hazard zonation mapping will help disaster mitigation in the case of landslides. **(Answer in 250 words)15**

2020 (jan 2021)

1. Discuss the recent measures initiated in disaster management by the Government of India departing from the earlier reactive approach.
(Answer in 250 words) 15

2021 (jan 2022)

1. Discuss about the vulnerability of India to earthquake related hazards. Give examples including the salient features of major disasters caused by earthquakes in different parts of India during the last three decades. (Answer in 150 words)

2. Describe the various causes and the effects of landslides. Mention the important components of the National Landslide Risk Management Strategy. (Answer in 250 words)

2022. sept 2022

1. Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples. (Answer in 150 words) 10

2. Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating the hazard? (Answer in 250 words)15

2023

1. Dam failures are always catastrophic, especially on the downstream side, resulting in a colossal loss of life and property. Analyze the various causes of dam failures. Give two examples of large dam failures. *(Answer in 150 words) 10*

UPSC DM exam related guidelines, questions asked and expected topic 2024

Guidlines / strategy by NDMA

UPSC questions asked

Most expected 2024 onwards

Natural disaster guidelines

1. Earthquakes 2007 2015 , earthquake related hazards 2022 (major disasters caused by earthquakes in different parts of India)
2. floods 2008
3. cyclone 2008
4. landslide 2009 Guidelines / 2019 Strategy 2019, 2022 (causes and the effects of landslides - Answer like landslide lakes (GC Leong), LLOF)
5. snow avalanche 2009
6. Tsunami 2010 2017
7. Urban flooding 2010 ,2016
8. Drought 2010 2014
9. boat safety 2017
10. Thunderstorm & Lightning/Squall/Dust/ Hailstorm & Strong Winds 2019
11. heatwave 2019
12. GLOF / LLOF 2020
13. cold wave and frost 2021
14. cloudburst 2016 , 2022

Man made disaster guidelines

Chemical 2007
Biological 2008
Nuclear and radiological 2009

additional Hazards Asked

High intensity rainfall 2016
Coastal erosion 2022
Dam failure 2023

1.13 Types of Disasters

Primarily disasters are triggered by natural hazards or human-induced or result from a combination of both. The human-induced factors can greatly aggravate the adverse impacts of a natural disaster. Even at a larger scale, globally, the UN Inter-Governmental Panel on Climate Change (IPCC) has shown that human-induced climate change has significantly increased both the frequency and intensity of extreme weather events. While heavy rains, cyclones, or earthquakes are all natural, the impacts may, and are usually, worsened by many factors related to human activity. The extensive industrialization and urbanization increase both the probability of human-induced disasters, and the extent of potential damage to life and property from both natural and human-induced disasters. The human society is also vulnerable to Chemical, Biological, Radiological, and Nuclear (CBRN) threats and events that might escalate to emergencies/ disasters.

1.13.1 Natural Hazards

The widely accepted classification system used by the Disaster Information Management System of DesInventar[3] classifies disasters arising from natural hazards into five major categories and is used globally for the Sendai targets monitoring:

1) Geophysical: Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Hydro-meteorological factors are important contributors to some of these processes.
2) Hydrological: Events caused by deviations in the normal water cycle and/or overflow of bodies of water caused by wind set-up
3) Meteorological: Events caused by short-lived/small to meso-scale atmospheric processes (in the spectrum from minutes to days)
4) Climatological: Events caused by long-lived meso- to macro-scale processes (in the spectrum from intra-seasonal to multi-decadal climate variability)
5) Biological: Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

A brief description of these five major categories of the disasters arising from natural factors with the sub-categories is given in Table 1-1. The below classification is not a watertight one. In real life situations, many disasters are a combination of different types of disasters. In addition, secondary disasters may occur after a disaster has occurred.

Table 1-1: Categories of Natural Hazards

	Family	Main Event	Short Description/ Secondary Disaster
1	Geophysical	Earthquake/ Mass movement of earth materials	• Landslide following earthquake; • Urban fires triggered by earthquakes; • Liquefaction - the transformation of (partially) water-saturated soil from a solid state to a liquid state caused by an earthquake

[3] http://www.desinventar.net/definitions.html (accessed Sep 20, 2019)

	Family	Main Event	Short Description/ Secondary Disaster
			• Mass movement of earth materials, usually down slopes • Surface displacement of earthen materials due to ground shaking triggered by earthquakes
		Volcano	• Surface displacement of earthen materials due to ground shaking triggered by volcanic eruptions • A type of geological event near an opening/vent in the Earth's surface including volcanic eruptions of lava, ash, hot vapour, gas, and pyroclastic material. • Ash fall; Lahar - Hot or cold mixture of earthen material flowing on the slope of a volcano either during or between volcanic eruptions; • Lava Flow • Pyroclastic Flow - Extremely hot gases, ash, and other materials of more than 1,000 degrees Celsius that rapidly flow down the flank of a volcano (more than 700 km/h) during an eruption
		Tsunami	Tsunamis are difficult to categorize they are essentially an oceanic process that is manifested as a coastal water-related hazard. A series of waves (with long wavelengths when traveling across the deep ocean) that are generated by a displacement of massive amounts of water through underwater earthquakes, volcanic eruptions or landslides. Tsunami waves travel at very high speed across the ocean but as they begin to reach shallow water they slow down, and the wave grows steeper.
2	Hydrological	• Flood • Landslides • Wave Action	• Avalanche, a large mass of loosened earth material, snow, or ice that slides, flows or falls rapidly down a mountainside under the force of gravity • Coastal Erosion - The temporary or permanent loss of sediments or landmass in coastal margins due to the action of waves, winds, tides, or anthropogenic activities • Coastal flood - Higher-than-normal water levels along the coast caused by tidal changes or thunderstorms that result in flooding, which can last from days to weeks • Debris Flow, Mud Flow, Rock Fall - Types of landslides that occur when heavy rain or rapid snow/ice melt send large amounts of vegetation, mud, or rock downslope by gravitational forces • Flash Flood Hydrological - Heavy or excessive rainfall in a short period of time that produce immediate runoff, creating flooding conditions within minutes or a few hours during or after the rainfall

	Family	Main Event	Short Description/ Secondary Disaster
			• Flood Hydrological - A general term for the overflow of water from a stream channel onto normally dry land in the floodplain (riverine flooding), higher-than normal levels along the coast and in lakes or reservoirs (coastal flooding) as well as ponding of water at or near the point where the rain fell (flash floods) • Wave Action: Wind-generated surface waves that can occur on the surface of any open body of water such as oceans, rivers and lakes, etc. The size of the wave depends on the strength of the wind and the travelled distance (fetch).
3	Meteorological	Hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that may last for minutes to days	• Cyclone, Storm Surge, Tornado, Convective Storm, Extra-tropical Storm, Wind • Cold Wave, Derecho • Extreme Temperature, Fog, Frost, Freeze, Hail, Heat wave • Lightning, Heavy rain • Sandstorm, Dust-storm • Snow, Ice, Winter Storm, Blizzard
4	Climatological	Unusual, extreme weather conditions related to long-lived, meso- to macro-scale atmospheric processes ranging from intra-seasonal to multi-decadal (long-term) climate variability	• Drought • Extreme hot/cold conditions • Forest/Wildfire Fires • Glacial Lake Outburst Flood (GLOF) • Subsidence
5	Biological	Exposure to germs and toxic substances	• Epidemics: viral, bacterial, parasitic, fungal, or prion infections • Insect infestations • Animal stampedes

1.13.2 Human-Induced Disasters

The NPDM 2009 notes that rise in population, rapid urbanization and industrialization, development within high-risk zones, environmental degradation, and climate change aggravates the vulnerabilities to various kinds of disasters. Due to inadequate disaster preparedness, communities, and animals are at increased risk from many kinds of human-induced hazards arising from accidents (industrial, road, air, rail, on river or sea, building collapse, fires, mine flooding, urban flooding, oil spills, etc.). Hazards due to CBRN threats and events rank very high among the causes that are human induced acts. Terrorist activities and secondary incidences arising from intentional or non -intentional activities also add to these risks and calls for adequate preparedness and planning.

VULNERABILITY PROFILE OF INDIA

India has been vulnerable, in varying degrees, to a large number of natural, as well as, human - made disasters on account of its unique geo-climatic and socio-economic conditions. Out of 35 states and union territories in the country, 27 are disaster prone. Almost 58.6 percent of the landmass is prone to earthquakes of moderate to very high intensity; over 40 million hectares (12 per cent of land) are prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; 68 per cent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches.

HAZARD PROFILE OF INDIA

India is one of the ten worst disaster prone countries of the world. The country is prone to disasters due to number of factors; both natural and human induced, including adverse geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, unscientific development practices etc. The four distinct regions of the country i.e. Himalayan region, the alluvial plains, the hilly part of peninsula, and the coastal zone have their own specific problems.

- The Himalayan region is prone to frequent seismic activities. As a result of various major river systems flowing from Himalaya and huge quantity of sediment brought down by them, the region is exposed to river channel siltation, resulting into frequent floods.

- The western parts of the country is very frequently hit by drought situation. The unusual change in the temperature and pressure gradient over ocean, results in cyclones in coastal regions. The geo-tectonic movements inside the ocean floor makes the coastal region prone to tsunami disaster too. India with its extended coast line is exposed to five to six tropical cyclones on an average, both from the Arabian Sea and the Bay of Bengal annually.

- Various human induced activities like increasing demographic pressure, deteriorating environmental conditions, deforestation, unscientific development, faulty agricultural practices over grazing, unplanned urbanisation, etc. are also responsible for accelerated impact and increase in frequencies of disasters in the country.

During the last three decades of the 20th century, (1980-2010) natural disasters in India have claimed a total death of 1,43,039 people (on an average more than 4,768

2.2.1 Multi-Hazard Vulnerability

As per the definition adopted by UNISDR, hazard is a dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. India, due to its, physiographic and climatic conditions is one of the most disaster-prone areas of the World. Nearly 59 per cent of the landmass is prone to earthquakes of moderate to very high intensity. More than 40 million hectares (12 per cent of land) is prone to floods and river erosion. Of the nearly 7,500 km long coastline, close to 5,700 km is prone to cyclones and tsunamis. Nearly 68% of the cultivable area is vulnerable to drought. Large tracts in hilly regions are at risk from landslides and some are prone to snow avalanches. Vulnerability to disasters/emergencies of CBRN origin also exists. Heightened vulnerabilities to disaster risks can be related to expanding population, urbanisation, and industrialisation, development within high-risk zones, environmental degradation, and climate change.

2.3 Regions/Areas Involving Multiple States Requiring Special Attention

While suggesting a holistic approach to DM, the High Power Committee[24] discussed three cases that merit special consideration on the geo-physical considerations: a) Himalayan region b) Coastal tracts, and c) Riverine areas. From the point of view of administrative and logistical perspectives, the North-East Region also requires specialized approach. Similarly, the Union Territories, remote Islands and offshore marine assets need to be treated differently given the specific administrative and logistical challenges. Therefore, there are six special categories:

1) Himalayan Region spanning more than one State
2) Coastal Tracts covering more than one State and UTs
3) Riverine Areas spread over one or more States
4) North East Region consisting of all eight States
5) Union Territories, Islands and Marine Assets located in one or more State and UTs
6) Arid and Semi-Arid Regions

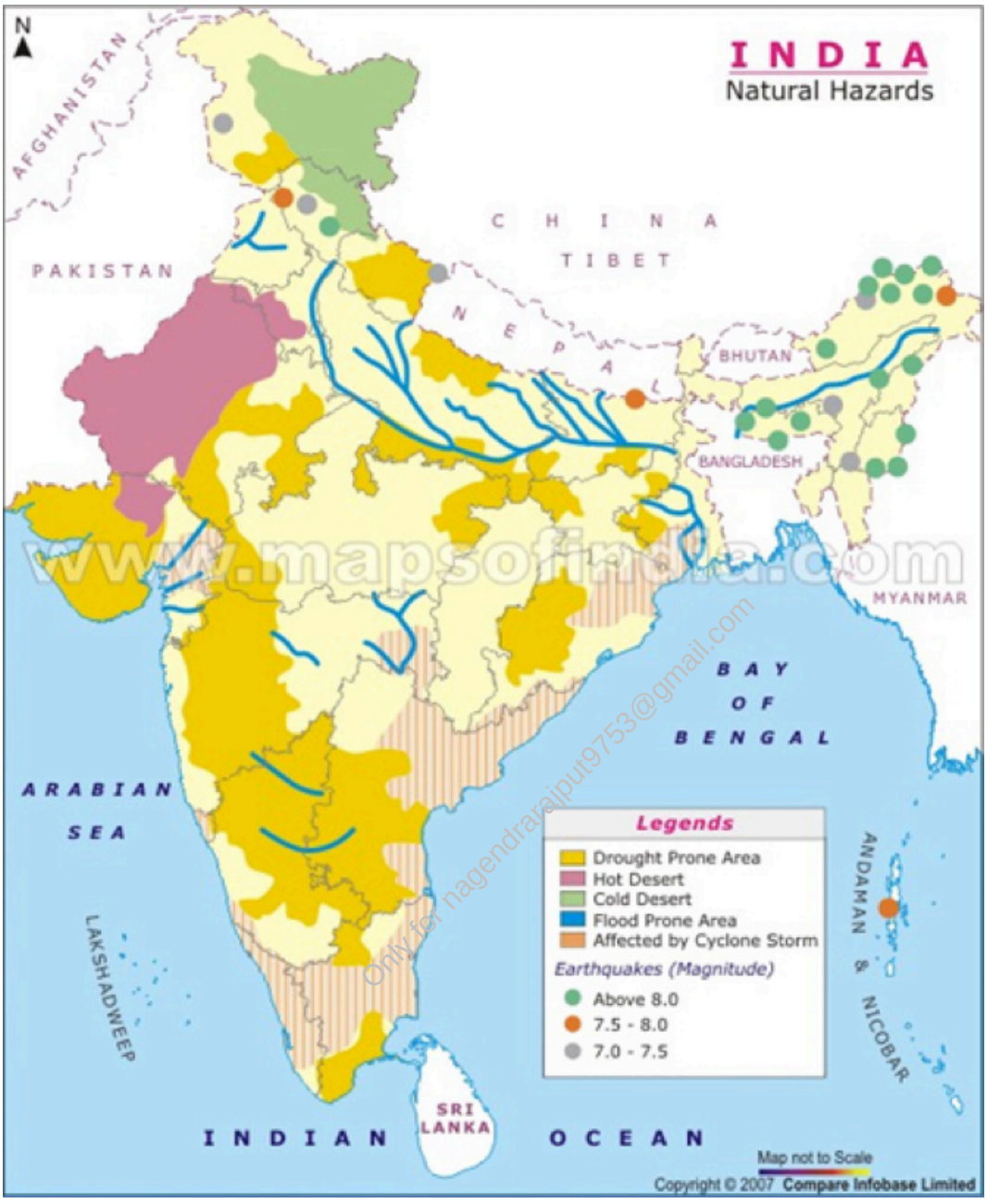


Table 1.9: India's major natural disasters since 1990

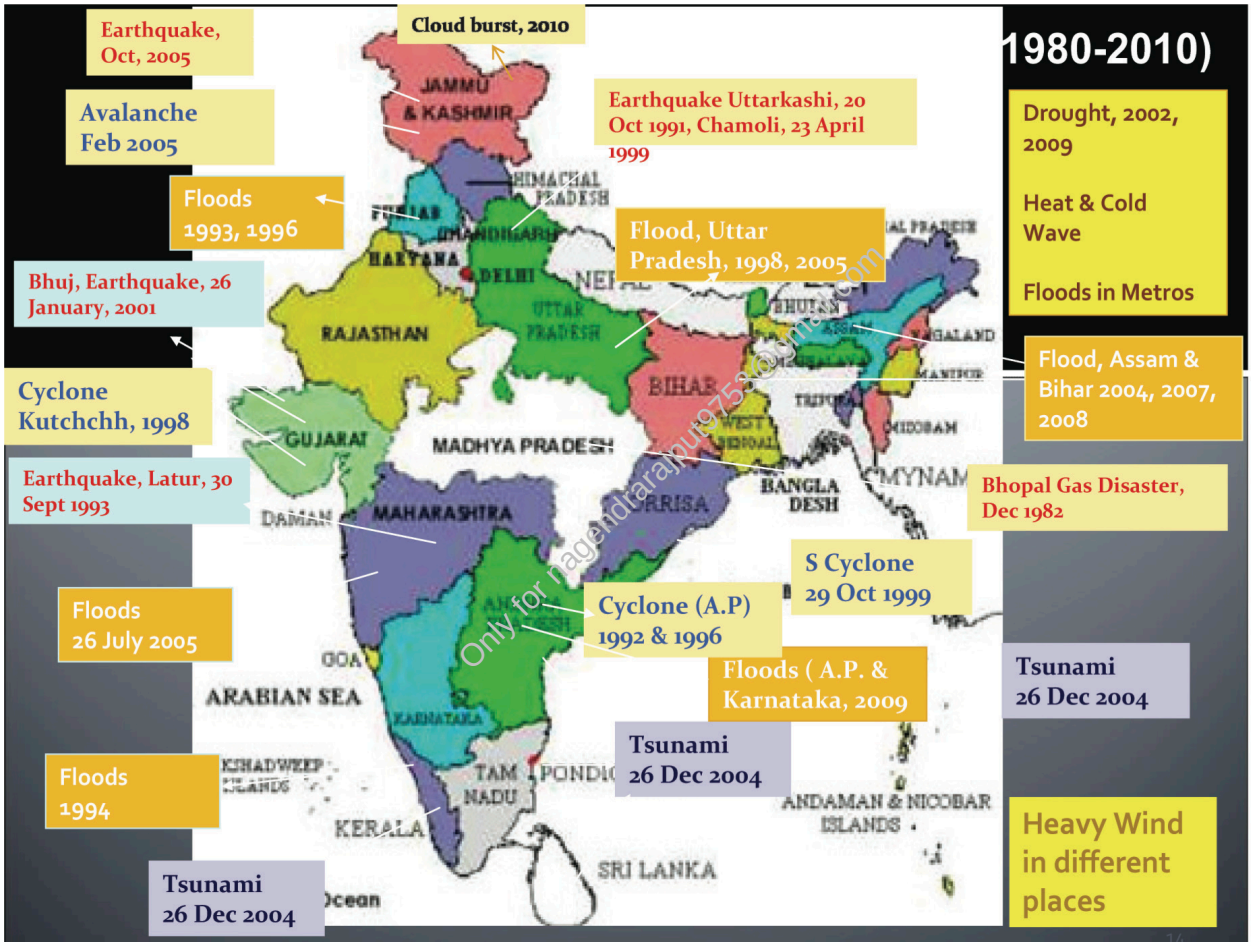
Year	Type	Affected population location	Loss (no. of human life)	Loss to crops & property
1990	Cyclone	Andhra Pradesh and Tamil Nadu	928	₹ 22.47 billion
1991	Earthquake	Uttar Kashi, Uttar Pradesh	768	₹ 0.89 billion
1992	Drought	Maharashtra		₹ 28.23 billion
1993	Floods	Arunachal Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Mizoram, Punjab, Rajasthan, Tripura and Uttar Pradesh	1643	₹ 21.06 billion
1993	Earthquake	Maharashtra	N.A.	N.A.
1994	Cyclone	Andhra Pradesh and Tamil Nadu	226	Loss to property estimated at ₹ 6.12 billion in Tamil Nadu and 4,44,194 ha. of land in Andhra Pradesh.
1995	Floods	Large parts of the country	1360	Property worth ₹ 17.7 billion and 2.35 million hectare crop damaged.
1996	Floods	Large parts of the country	1700	Property worth ₹ 22.0 billion and 20.0 million hectare crop damaged.
1996	Cyclone	Andhra Pradesh	1058	0.3 million houses fully and a similar number partially damaged. 0.1 million hectare crop damaged. Loss to property worth ₹ 61.26 billion.
1997	Earthquake	Jabalpur	39	N.A.
1998	Earthquake	Chamoli	100	N.A.
1999	Cyclone	Odisha	9887	1.8 million hectare crop area and 1.6 million houses damaged.
1999	Cyclone	West Bengal	N.A.	₹ 577.30 million
2000	Floods	Andhra Pradesh, Assam, Arunachal Pradesh, West Bengal, Bihar, Punjab,Uttar Pradesh, Himachal	3048	Estimated value of public properties ₹ 1957.82 crores.

Year	Type	Affected population location	Loss (no. of human life)	Loss to crops & property
		Pradesh, Gujarat, Karnataka, Kerala, MP and Sikkim		
2001	Earthquake	Gujarat	N.A.	Estimated value of public properties ₹ 21,262 crores. Over 20,000 people killed, 1,50,000 injured and 1,59,00,000 affected, 12.54 lakh house damaged.
2004	Tsunami/ Tide waves	Andaman & Nicobar Islands, Andhra Pradesh, Tamil Nadu and Puducherry	N.A.	Over 10,749 people killed. 5,640 people expected missing. About 6.5 lakh people moved to the referred places.
2005	Earthquake	Pakistan & Kashmir	N.A.	Over 87,000 people killed.
2008	Kosi floods	North Bihar	527	19323 livestock perished, 3.3 million persons affected.
	Cyclone Nisha	Tamil Nadu	204	
2009	Floods	Andhra Pradesh, Karnataka	300	N.A.
	Drought	252 districts in 10 States	N.A.	N.A.
2010	Cloud-burst	Leh, Ladakh in Jammu & Kashmir	N.A.	N.A.
2011	Earthquake	North Eastern India with epicenter near Nepal Border and Sikkim	97	N.A.
	Floods	19 districts of Odisha	45	N.A.
	Earthquake	Sikkim, West Bengal, Bihar	60	N.A.
	Cyclone Thane	Tamil Nadu, Puducherry	47	N.A.
2012	Floods	Assam	N.A.	N.A.
	Floods	Uttarkashi, Rudraprayag and Bageshwar district & of Uttarakhand	52	N.A.
	Cyclone Nilam	Tamil Nadu	65	N.A.
2013	Cyclone Mahasen	Tamil Nadu	8	N.A.
	Floods/Land-	Uttarakhand and Himachal Pradesh	4094	N.A.

Year	Type	Affected population location	Loss (no. of human life)	Loss to crops & property
	slides			
	Cyclone Phailin	Odisha and Andhra Pradesh	23	N.A.
	Floods	Andhra Pradesh	53	N.A.
	Floods	Odisha	21	N.A.
2014	Cyclone Hud Hud	Andhra Pradesh & Odisha	N.A.	N.A.
	Floods	Jammu & Kashmir	N.A.	N.A.
2015	Cyclonic Storms	West Bengal	N.A.	N.A.
	Floods and Heavy Rains	Tamil Nadu, Rajasthan, Andhra Pradesh, Gujarat	N.A.	N.A.
2016	Cyclonic Storm	Tamil Nadu	N.A.	N.A.
2017	Lightning	Odisha and Maharashtra	N.A.	N.A.
2018	Floods and Heavy Rains	Kerala and Uttar Pradesh	N.A.	N.A.
2019	Floods and Heavy Rains	Bihar, Maharashtra and Kerala	N.A.	N.A.

Note : N.A.: Not available.

Source : EnviStats India 2020, Central Statistics Office, Ministry of Statistics & Programme Implementation, Govt. of India.
(Website: http://www.mospi.gov.in/publication/envistats-india-2020-vol-1-environment-statistics)



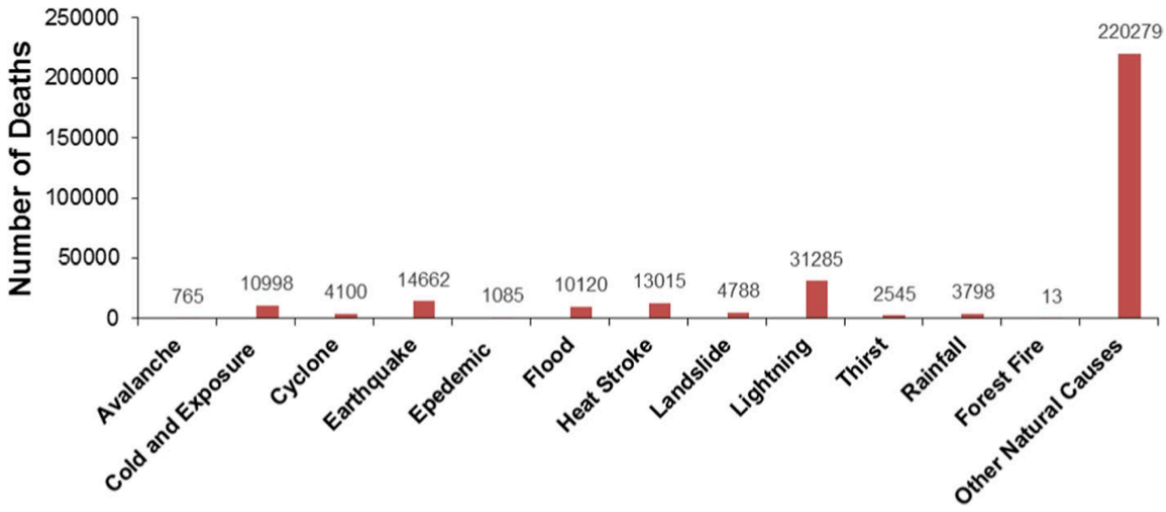


Fig. 2 Death due to various natural disasters over India in the period of 1998–2013

Table 1-3: Nodal Ministry for Management/ Mitigation of Different Disasters

SN	Disaster	Nodal Ministry/ Department
1.	Accident – Air (Civil Aviation)	Min. of Civil Aviation (MOCA)
2.	Accidents – Rail	Min. of Railways (MOR)
3.	Accidents – Road	Min. of Road Transport and Highways (MRTH)
4.	Avalanche	Min. of Defence (MOD) – Border Road Organization (BRO)
5.	Biological Emergencies	Min. of Health and Family Welfare (MHFW)
6.	Cold-Wave	Min. of Agriculture and Farmers Welfare (MAFW)
7.	Cyclone/ Tornado	Min. of Earth Sciences (MOES)
8.	Drought	Min. of Agriculture and Farmers Welfare (MAFW)
9.	Earthquake	Min. of Earth Sciences (MOES)
10.	Flood	Min. of Jal Shakti (MOJS)
11.	Floods – Urban	Min. of Housing and Urban Affairs (MHUA)
12.	Forest Fire	Min. of Environment, Forests, and Climate Change (MEFCC)
13.	Frost	Min. of Agriculture and Farmers Welfare (MAFW)
14.	Hailstorm	Min. of Agriculture and Farmers Welfare (MAFW)
15.	Industrial and Chemical	Min. of Environment, Forests and Climate Change (MEFCC)
16.	Landslides	Min. of Mines (MOM)
17.	Nuclear and Radiological	Dept. of Atomic Energy (DAE)
18.	Oil Spills	Min. of Defence (MOD) – Indian Coast Guard (ICG)
19.	Pest Attack	Min. of Agriculture and Farmers Welfare (MAFW)
20.	Tsunami	Min. of Earth Sciences (MOES)

Table 3.1: Convenor - Nodal Ministry/Department for Management/Mitigation of Different Disasters

S. No.	Disaster	Disaster Management by	Mitigation efforts	
			Nodal Ministry	Member Ministries on Mitigation Plan Committee (MPC)
1.	Earthquake	MHA	Ministry of Earth Sciences	Ministries of Science and Technology, Urban Development; Rural Development; HRD; Health & Family Welfare; Panchayati Raj; Youth Affairs & Sports; Women & Child Development; IT & Telecommunication; I & B; and Space
2.	Flood	MHA	Ministry of Water Resources	Space; Telecommunication
3.	Drought, Hailstorm and Pest Attack	A&C	Deptt. of Agriculture and Cooperation, Ministry of Agriculture	---
4.	Landslide	MHA	Ministry of Mines	Road Transport and Highways and Shipping
5.	Avalanche	MHA	Ministry of Defence	Road Transport and Highways and Shipping
6.	Forest Fire	E&F	Ministry of Environment and Forests	
7.	Nuclear Disaster	MHA/ AE	Deptt. of Atomic Energy	Defence; Health and Family Welfare
8.	Industrial and Chemical Disasters	E&F	Ministry of Environment and Forests	
9.	Biological Disaster	H&FW	Ministry of Health and Family Welfare	Defence, Environment and Forests, Agriculture and Co-operation, Animal Husbandry, Dairying & Fisheries; and Chemicals & Fertilizers
10.	Rail Accidents	Rly	Ministry of Railways	---
11.	Road Accidents	RTH&S	Ministry of Road Transport and Highways and Shipping	---
12.	Aviation Accidents	CA	Ministry of Civil Aviation	---
13.	Cyclone/ Tornado/ Hurricane	MHA	India Metrological Deptt. under Ministry of Earth Sciences	---
14.	Tsunami	MHA	Ministry of Earth Sciences	---

Table 8-1: Central Agencies Designated for Natural Hazard-Specific Early Warnings

SN	Hazard	Ministry	Agency
1.	Avalanches	MOD	Snow and Avalanche Study Establishment (SASE)
2.	Cold Wave	MOES	India Meteorological Department (IMD)
3.	Cyclone	MOES	India Meteorological Department (IMD) Regional Specialized Meteorological Centre (RSMC) Tropical Cyclone Warning Centres (TCWC) for different regions
4.	Drought	MAFW	Central Drought Relief Commissioner (CDRC) and Crop Weather Watch Group (CWWG)
5.	Earthquake	MOES	India Meteorological Department (IMD)
6.	Epidemics	MHFW	Ministry of Health and Family Welfare (MHFW)
7.	Floods	MOJS	Central Water Commission (CWC)
8.	Heat Wave	MOES	India Meteorological Department (IMD)
9.	Landslides	MOM	Geological Survey of India (GSI)
10.	Tsunami	MOES	India National Centre for Oceanic Information Services (INCOIS)

Box 5.1: Disaster wise nodal agencies for Forecast	
Disasters	**Agencies**
Cyclone	Indian Meteorological Department
Tsunami	Indian National Centre for Oceanic Information Services
Floods	Central Water Commission
Landslides	Geological Survey of India
Avalanches	Snow and Avalanche Study Establishment
Heat & Cold Waves	Indian Meteorological Department

2.2 Hazard Risks and Vulnerabilities

2.2.1 Multi-Hazard Vulnerability

As per the definition adopted by UNISDR, hazard is a dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. India, due to its, physiographic and climatic conditions is one of the most disaster-prone areas of the World. Nearly 59 per cent of the landmass is prone to earthquakes of moderate to very high intensity. More than 40 million hectares (12 per cent of land) is prone to floods and river erosion. Of the nearly 7,500 km long coastline, close to 5,700 km is prone to cyclones and tsunamis. Nearly 68% of the cultivable area is vulnerable to drought. Large tracts in hilly regions are at risk from landslides and some are prone to snow avalanches. Vulnerability to disasters/emergencies of CBRN origin also exists. Heightened vulnerabilities to disaster risks can be related to expanding population, urbanisation, and industrialisation, development within high-risk zones, environmental degradation, and climate change.

Building Materials & Technology Promotion Council (BMTPC) has prepared the Vulnerability Atlas of India (VAI), which has been updated in 2019 (third edition) and is available online[6]. Some of the maps for the country are provided in Annexure-II. These maps present for each State/UT the hazard map for earthquake, wind, and flood. The maps available online show not only the boundaries of the hazard zones of various intensities but also indicate district-wise areas lying in the different intensities. The Vulnerability Atlas has been structured to serve as a tool towards natural disaster prevention, preparedness and mitigation for housing and related infrastructure at local as well as national levels.

In the context of human vulnerability to disasters, economically and socially weaker segments of the population are the ones that are most seriously affected. Within the vulnerable groups, elderly persons, women, children— especially women rendered destitute, children orphaned by disasters and differently abled persons are exposed to higher risks. The DM Act 2005 and National Policy on Disaster Management 2009 consider disasters to be a) natural and b) human-induced including CBRN for defining the roles and responsibilities.

Besides with the natural factors discussed earlier, various human-induced activities like increasing demographic pressure, deteriorating environmental conditions, deforestation, unscientific development, faulty agricultural practices and grazing, unplanned urbanisation, construction of large dams on river channels etc. are also responsible for accelerated impact and increase in frequency of disasters in the country.

2.2.2 Natural Hazards

2.2.2.1 Cyclone and Wind

1

India's long coastline of nearly 7,500 km consists of 5,400 km along the mainland, 132 km in Lakshadweep and 1,900 km in the Andaman and Nicobar Islands. About 10 per cent of the World's tropical cyclones affect the Indian coast. Of these, the majority has their initial genesis over the Bay of Bengal and strike the east coast of India. On an average, five to six tropical cyclones form every year, of which two or three could be severe. Cyclones occur frequently on both the west coast in the Arabian

[6] Vulnerability Atlas of India. http://www.bmtpc.org/DataFiles/CMS/file/VAI2019/Index.html (accessed Oct. 15, 2019)

Sea and the east coast in the Bay of Bengal. More cyclones occur in the Bay of Bengal than in the Arabian Sea. An analysis of the frequencies of cyclones on the East and West coasts of India during 1891-2000 shows that nearly 308 cyclones (out of which 103 were severe) affected the East Coast[7].

In India, tropical cyclones occur in the months of May-June and October-November. The cyclones of severe intensity and frequency in the northern part of the Indian Ocean are bimodal in character, with their primary peak in November and secondary peak in May. The disaster potential is particularly high at the time of landfall in the northern part of Indian Ocean (Bay of Bengal and the Arabian Sea) due to the accompanying destructive wind, storm surges and torrential rainfall. Of these, storm surges are the greatest killers of a cyclone, by which sea water inundates low lying areas of coastal regions and causes heavy floods, erodes beaches and embankments, destroys vegetation and reduces soil fertility.

Tropical Cyclones

Tropical cyclone, generally known as 'cyclone', is the term used globally to cover tropical weather systems in which winds equal or exceed 'gale force' (minimum of 34 knot, i.e., 62 kmph). These are intense low-pressure areas of the earth-atmosphere coupled system and are extreme weather events of the tropics. Although the North Indian Ocean (NIO) Basin (including the Indian coast) generates only about seven per cent of the World's cyclones, their impact is comparatively high and devastating, especially when they strike the coasts bordering the North Bay of Bengal. As per broad scale assessment of the population at risk, nearly one third of India's population is vulnerable to cyclone-related hazards. Climate change with the resultant sea-level rise and expected increase in severity of cyclones can significantly increase the vulnerability of the coastal population.

Though tropical cyclones differ by name across regions, they are classified according to their wind speed. The classification, however, varies from region to region. The classification used in India[8] of these intense low-pressure systems (cyclonic disturbances) is given in Table 2-2.

Table 2-2: Classification used in India for tropical cyclones

	Type	Wind Speed	
		km per hour (kmph)	*Knots*
1	Low Pressure area	Less than 31	Less than 17
2	Depression	31 to 49	17 to 27
3	Deep Depression	50 to 61	28 to 33
4	Cyclonic Storm	62 to 88	34 to 47
5	Severe Cyclonic Storm	89 to 118	48 to 63
6	Very Severe Cyclonic Storm	119 to 221	64 to 119
7	Super Cyclone	More than 221	More than 119

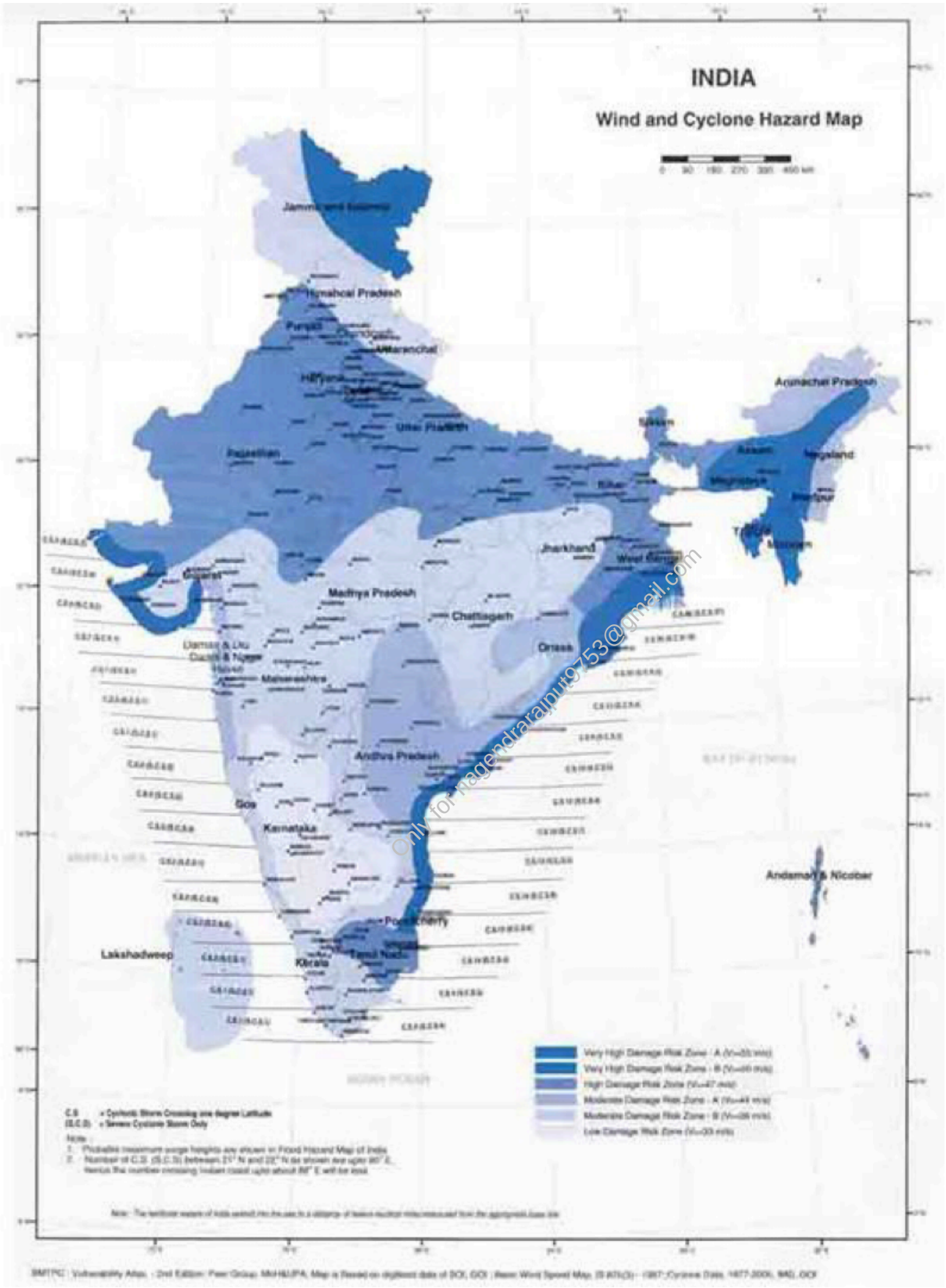
Note: One kmph = 0.54 knot; one knot = 1.852 kmph

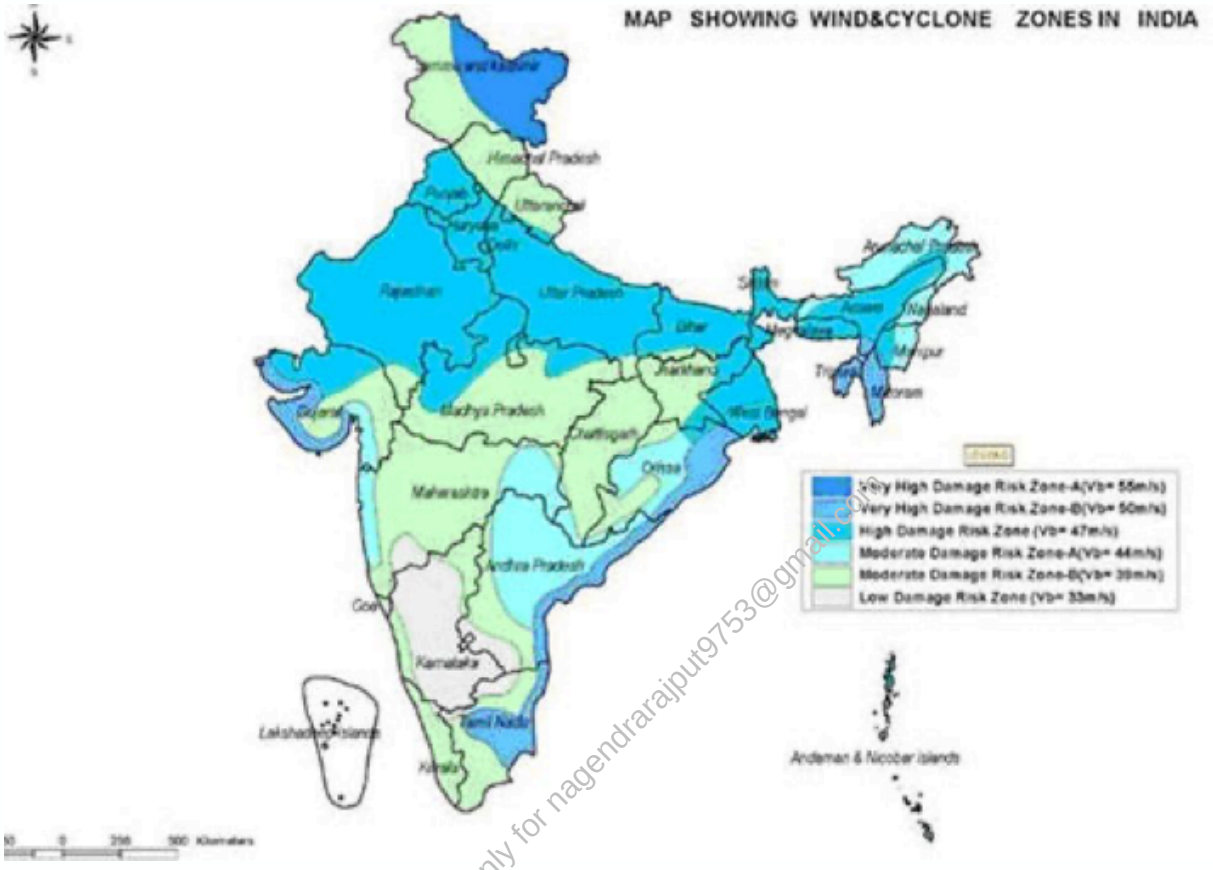
The coastal states and union territories (UTs) in the country, encompassing 84 coastal districts which are affected by tropical cyclones. Four states (Tamil Nadu, Andhra Pradesh, Odisha and West Bengal) and one UT (Puducherry) on the east coast and one state (Gujarat) on the west coast are highly vulnerable to cyclone disasters.

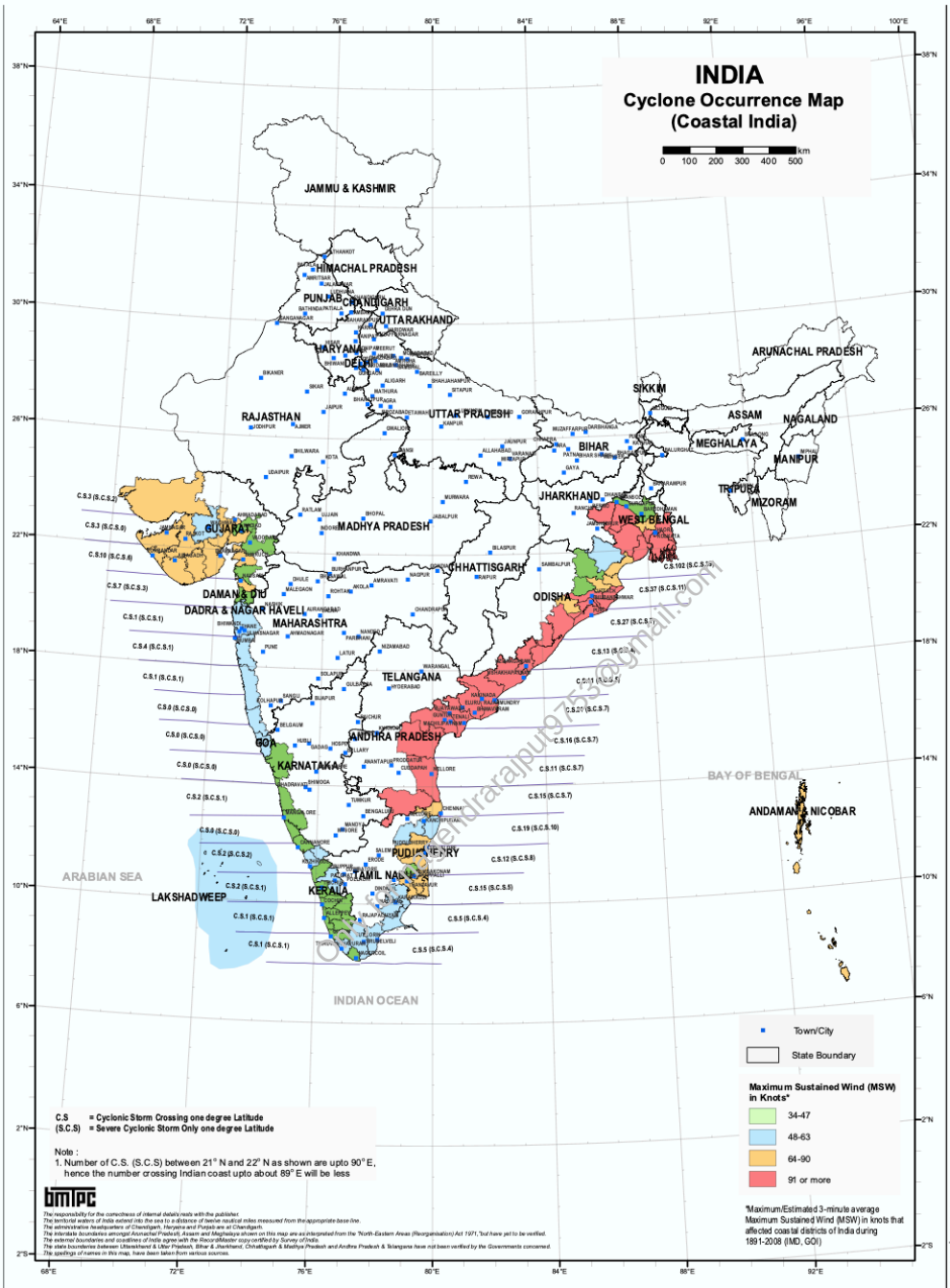
[7] Cyclones and their Impact in India: https://ncrmp.gov.in/cyclones-their-impact-in-india/ (accessed Sep. 20, 2019)

[8] IMD (2016)

Wind Hazard Map







BMTPC : Vulnerability Atlas- 3rd Edition; Peer Group, MoHUA; Map is Based on digitised data of SOI, GOI; Maximum Sustained Wind (MSW) Data from IMD, GOI. Disclaimer: The maps are solely for thematic presentation.

1. **The National Cyclone Risk Mitigation Project** (NCRMP) with a view to address

cyclone risks in the country.The overall objective of the Project is to undertake suitable structural and non-structural measures to mitigate the effects of cyclones in the coastal states and UTs of India.

Box 4.2: National Cyclone Risk Mitigation Project

Aim: The scheme aims to upgrade cyclone forecasting, tracking and warning systems, build capacity in multi-hazard risk management and to construct major infrastructures including multi-purpose cyclone shelters and embankments.

Outcome: The project is expected to benefit 5.60 lac people in Orissa and over 5.50 lacs in Andhra Pradesh.

Execution Authority: The National Disaster Management Authority (NDMA) has been designated as the implementing agency. The scheme is regularly monitored by NDMA and MHA.

Principal Components: The major components under the scheme are as follows;

- Community mobilisation and training,
- Cyclone Risk Mitigation Infrastructure (construction of cyclone shelters, roads/missing links and construction/repair of Saline Embankments etc.),
- Technical assistance for capacity building on Disaster Risk Management (risk assessment, damage and need assessment),
- Capacity Building and knowledge creation along with project management and implementation support.

States covered: In the first phase of the project, states of Orissa and Andhra Pradesh are being covered.

Project cost: The total outlay of the project is ₹1496.71 crore. The World Bank is providing financial assistance equivalent to ₹1198.44 crore and contribution from the state governments is ₹298.27 crore (i.e. Orissa- ₹ 132.98 crore and Andhra Pradesh – ₹165.29 crore).

Cyclone

Safety Tips :

- Listen to radio or TV weather reports and alert everyone through a loud speake or by going home to home.
- Identify safe shelter in your area. These should be cyclone resistant and also find the closest route to reach them.
- Keep your emergency kit and basic food supply, medicines, torch and batteries etc. ready.
- Doors, windows, roof and walls should be strengthened before the cyclone season through retrofitting and repairing. Store adequate food grains and water in safe places.
- Conduct Mock Drills for your family and the community.
- Do not venture into the sea. Stay Indoors under the strongest part of the house if not moved to the cyclone shelter.
- Remain indoors until advised that the cyclone has passed away.
- Do not go out till officially advised that it is safe. If evacuated, wait till advised to go back.
- Use the recommended route to return to your home. Do not rush.
- Be careful of broken powers lines, damaged roads and house, fallen trees etc.

Storm Surge

Storm surge, a coastal phenomenon, is the inherent destructive aspect of cyclones the World over. Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. It should not be confused with storm tide. The rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 6 metres or more in some cases. The degree of destructive potential depends on the storm surge amplitude associated with the cyclone. Large number of casualties during tropical cyclones occur as a result of storm surge. Climate change with the resultant sea-level rise will worsen the impacts of storm surges.

2.2.2.2 Flood

2

Floods affect an average area of around 7.5 million hectares per year. According to the National Commission on Floods, the area susceptible to floods was estimated in 1980 to be around 40 million hectares and it is possible to provide reasonable degree of protection to nearly 80 per cent (32 million ha). Riverine flooding is perhaps the most critical climate-related hazard in India. Flood control is a key element of national policies for water resource management. The occurrence of floods and droughts is closely linked to the summer monsoon activity. Floods occur in almost all river basins of the country. Heavy rainfall, inadequate capacity of rivers to carry the high flood discharge, inadequate drainage to carry away the rainwater quickly to streams/rivers are the main causes of floods. Ice jams or landslides blocking streams; and cyclones also cause floods. Out of 40 million hectare of the flood prone area in the country, on an average, floods affect an area of around 7.5 million hectare per year. Floods in the Indo-Gangetic-Brahmaputra plains are an annual feature. On an average, a few hundred lives are lost, millions of people are rendered homeless, lakhs of hectares of crops are damaged, thousands of animals are affected (killed and injured). The National Flood Control Programme was launched in 1954. Since then, sizeable progress has been made in the flood protection measures. The global climate change and the resultant increase in extreme weather events will naturally worsen the uncertainties associated with floods.

2.2.2.3 Urban Floods

3

The problem of urban flooding is a result of both natural factors and land-use changes brought about by urban development. Urban flooding is significantly different from rural flooding as urbanisation leads to developed catchments which increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Consequently, flooding occurs very quickly due to faster flow times, sometimes in a matter of minutes. Urban flooding is caused by the combination of meteorological, hydrological, and human factors. Due to land-use changes, flooding in urban areas can happen very rapidly with large flow. The challenges of Urban Floods Disaster Management (UFDM) tend to be considerably different from that of flooding in other areas. In 2010, the NDMA published separate guidelines for UFDM. Problems associated with urban floods range from relatively localised incidents to major incidents, resulting in inundation of some or large parts urban areas for several hours to many days. The impact can vary from being limited to widespread. It may result in temporary relocation of people, dispersal of animals, damage to civic amenities, deterioration of water quality and risk of epidemics.

2.2.2.4 Earthquake

4

Nearly 59 per cent of India's territory is prone to moderate to severe earthquakes. Three recent major earthquakes affected Gujarat in January 2001, Jammu and Kashmir in October 2005 and Sikkim in 2011. Many smaller- quakes have been occurring in various parts of India. Seven states in North East (Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya), the Andaman and Nicobar Islands and part of eight other States/UTs (Bihar, Gujarat, Himachal Pradesh, Uttarakhand,

Jammu & Kashmir, Ladakh, Punjab and West Bengal) are in Seismic Zone V i.e., prone to very high damage risk. Wide-spread losses—human and material, collapse of infrastructure and services may be the major consequences of the earthquake. Hundreds of thousands may be displaced, often in remote mountainous areas in the North and North-East.

2.2.2.5 Tsunami

Tsunamis (Japanese for "harbour wave"), also known as a seismic sea wave, are a series of very large waves with extremely long wavelength, in the deep ocean, the length from crest to crest may be 100 km and more. It is usually generated by sudden displacements in the sea floor caused by earthquake, landslides, or volcanic activity[9]. Most tsunamis, including the most destructive ones are generated by large and shallow earthquakes which usually occur near geological plate boundaries, or fault-lines, where geological plates collide. When the seafloor abruptly deforms the sudden vertical displacements over large areas disturb the ocean's surface, displace water, and generate tsunami waves. Since the wave height in deep ocean will be only a few decimetres or less (i.e., a few inches), tsunamis are not usually felt aboard ships. Nor are they visible from the air in the open ocean. The waves could travel away from the triggering source with speeds exceeding 800 km/h over very long distances. They could be extremely dangerous and damaging when they reach the coast, because when the tsunami enters shallow water in coastal areas, the wave velocity will decrease accompanied by increase in wave height. In shallow waters, a large tsunami crest height may rise rapidly by several metres even in excess of 30 m causing enormous destruction in a very short time[10].

As seen on Indian Ocean shores in December 2004, tsunami can cause massive death and destruction. They are particularly dangerous close to their sources, where the first waves in the tsunami train can arrive within a few to tens of minutes of the triggering event. The earthquake and resulting tsunami in Indian Ocean on 26 Dec 2004 had devastating effects on India. Many people died and millions were displaced. The hardest hit areas were on Southern coast and the Andaman and Nicobar Island. Tsunamis have the potential of causing significant casualties, widespread property damage, massive infrastructure loss and long-term negative economic impacts. People caught in the path of a tsunami often have little chance of survival. People die from drowning or debris crushing them.

2.2.2.6 Landslides and Snow Avalanches

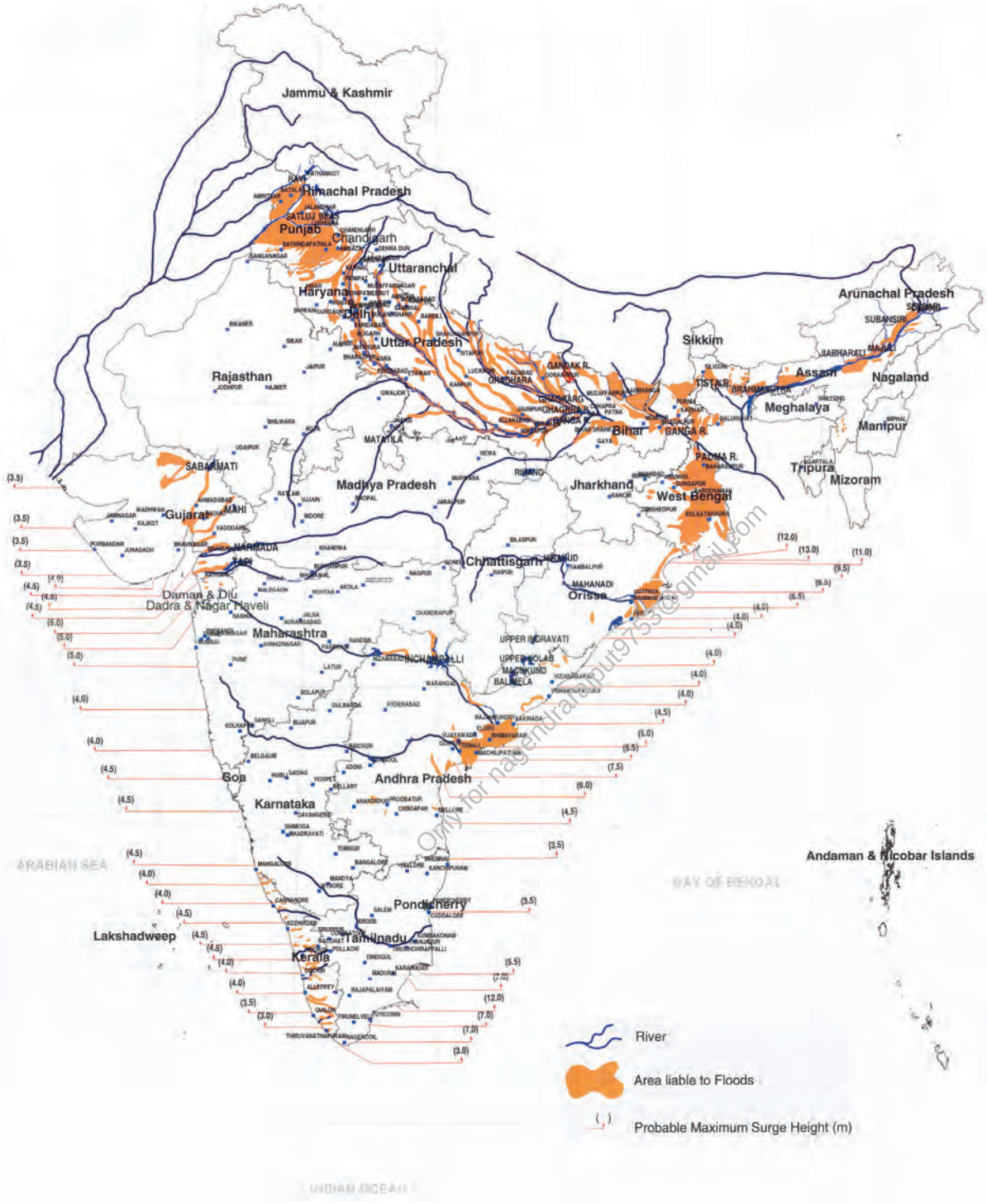
Landslides

Landslides occur in the hilly regions of India such as the Himalaya, North-East India, the Nilgiris, Eastern Ghats and Western Ghats. It is estimated that 30 per cent of the World's landslides occur in the Himalayan ranges. The Himalayan range, which constitutes the youngest and most dominating mountain system in the World, is not a single long landmass but comprises a series of seven curvilinear parallel folds running along a grand arc for a total of 3,400 kilometres. Landslides are also common in Western Ghat. In the Nilgiris, in 1978 alone, unprecedented rains in the region triggered about one hundred landslides which caused severe damage to communication lines, tea gardens and other cultivated crops. Scientific observations in north Sikkim and Garhwal regions in the Himalayas clearly reveal that there is an average of two landslides per sq. km. The mean rate of land loss is to the tune of 120 meter per km per year and annual soil loss is about 2500 tons per sq. km. Landslides have been a major and widely spread natural disaster that often affect life and property, leading to major concern.

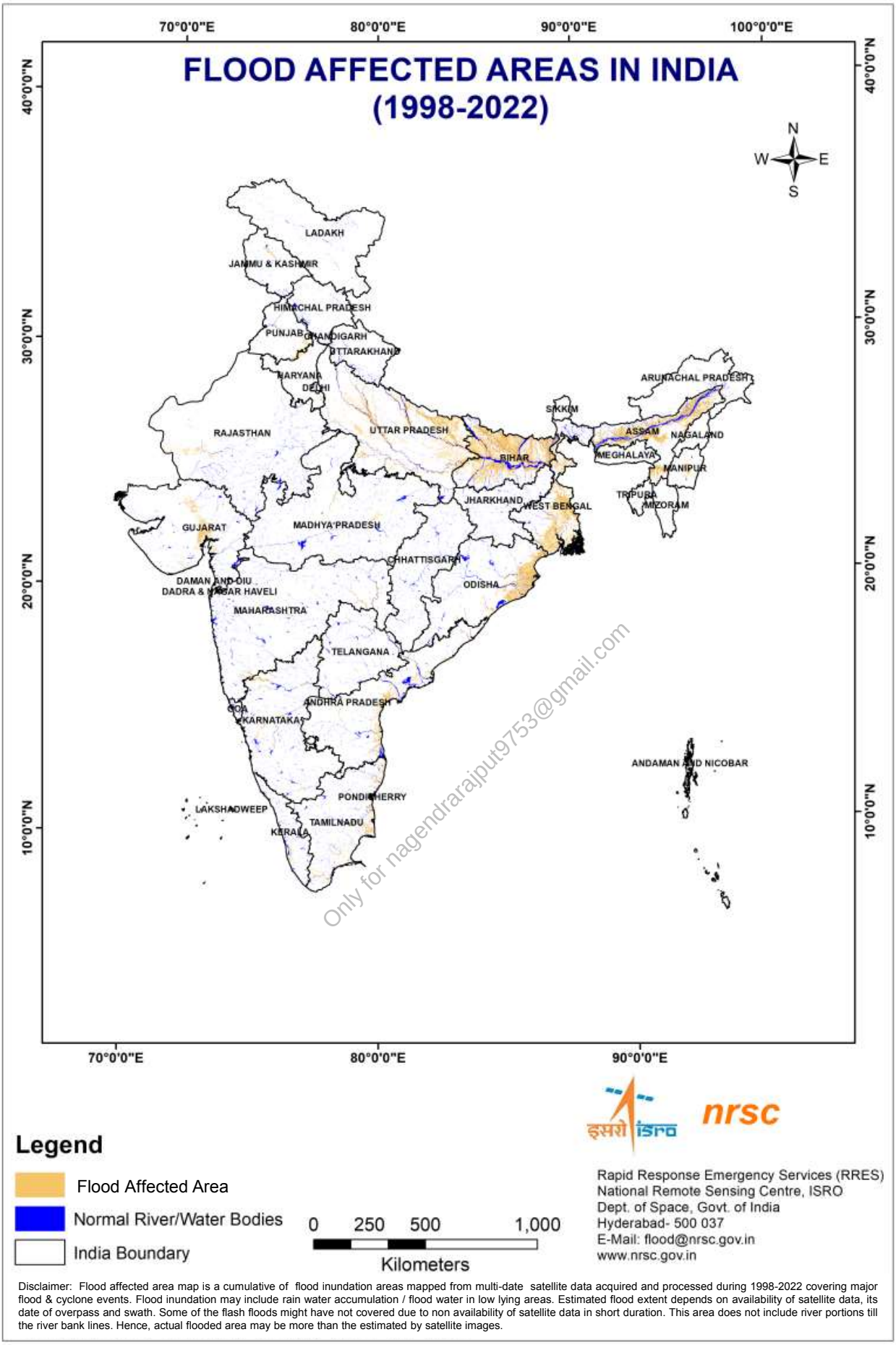
[9] https://ntwc.ncep.noaa.gov/?page=tsunamiFAQ (accessed Sep 20, 2019)
[10] http://www.unisdr.org/2006/ppew/tsunami/what-is-tsunami/backinfor-brief.htm (accessed Sep 20, 2019)

4. **Flood Risk Mitigation Scheme (FRMS)**
The Scheme covers activities like a) Pilot Projects for development of model Multi-Purpose Flood Shelters and b) Development of River Basin specific Flood Early Warning System and Digital
Elevation Maps for preparation of Inundation Models for giving early warning to the villagers for evacuation in case of flood. Under the Scheme, financial support is to be provided to the Flood prone States for undertaking pilot scheme in respect of above two activities. The Scheme is under preparation.

Map 2
FLOOD ZONES IN INDIA



Source: BMTPC Vulnerability Atlas



Disclaimer: Flood affected area map is a cumulative of flood inundation areas mapped from multi-date satellite data acquired and processed during 1998-2022 covering major flood & cyclone events. Flood inundation may include rain water accumulation / flood water in low lying areas. Estimated flood extent depends on availability of satellite data, its date of overpass and swath. Some of the flash floods might have not covered due to non availability of satellite data in short duration. This area does not include river portions till the river bank lines. Hence, actual flooded area may be more than the estimated by satellite images.

Figure.5.1. Flood Affected Area in India

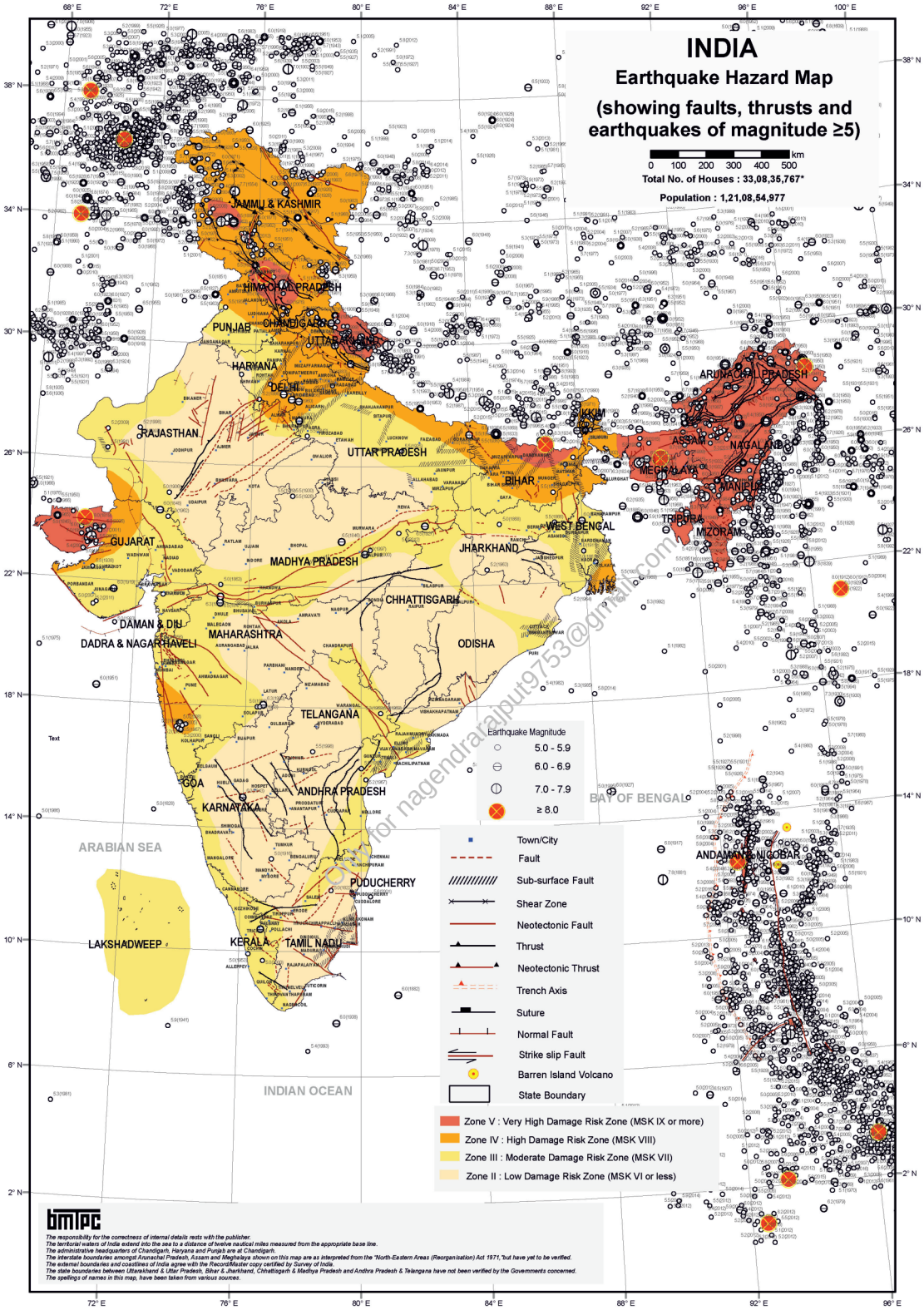
Flood

Safety Tips :

- All your family members should know the safe routes to nearest shelter/raised pucca house.
- If your area is flood-prone, consider suitable flood resistant building materials.
- Tune to your local radio/TV for warnings and advice. Have an emergency kit ready.
- Keep dry food, drinking water and clothes ready. Drink preferably boiled water. Keep your food covered, don't take heavy meals.
- Do not let children and pregnant woman remain empty stomach.
- Be careful of snakes, as snake bites are common during floods.
- Pack warm clothing, essential medication, valuables, personal papers, etc. in waterproof bags, to be taken with your emergency kit.
- Raise furniture, clothing and valuable onto beds, tables and in attic.
- Turn off the main electricity power supply. Do not use electrical appliances, which have been in flood water.
- DO not get into water of unknown depth and current.
- Do not allow children to play in, or near flood water.

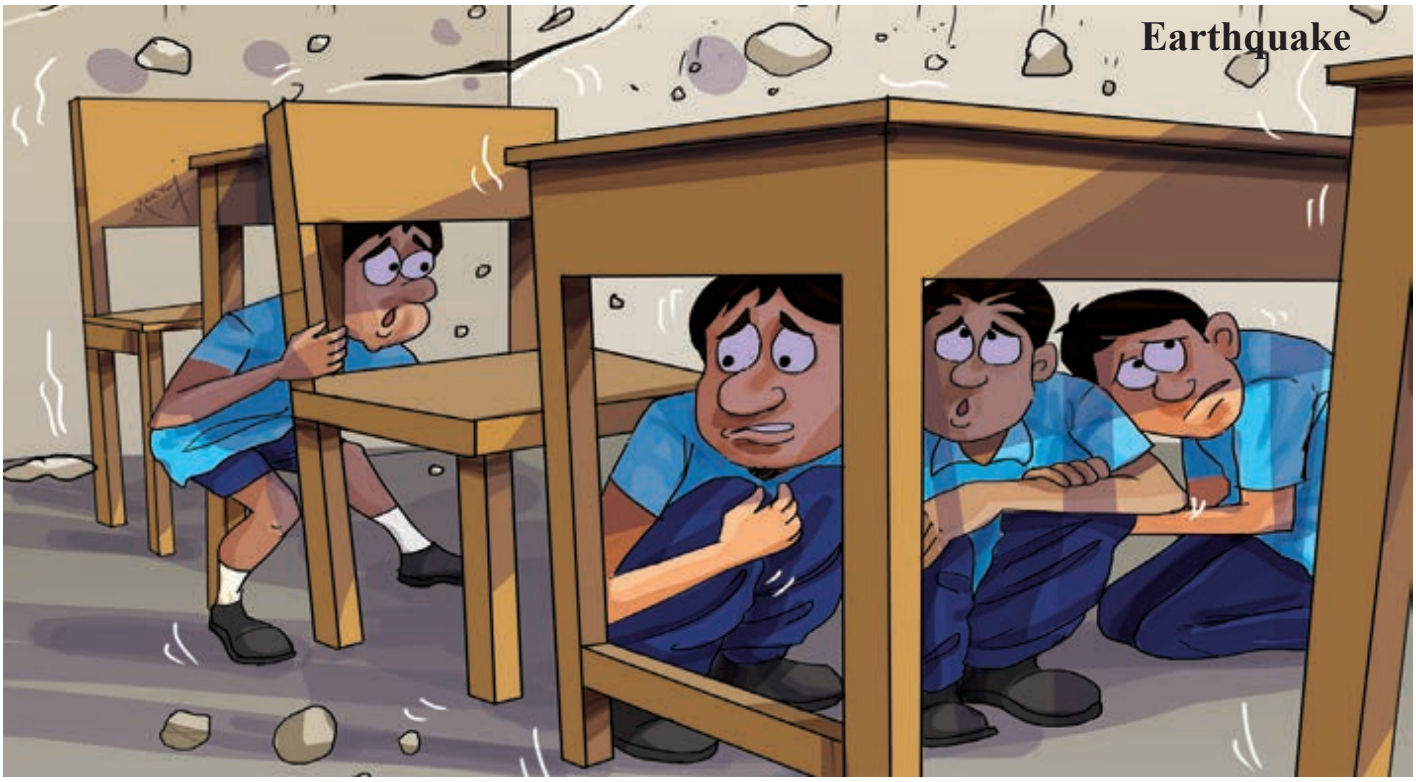
Earthquake Hazard Map

(http://www.bmtpc.org/DataFiles/CMS/file/VAI2019/eq.html , accessed Oct 15, 2019)



BMTPC : Vulnerability Atlas - 3rd Edition : Peer Group, MoHUA, GOI; Map is Based on digitised data of SOI; Seismic Zones of India Map IS 1893 (Part I): 2002, BIS; Earthquake Epicentre from IMD; Seismotectonic Atlas of India and its Environs, GSI; Houses/Population as per Census 2011; *Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

5. **National Earthquake Risk Mitigation Project**



Earthquake

Safety Tips :

- Make your house earthquake resistant and secure heavy furniture and objects.
- Choose a couple of family meeting place; pick easy to identify, open and accessible places that you can easily reach. Prepare to be self-sufficient for a minimum of three days.
- If inside, stay inside."DUCK, COVER and HOLD! Duck under firm furniture. Cover as much of your head and upper body as you can. Hold onto the furniture. Move to an inside wall and sit with your back to the wall, bring your knees to your chest and cover your head. Stay away from mirror and window. Do not exit the building during the shaking.
- If outdoors, move to an open area away from all structures, especially buildings, bridges, and overhead power lines.
- Move cautiously, and check for unstable objects and other hazards above and around you. Check yourself for injuries.
- Anticipate aftershocks, especially if the shaking lasted longer than two minutes.
- Stay out of damaged buildings. Listen to the radio or watch local TV for emergency information and additional safety instructions.

Tsunami

Safety Tips :

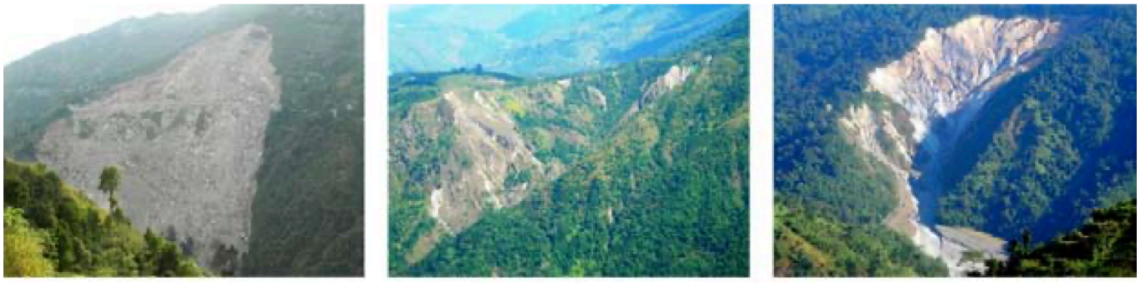
- Find out if your home is in the danger zone.
- Know the height of your street/house above sea level and the distance from the coast.
- People living along the coast should consider earthquake or strong ground rumbling as a warning signal.
- Try and climb a raised platform or climb the highest floor of any house or building which you might see.
- Make evacuation plans and a safe route for evacuation. Stay away from the beach.
- Never go down near the beach to watch the Tsunami.
- Listen to a radio or television to get the latest information and be ready to evacuate if asked to do so.
- If you hear an official warning, evacuate at once. Return home only after authorities advice it is safe to do so.
- Stay tuned to battery-operated radio for the latest emergency information. Help injured and trapped persons.
- Stay away from flooded and damaged areas until officials say it is safe to return.
- Enter your home with caution.
- Use flashlight when entering damaged houses. Check for electrical short circuit and live wires.

Landslide Incidence Map

(http://www.bmtpc.org/DataFiles/CMS/file/VAI2019/landslide.html , accessed Oct 15, 2019)

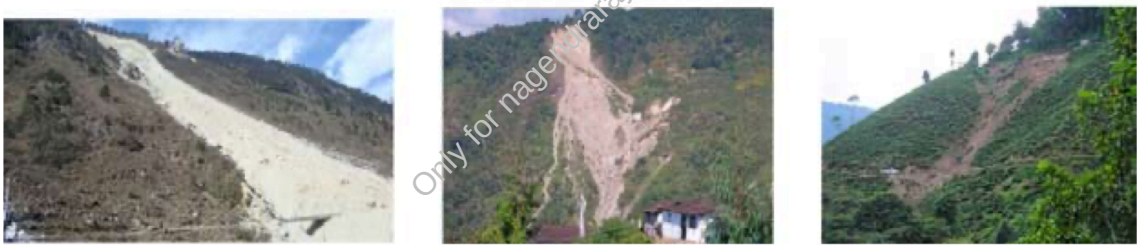
BMTPC; Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA,GOI: Map is Based on digitised data of SOI; Landslide Incidence data GSI; Annual Rainfall data IMD. Houses/Population as per Census 2011;
* Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Map 4
LANDSLIDE AFFECTED STATES



Deep-seated large landslides

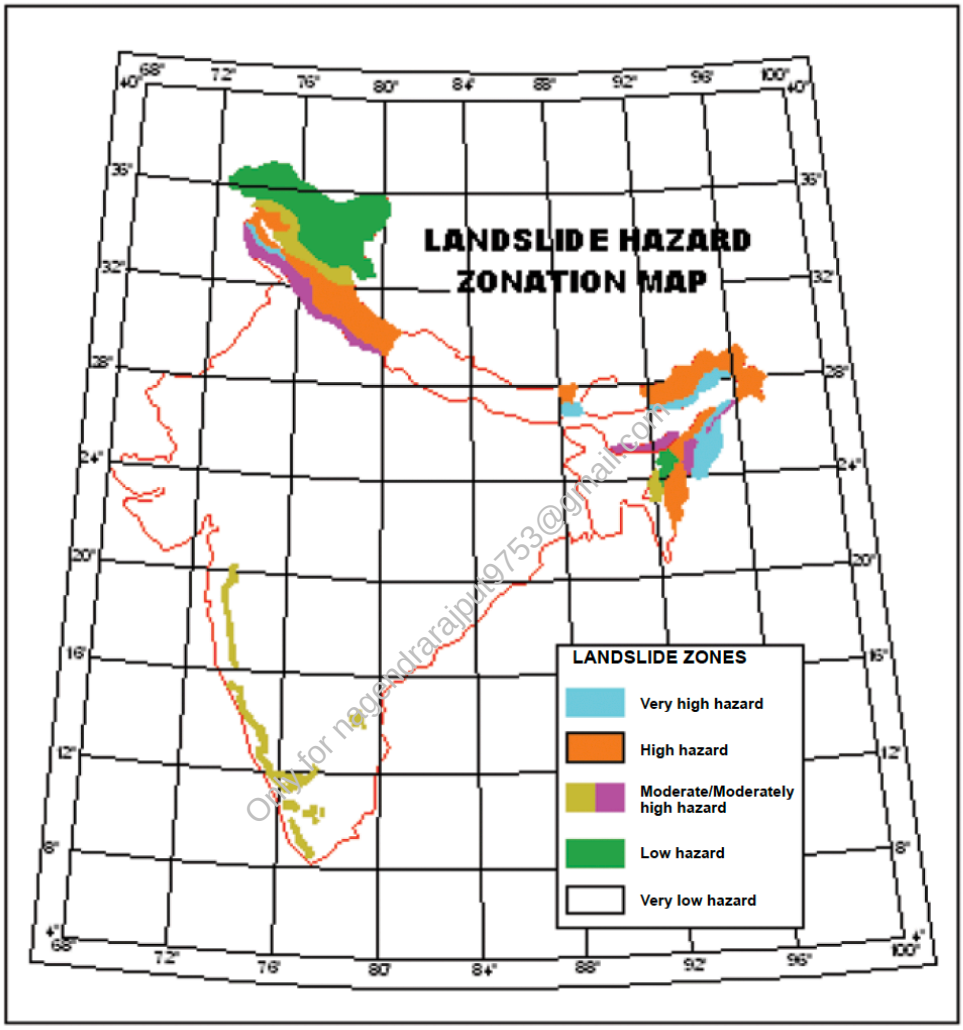
Shallow translational landslides



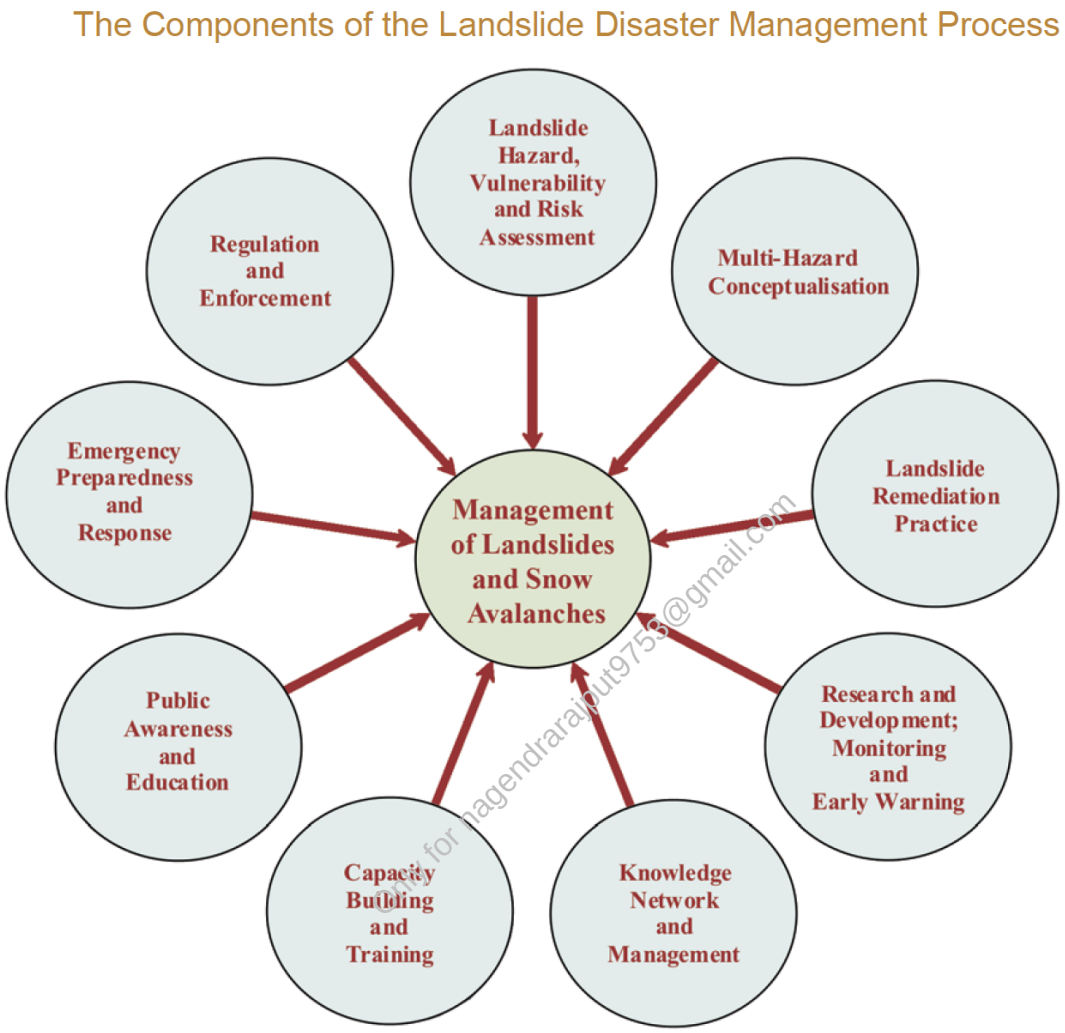
Slide and Flows

Fig. 1: Different types of landslides and failure mechanism that are prevalent in India

Figure 1.2: Landslide Hazard Zonation Map of India (Prepared by GSI)



3. **Landslide Risk Mitigation Scheme (LRMS)**
The Scheme envisages financial support for site specific Landslide Mitigation Projects recommended by landslide prone States, covering “disaster prevention strategy, disaster mitigation and R& D in monitoring of critical Landslides” thereby leading to the development of Early Warning System and Capacity Building initiatives. The Scheme is under preparation.



Landslide

Safety Tips :

- Avoid building houses near steep slopes, close to mountain edges, near drainage ways or along natural erosion valleys.
- Avoid going to places affected by debris flow. In mud flow areas, build channels to direct the flow around buildings.
- Stay alert and awake. Many deaths from landslides occur while people are sleeping.
- Listen for unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together.
- Move away from the landslide path or debris flow as quickly as possible.
- Avoid river valleys and low-lying areas. If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and notice whether the water changes from clear to muddy.
- Go to designated public shelter if you have been told to evacuate.
- Stay away from the slide area as there may be danger of additional slides.
- Check for injured and trapped persons near the slide, without entering the direct slide area.

Jammu & Kashmir, Ladakh, Punjab and West Bengal) are in Seismic Zone V i.e., prone to very high damage risk. Wide-spread losses—human and material, collapse of infrastructure and services may be the major consequences of the earthquake. Hundreds of thousands may be displaced, often in remote mountainous areas in the North and North-East.

2.2.2.5 Tsunami

5

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2.2.2.6 Landslides and Snow Avalanches

Landslides

6

Landslides occur in the hilly regions of India such as the Himalaya, North-East India, the Nilgiris, Eastern Ghats and Western Ghats. It is estimated that 30 per cent of the World's landslides occur in the Himalayan ranges. The Himalayan range, which constitutes the youngest and most dominating mountain system in the World, is not a single long landmass but comprises a series of seven curvilinear parallel folds running along a grand arc for a total of 3,400 kilometres. Landslides are also common in Western Ghat. In the Nilgiris, in 1978 alone, unprecedented rains in the region triggered about one hundred landslides which caused severe damage to communication lines, tea gardens and other cultivated crops. Scientific observations in north Sikkim and Garhwal regions in the Himalayas clearly reveal that there is an average of two landslides per sq. km. The mean rate of land loss is to the tune of 120 meter per km per year and annual soil loss is about 2500 tons per sq. km. Landslides have been a major and widely spread natural disaster that often affect life and property, leading to major concern.

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[10] http://www.unisdr.org/2006/ppew/tsunami/what-is-tsunami/backinfor-brief.htm (accessed Sep 20, 2019)

7

Snow Avalanches

see below and first cover types then this

Avalanches are block of snow or ice descending from the mountain tops at a river like speedy flow. They are extremely damaging and cause huge loss to life and property. In Himalayas, avalanches are common in Drass, Pir Panijal, Lahaul-Spiti and Badrinath areas. As per Snow and Avalanche Study Establishment (SASE), of Defence Research and Development Organisation (DRDO), on an average, around 30 people are killed every year, due to this disaster in various zones of the Himalayan range. Beside killing people, avalanches also damage the roads, properties, and settlements falling in its way. Traffic blockage, structural damages of roads, and retaining wall damages occur most frequently due to avalanches. Snow avalanches occur in several stretches of the Himalayan range with the following areas being more vulnerable:

- Western Himalaya – the snowy regions of J&K, Ladakh, HP and Uttarakhand, especially Tehri Garhwal and Chamoli districts
- J&K and Ladakh – Higher reaches of Kashmir and Gurez valleys, Kargil, Ladakh and along some of the major roads
- HP – Chamba, Kullu-Spiti and Kinnaur

2.2.2.7 Drought

There is no globally adopted operational definition for drought applicable to all contexts. This is the primary reason why policy makers, resource planners, and other decision-makers as well as administrators have considerable difficulty recognizing and planning for drought than they do for other disasters. Global Assessment Report (GAR) 2015 notes that agricultural drought is probably the most "socially constructed" of all disaster risks (UNISDR 2015b) and warns that due to global climate change, its frequency is expected to vary much. To determine the beginning of drought, operational definitions specify the degree of departure from the long-term (usually at least 30 years) average of precipitation or some other climatic variable. Broadly, drought is perceived as sharply felt water deficit caused by variations in the natural hydro-metrological factors, agro-ecological conditions, moisture requirements of crops under prevailing cropping choices (systems, patterns).

The WMO considers drought as a slow creeping natural hazard that occurs in part due to the natural climatic variability. In recent years, concern has grown world-wide that droughts may be increasing in frequency due to climate change. Responses to droughts in most parts of the world are generally reactive in terms of crisis management and are known to be untimely, poorly coordinated and disintegrated. Conceptual definitions, formulated in general terms, help people understand the concept of drought. Conceptually, drought is characterised by a protracted period of deficient precipitation resulting in water deficits, extensive crop damage, resulting in loss of yield. Operational definitions help define the onset, severity, and end of droughts. No single operational definition of drought works in all circumstances, and this is a big part of why policy makers, resource planners, and others have more trouble recognizing and planning for drought than they do for other natural disasters. In fact, mostly, decision-makers/ planners now rely on mathematical indices to decide when to start implementing water conservation or drought response measures. To determine the beginning of drought, operational definitions specify the degree of departure from the average of precipitation or some other climatic variable over some period. This is usually done by comparing the current situation to the historical average, often based on at least a 30-years record.

Droughts affect vast areas of the country, transcending State boundaries. A third of the country is drought prone. Recurrent drought results in widespread adverse impact on people's livelihoods and young children's nutrition status. It affects parts of Rajasthan (chronically), Gujarat, Maharashtra,

nowcast alerts/warnings should be accompanied with actionable information (Do's and Don'ts) and potential impact (expected damage).
Besides SDMAs and DDMAs, tehsil-level Disaster Management Group (TMG) at subdivision/ tehsil level should be formed with representatives of various line departments, including Agriculture, Forest, BSNL and other telecom service providers, Electricity Board, Revenue, P.W.D, Health, Police and Fire Brigade. Village Disaster Management Committees (VDMCs) should also be formed at the village level comprising local villagers. This would certainly strengthen the local response mechanisms to disasters.

g. Emergency Plan for Hospitals and Health Centres: Emergency expansion plan for civil hospitals, community health centres, Primary Health Centres (PHCs) and additional PHCs, including schemes for mobile medical teams for a post-disaster situation, should be in place. A list
of Army hospitals, Govt. Hospitals (both Centre and State), private hospitals and nursing homes in each district should be prepared. Phone numbers of all these medical facilities should be available in the District Control Room as well as in the SEOC. Based on the hazard assessment, emergency medicines, Operation Theatres and life-saving drugs should be kept ready. Vacant post of doctors and paramedical staff should be filled in all the government hospitals in order to make available the
required number of medical workers at the time of an emergency. An Action Plan must be considered for training of doctors and paramedical staff on handling patient inflow and treating them in case of a disaster.

h. Focusing on Research and Establishing a Forecasting Centre for Thunderstorm and Squall to carry out the hazard zonation and vulnerability analysis for thunderstorm and squall with State-level knowledge institutions.

i. Making Disaster Risk Reduction (DRR) a part of school and college curriculum: Youth and children can be taught about extreme weather incidents and the Do's and Don'ts to be followed
before, during and after a disaster. They act as agents of change and bring about greater awareness
in the neighbourhood and society.

snow avalanche

2009 guidelines

The Snow Avalanche Hazard
1.7.1 Introduction

The snow avalanche, a common occurrence in snow covered mountainous regions, is a slide of snow mass down a mountainside. This is a rapid downslope movement of a large detached mass of snow, ice, and associated debris such as rocks and vegetation. Small avalanches, or sluffs, occur in large numbers, while large avalanches that may encompass slopes a kilometre or more in length with millions of tons of snow, occur infrequently but cause most of the damage. Humans have been exposed to the threat of sliding snow for as long as they have inhabited mountainous regions. A large avalanche can run for many kilometres, and result in massive destruction of forests and anything else that comes in its way.

These threats are felt in the Indian context as well. Most recently, snowfall of up to 2m occurred at many places on the higher reaches of the Pir Panjal range between 16–20 February 2005, resulting in avalanches at several places in Anantnag, Doda, Poonch, Pulwama, and Udhampur

1.7.2 **Types of Avalanches**
There are two basic types of avalanches,
a) loose snow avalanches and
b) slab avalanches.

Most avalanches of dangerous size therefore originate on slopes with inclinations of between 30 degrees and 45 degrees.

Avalanches reach speeds of up to 200 km an hour and can exert forces great enough to destroy structures coming in their way and uproot or snap off large trees.

These are further sub-divided according to whether the snow involved is dry, damp or wet, whether the snowslide originates in a surface layer or involves the whole snow cover (slides to the ground), and whether the motion is on the ground, in the air, or mixed.

Loose snow avalanches form in snow masses with little internal cohesion among the individual snow crystals. When such snow lies in a state of unstable equilibrium on a slope steeper than its natural angle of repose, a slight disturbance sets progressively more and more snow in downhill motion. If enough momentum is generated, the sliding snow may run out onto level ground, or even ascend an opposite valley slope. Such an avalanche originates at a point and grows wider as it sweeps up more snow in its descent. The demarcation between sliding and undisturbed snow is diffuse, especially in dry snow. Though very common, most dry, loose snow avalanches are small and few achieve sufficient size to cause damage. With the onset of melting, wet loosesnow avalanches become common. Most of the

Causes of Snow Avalanches
Avalanches form as soon as the force of gravity on the snow cover exceeds its mechanical strength. To be caused, an avalanches needs a steep slope, snow cover, a weak layer in the snow cover, and a trigger to initiate movement. Snow avalanches may occur on any slope where enough snow is deposited in the right circumstances. Snow does not accumulate significantly on steep slopes; also, snow does not flow easily on flat slopes. On slopes from 45 degrees to 50 degrees, sluffs and small avalanches are common, but snow seldom accumulates to sufficient depths to generate large snow slides. Convex slopes are more susceptible to avalanches than concave slopes.

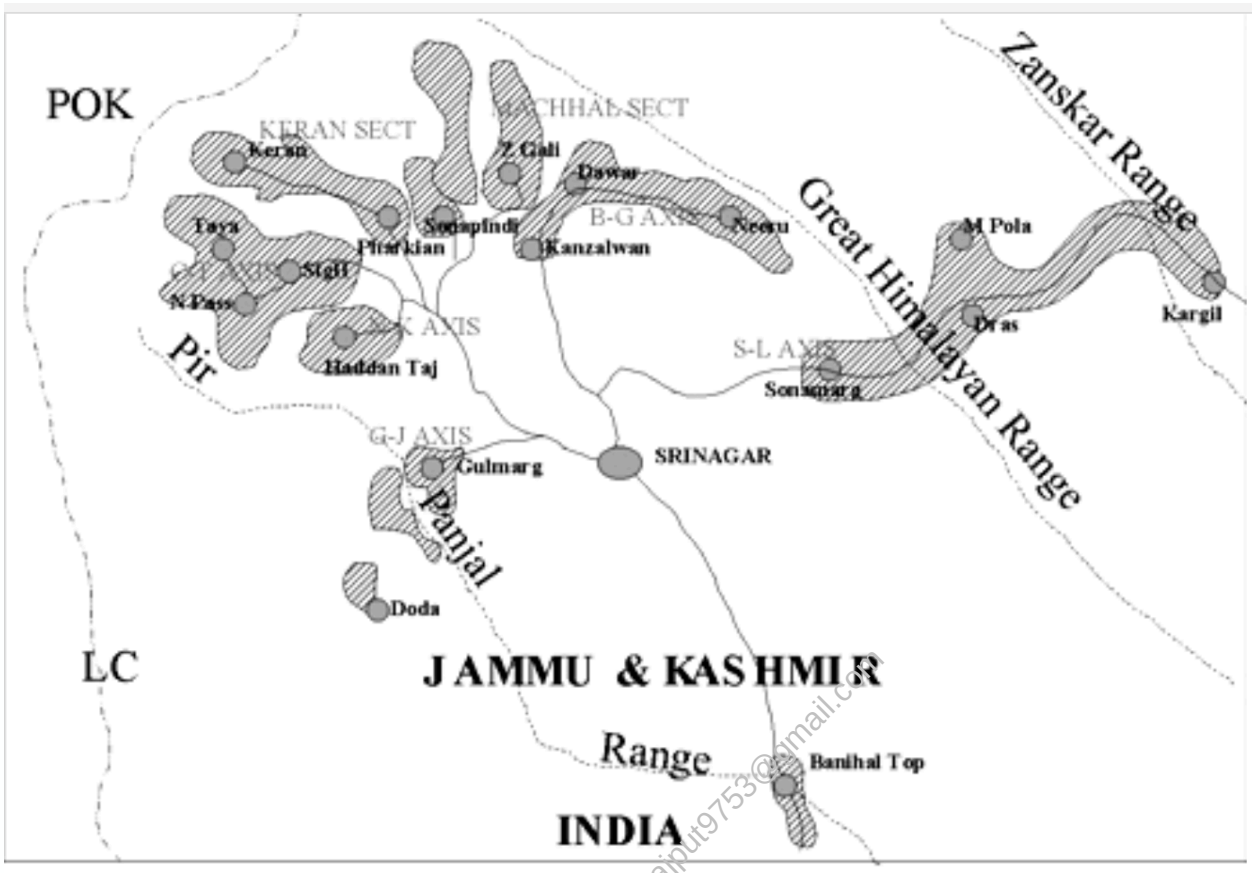
Avalanches are released (spontaneously or artificially) by an increase in stress (e.g., by fresh snow) and/or a decrease in strength (e.g., by warming or rain). Though internal metamorphism or stress development may sometimes initiate a snow rupture, avalanches are often dislodged by external triggers. Ice fall, falling cornices, earthquakes, rock falls, thermal changes, blizzards, and even other avalanches are common natural triggers. Avalanches can also be triggered by loud sounds such as shouts, machine noise, and sonic booms. In the absence of external triggers, unstable snow may revert to stability with the passage of time as long as no avalanche occurs. The rheology of snow cover is similar to that of ice as both are visco-elastic materials that exhibit creep behaviour over time. Snow deforms continually without fracturing as the load on top of it increases. However, the loading rate is critical. Heavy snow fall over a short duration leads to a greater probability of avalanche occurrence. A snow fall of 1m in one day is far more hazardous than 1m over three days. When the snow pack becomes unstable, it is released suddenly and descends rapidly downslope, either over a wide area or concentrated in an avalanche track. It may be preceded by an ‘air blast’ capable of damaging constructions and forest cover.
The complete path of an avalanche is made up of a starting zone at the top where the unstable

snow breaks away from the more stable part of the snow cover, a run-out zone at the bottom where the moving snow and entrained debris stop, and a track that runs between the two zones. The air blast zone is usually in the vicinity, but not necessarily continuous with the lower track or run-out zone. In some cases it may even run way up the slope across the valley from the avalanche path.

In general the run-out zone is the critical area for land use decisions because of its otherwise attractive setting for development. Avalanches run on the same paths year after year, the danger zones often being well known in normal circumstances. Exceptionally uneventful weather intervals lasting for many years may produce exceptional avalanches which overrun their normal paths and even break new ones where none existed for centuries. Avalanche prone lands may pass many winters or even decades without a serious avalanche.
Avalanches are not confined to specific terrain features: they may follow narrow gullies or ravines for all or a part of their path, they may occur on broad, uniform slopes or even ridges and spurs. The longitudinal profiles of the paths may be concave, convex, or stepped. On stepped paths, small avalanches will often stop on a bench some distance down the tract while larger ones will run the full length of the path.

The Impact of Snow Avalanches
The forces generated by moderate or large avalanches can damage or destroy most manmade structures. The debris from even small avalanches is enough to block a highway or rail-road.

Avalanches are extremely destructive due to the great impact forces of the rapidly moving snow and debris and the burial of areas in the run-out zone. Structures not specifically designed to withstand these impacts are generally totally destroyed. Where avalanches cross highways, passing vehicles can be swept away and destroyed, killing their occupants.
In general, land use within an avalanche area should not include buildings intended for winter and early spring occupancy. Ordinarily, use of avalanche areas in the summer does not constitute any hazard. Structures including power lines, highways, railroads, and other facilities that are placed in avalanche paths and run-out zones should be designed for expected impact even if other preventive measures are implemented.



ın overview of avalanche prone areas of western Himalaya.

Snow Avalanches

Avalanches are block of snow or ice descending from the mountain tops at a river like speedy flow. They are extremely damaging and cause huge loss to life and property. In Himalayas, avalanches are common in Drass, Pir Panijal, Lahaul-Spiti and Badrinath areas. As per Snow and Avalanche Study Establishment (SASE), of Defence Research and Development Organisation (DRDO), on an average, around 30 people are killed every year, due to this disaster in various zones of the Himalayan range. Beside killing people, avalanches also damage the roads, properties, and settlements falling in its way. Traffic blockage, structural damages of roads, and retaining wall damages occur most frequently due to avalanches. Snow avalanches occur in several stretches of the Himalayan range with the following areas being more vulnerable:

- Western Himalaya – the snowy regions of J&K, Ladakh, HP and Uttarakhand, especially Tehri Garhwal and Chamoli districts
- J&K and Ladakh – Higher reaches of Kashmir and Gurez valleys, Kargil, Ladakh and along some of the major roads
- HP – Chamba, Kullu-Spiti and Kinnaur

2.2.2.7 Drought

8

There is no globally adopted operational definition for drought applicable to all contexts. This is the primary reason why policy makers, resource planners, and other decision-makers as well as administrators have considerable difficulty recognizing and planning for drought than they do for other disasters. Global Assessment Report (GAR) 2015 notes that agricultural drought is probably the most "socially constructed" of all disaster risks (UNISDR 2015b) and warns that due to global climate change, its frequency is expected to vary much. To determine the beginning of drought, operational definitions specify the degree of departure from the long-term (usually at least 30 years) average of precipitation or some other climatic variable. Broadly, drought is perceived as sharply felt water deficit caused by variations in the natural hydro-metrological factors, agro-ecological conditions, moisture requirements of crops under prevailing cropping choices (systems, patterns).

The WMO considers drought as a slow creeping natural hazard that occurs in part due to the natural climatic variability. In recent years, concern has grown world-wide that droughts may be increasing in frequency due to climate change. Responses to droughts in most parts of the world are generally reactive in terms of crisis management and are known to be untimely, poorly coordinated and disintegrated. Conceptual definitions, formulated in general terms, help people understand the concept of drought. Conceptually, drought is characterised by a protracted period of deficient precipitation resulting in water deficits, extensive crop damage, resulting in loss of yield. Operational definitions help define the onset, severity, and end of droughts. No single operational definition of drought works in all circumstances, and this is a big part of why policy makers, resource planners, and others have more trouble recognizing and planning for drought than they do for other natural disasters. In fact, mostly, decision-makers/ planners now rely on mathematical indices to decide when to start implementing water conservation or drought response measures. To determine the beginning of drought, operational definitions specify the degree of departure from the average of precipitation or some other climatic variable over some period. This is usually done by comparing the current situation to the historical average, often based on at least a 30-years record.

Droughts affect vast areas of the country, transcending State boundaries. A third of the country is drought prone. Recurrent drought results in widespread adverse impact on people's livelihoods and young children's nutrition status. It affects parts of Rajasthan (chronically), Gujarat, Maharashtra,

Madhya Pradesh (MP), Uttar Pradesh (UP), Chhattisgarh, Jharkhand, and Andhra Pradesh. Drought is not uncommon in certain districts. Droughts cause severe distress in the affected areas.

Drought is a phenomenon that is widely considered as a 'creeping disaster' whose onset, end, and severity are difficult to determine. Unlike the suddenly occurring disasters, a drought may develop very slowly over several months affecting very large geographical area without causing little or no structural damage. The impacts depend on natural conditions, socio-economic situation, and the kind of land and water resources as well as the use patterns in the affected region.

Mostly, the occurrence of droughts is a result of natural climate variability in all the drought-prone regions and it usually exhibits a certain pattern of occurrence. While droughts are quite frequent in arid and semi-arid regions, it can occur even in humid regions blessed with abundant rainfall with lower frequency. The capacity to cope depends largely on the technical, institutional, political, and social mechanisms to manage the water resources anticipating the severity of the drought. Effective mitigation measures must prevent a drought turning into a famine due to water and food shortages.

Drought results from long period of dry weather and insufficient precipitation, which causes acute dry conditions. The National Commission on Agriculture in India defines three types of droughts:

a) Meteorological drought, defined as a situation when there is more than 25% decrease from the long-term average precipitation over an area
b) Agricultural drought, signifying the situation when soil moisture and rainfall are inadequate to support healthy crop growth
c) Hydrological drought resulting from prolonged meteorological drought manifested in depletion of surface and sub-surface water resources, which could occur even when the rainfall is normal, if there has been a substantial reduction in surface water holding capacity

Most classifications emphasize physical aspects of drought, particularly in the context of agriculture (including livestock rearing), although its impacts will be felt in both farm and non-farm sector. The direct impacts are usually visible in falling agricultural production and heightened food insecurity among poor and vulnerable sections; depleted water levels; higher livestock and wildlife mortality; cattle and animal migration; damage to ecosystem from indiscriminate exploitation; increased fire hazards etc. Indirect impacts of drought can be gauged from the reduction in incomes for farmers and agribusinesses, increased prices for food and fodder, reduction in purchasing capacity and slump in consumption, default on agricultural loans, distress sale of agricultural land & livestock, rural unrest, shrinkage in avenues for agricultural employment etc.

The impact, response, and interventions would vary depending on at what point of time in a crop calendar there is acute water or soil moisture deficit. Generally, three situations are recognised:

a) Early season: delayed rainfall (delayed onset of monsoon), prolonged dry spells after onset
b) Mid-season: inadequate soil moisture between two rain events, and
c) Late season: early cessation of rains or insufficient rains

The IMD recognizes five drought situations:

a) 'Drought Week' when the weekly rainfall is less than half of the normal
b) 'Agricultural Drought' when four drought weeks occur consecutively during mid-June to September
c) 'Seasonal Drought' when seasonal rainfall is deficient by more than the standard deviation from the normal

d) 'Drought Year' when annual rainfall is deficient by 20 per cent of normal or more, and
e) 'Severe Drought Year' when annual rainfall is deficient by 25 to 40 per cent of normal or more

In the absence of an unambiguous criterion, the NDMA Guideline on 'Management of Drought' notes that there is a need to develop a multi-criteria index to classify droughts based on several factors such as the following:

- Meteorological (rainfall, temperature, etc.)
- Soil conditions (depth, type, available water content, etc.)
- Surface water use (proportion of irrigated area, surface water supplies, etc.)
- Ground water (availability, utilization, etc.)
- Crop (cropping pattern changes, land use, crop conditions, anomalies in crop condition, etc.)
- Socio-economic (proportion of weaker sections, poverty, size class of farm holdings, etc.)

Increasing severity of drought can lead to a major livelihood crisis with crop losses and widespread unemployment. It is essential that along with a drought monitoring system, medium and long-term area specific plans be prepared for drought proofing of susceptible areas. While drought-proofing measures can significantly improve the coping capacity and dampen the impact of drought, if drought conditions worsen, many agencies of the state and centre will have to work in concert to prevent acute rural distress. Since progression of drought is slow, agencies can respond by closely monitoring the situation using various technical capabilities available.

2.2.2.8 Cold Wave and Frost

Cold wave and frost are seasonal and localized hazards occurring only in the parts with severe winter. Prolonged frost conditions and cold wave can damage certain frost-sensitive plants causing crops loss. The susceptibility to frost varies widely across crops. The extent of damage caused by cold wave depends on temperature, length of exposure, humidity levels, and the speed at which freezing temperature is reached. It is difficult to predict a definite temperature level up to which crops can tolerate cold wave/frost because many other factors also affect it. Cold wave can cause death and injury to human beings, livestock and wildlife. Higher caloric intake is needed for all animals, including humans to withstand exposure to cold and poor nutritional status can prove deadly in extreme cold conditions. If a cold wave is accompanied by heavy and persistent snow, grazing animals may be unable to get the requisite food. They may die of hypothermia from prolonged exposure or starvation.

Described below are the IMD definitions[11] for Cold Wave and Cold Day:

> Wind chill factor plays an important role and brings down the actual minimum temperature depending upon the wind speed. The actual minimum temperature of a station should be reduced to "Wind Chill Effective Minimum Temperature (WCTn)" based on wind chill factor using the relevant WMO criteria. For declaring "Cold Wave" and "Cold Day" WCTn should only be used.

If WCTn is 10°C or less, then only the conditions for cold wave should be considered. There is a Cold Wave

a) When normal minimum temperature is equal to 10°C or more; Cold Wave if the departure from normal is -5°C to -6°C and 'Severe Cold Wave' Departure from normal is -7°C or further

wind chill is simply a combination of temperature and wind speed

[11] http://imd.gov.in/section/nhac/termglossary.pdf (accessed Sep 20, 2019)

Drought

Safety Tips :

- Never pour water down the drain, use it to water your indoor plants or garden.
- Repair dripping taps by replacing washers.
- Check all plumbing for leaks and get them repaired.
- Choose appliances that are more energy and water efficient.
- Develop and use cop contingency plan to meet drought situation
- Plant drought-tolerant grasses, shrubs and trees.
- Install irrigation devices which are most water efficient for each use, such as micro and drip irrigation.
- Consider implementing rainwater harvesting wherever it is suitable
- Avoid flushing the toilet unnecessarily
- Avoid letting the water run while brushing your teeth, washing your face or shaving.

Value the ecological service of nature,
For a safe and disaster free future

d) 'Drought Year' when annual rainfall is deficient by 20 per cent of normal or more, and
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cold wave india

The major factors for Cold Wave occurrence over India
• A build-up of a ridge (an extended area of relatively high atmospheric pressure) in the jetstream over northwest Asia;
• Formation of surface high-pressure over north & central India;
• Movement of cold air masses in response to steering by upper-level winds;
• Triggering mechanisms like a strong westerly waves approaching northwest India to enhance winds for transporting cold air southeastward; and
• Extensive snow covers over northwest Himalayas.

Impact of Cold Wave in India

health (deaths),agriculture, livestock, fisheries, transport,enegy and power, water, tourism, small street vendors,

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cold wave india

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4.4. Key Strategy for Cold Wave Management

Severe and extended cold wave can also cause disruption to general, social and economic service. As cold wave/frost is a localised disaster event, location-specific strategies are to be drawn up by the State Governments. Government agencies will have a critical role to play in preparing and responding to cold wave at the local level, working closely with agriculture, health, livestock and other related departments on a long-term strategic plan. The strategy for cold wave management comprises of:
(i) Identification of cold wave risk and vulnerability assessment;
(ii) Establishing qualitative early warning, forecasting and alerts dissemination;
(iii) Develop inter-agency coordination at different levels;
(iv) Preparedness at the local level;
(v) Structural & non-structural measures including cold wave related programmes/schemes;
(vi) Public awareness and community outreach;
(vii) Capacity building and training programmes;
(viii) Collaboration with private, non-government organisations and civil society;
(ix) Research & Development; and
(x) Assessing the impact
(xi) Receiving feedback for reviewing and updating the plan.

preventive measures

Measures to manage cold wave have been in place by the local state/ district level administration. Some of the general and prevailing measures adopted by cold wave prone states, which may be useful for other States too:
• Identification of vulnerable areas and preparation of Winter Action Plans covering all sectors;
• Timely dissemination of early warning to all concernedstakeholders;
• Regular and frequent meetings of administration at all levels;
• Ensure adequate quantity of supplies of food, drinking water, fuel, and medicines etc.;
• Well planned out and timely arrangements for day and night shelters for the homeless;
• Preparations for necessary medical facilities to handle cases of cold wave victims;
• Arrangements of Rescue Teams linked with CATs Ambulance to facilitate transportation of needy persons to hospitals;
• Creating and publicising helpline numbers for people to contact authorities and get required help;
• Advance planning to ensure uninterrupted power supply;
• Preventing crops from cold waves and also promoting cold weather sustainable crops; and
• Issue of advisories for common people to help them keep safe from cold waves.

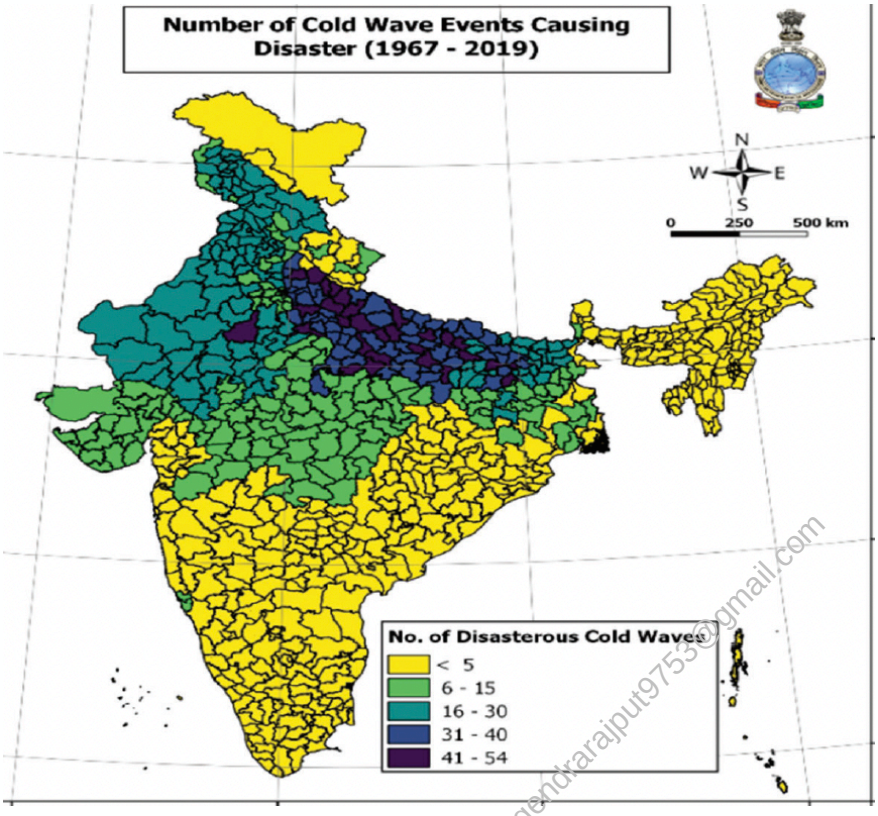
preparedness

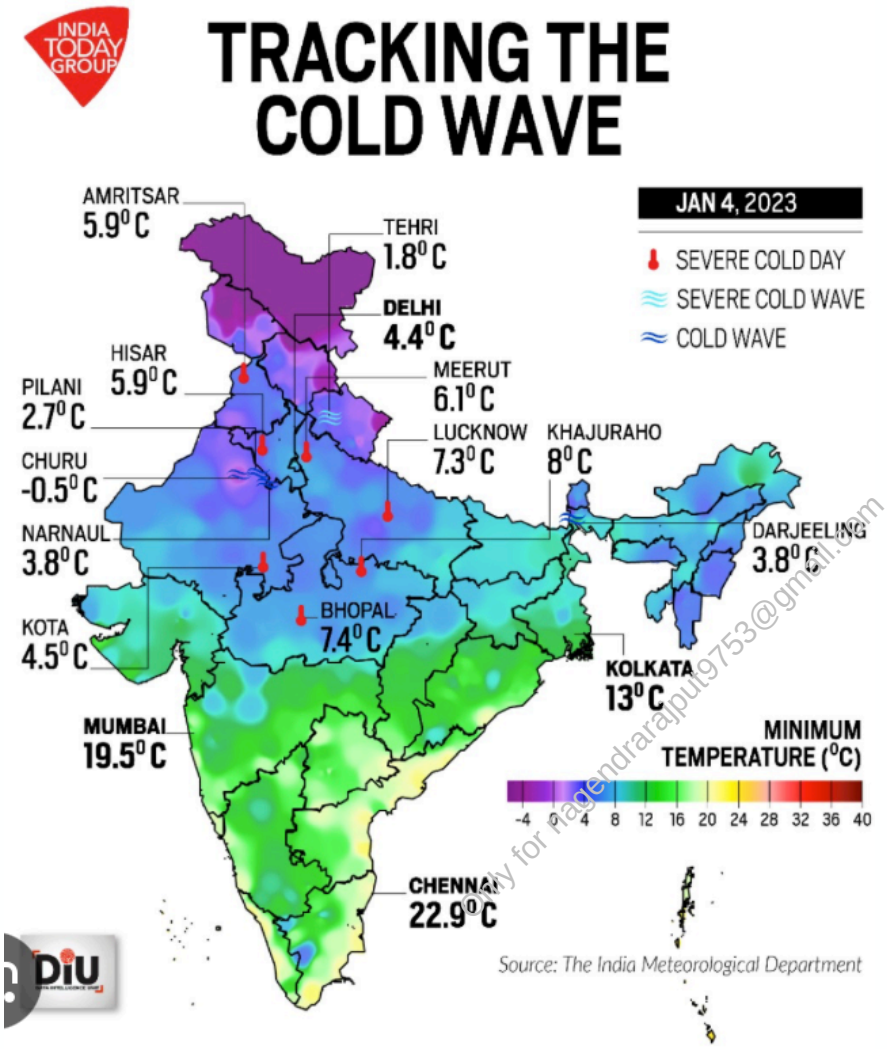
Advisories and Early Warning: Timely advisory and early warning in coordination with IMD can prevent likely loss of lives or damages due to cold waves.

• Health and Medical Facilities: Saving loss of lives and preventing cold wave related illnesses are top priorities; adequate health and medical facilities are necessary to deal with cold wave impacts.
• Agriculture: Impact of cold waves on Agriculture is huge and significant. Protection of crops and plants from cold wave / frosts is crucial.
• Animals and Livestock: Protection of animals and livestock is also important as they are part of livelihood for large number of households.
• Energy: Role of Power/Energy is vital in management of cold waves. Uninterrupted power supply helps in keeping the internal environment warm and it also helps in medical and health services.
• Water Supply: Prevention of water from freezing during extreme cold and to ensure normal water supply is very essential.
• Transportation and Traffic Management: Clearing of snow and taking safety measures during fog are some of the important measures to be taken for cold waves.
• Tourism: Tourism has both positive and negative impacts of the cold waves. It is important to ensure that positive impacts continue whereas the negative impacts are checked and controlled.

Community/Family preparedness during cold wave
Community/Family should be adequately prepared for meeting the challenges of cold wave. Community/local level preparedness plan, and IEC activities to create awareness among the community members is essential. As part of the awareness or community & families special focus should be paid to the following do's and don'ts. A detailed list of Do's and Don'ts is in Annexure-1
• Assess the risks where you live, work, study and (kids) play
• Assess individual capabilities and needs
• Keep emergency contact and health information available
• Know your building exit routes
• Make hazard-specific plans about whether to stay or go and where to shelter (applicable for other hazards as well). Learn the location of cold wave-shelters or temporary housing.
• Respond to early warnings issued by competent authority. Learn and participate in your community's early warning systems and practise regular emergency mock-drills
• Construct your home in a safe place in compliance with building regulations
• Take annual home maintenance measures to keep your home safe
• Know your building well and identify places that may fail due to snowfall or heavy precipitation
• As keeping hot-pots and other heating mechanisms is common during cold wave, practices home fire prevention methods
• Protect your domestic animals and livestock
• In case of power outage, take fire precautions
• After hazard impact, after making sure you're safe, help those around you.

Capacity Building and Training Measures
• Facilitate: Knowledge & Skills required for Cold wave management through short/medium Training Courses
• Integrate training sessions on Cold Wave management as part of other official training programmes for senior and mid-level government officials from various line departments
• Study ours and training programs for State/District officials.
• Training for Shelter Management including arrangement of essential supplies and medicines for local administration;
• Training of Fire Department for responding to fire situations;
• Awareness campaigns;
• Training of health workers under Integrated Disease Surveillance Programme (IDSP);
• Training programmes for farmers about measures for protecting their crops and livestock.
• Develop Modules on related areas based on NDMA guidelines- enable in training sessions of government offices/states converting into School, College Syllabus, Curriculum etc





Colour Code early warning

Colour code	Alert	Warnings	Impact	Suggested Action
Green (No Action)	Normal day	Minimum tempertures are near normal	Comfortable temperature.	No precautionary action required.
Yellow Alert (Be Updated)	Cold Wave Alert	Cold wave conditions in isolated areas persist for two days.	• Moderate temperature. Chilly winds may aggravate cold at time. • Cold is tolerable but mild health concern for vulnerable people. (Infants, pregnant women, elderly, people with chronic diseases etc.)	• Avoid prolonged exposure to cold. • Wear several layers of loose fitting, light weight; warm woollen clothing rather than one layer of heavy cloth. • Cover your head, neck, hands and toes adequately as majority of heat loss occurs through these body parts.
Orange Alert (Be Prepared)	Severe Cold Wave Alert	(I) Severe cold wave conditions persist for two days.	• An increased likelihood of various illnesses like flu, running/ stuffy nose or nosebleed,	• Listen to radio; watch TV, read newspaper for weather updates/ forecasts.

		(II) Though not severe, cold wave conditions persist for four days or more.	which usually set in or get aggravated due to prolonged exposure to cold. • Do not ignore shivering. It is the first sign that the body is losing heat. Get indoors. • Frostbite can occur due to prolonged exposure to cold. The skin turns pale, hard and numb and eventually black blisters appear on exposed body parts such as fingers, toes, nose and or earlobes. • Severe frostbite needs immediate medical attention and treatment.	• Wear insulated/waterproof shoes. • Moisturise your skin regularly with oil, petroleum jelly or body cream. • Eat healthy fruits and vegetables rich in vitamin-C and drink lots of fluids to maintain adequate immunity. • Avoid or limit outdoor activities. • Keep dry, if wet, change clothes immediately to prevent loss of body heat. • Warm the affected area of the body slowly with lukewarm water; do not rub the skin vigorously. • If the affected skin area turns black, immediately consult a doctor. • Maintain ventilation while using heaters to avoid inhaling toxic fumes. • Take safety measures while using electrical and gas heating devices. • Don't drink alcohol. It reduces your body temperature. • Drink hot drinks regularly.
Red Alert (Take Action)		(I) Severe cold wave conditions persist for more than two days. (II) Total number of cold wave/severe cold wave/days exceeding six days.	• Severe exposure to cold wave can lead to Hypothermia; a decrease in body temperature which causes confusion, shivering, difficulty in speaking, sleepiness, stiff muscles, heavy breathing, weakness and/or loss of consciousness. Hypothermia is a medical emergency that needs immediate medical attention.	• Along with suggested action for orange alert, extreme care needed for vulnerable people. • Regularly check on elderly neighbours, especially those who live alone. Stay indoors, if possible. Avoid unnecessary exertion. • Locate designated public shelter nearby. • In case of electricity or heating mechanism failure, take the affected person to such designated shelters. • Seek medical attention as

			• Frost and cold wave affect pulse crops and livestock.	soon as possible for someone suffering from frostbite/ Hypothermia. • Do not give the affected person any fluids unless fully alert. • Store adequate water as pipes may freeze. • Move pets indoors. Likewise, protect livestock or other big animals from cold weather by moving them to an enclosure.

Source: IMD and NDMA

Cold Wave

Safety Tips :

- Keep ready the Emergency Kit along with snow shovels, wood for your fireplace and adequate clothing.
- Listen to local Radio Station for weather updates.
- Stay indoors; minimize travel.
- Keep dry. Change wet clothing frequently to prevent loss of body heat.
- Watch for symptoms of frostbite like numbness, white or pale appearance on fingers, toes, ear lobes, and the tip of the nose.
- Maintain proper ventilation when using kerosene heaters or coal oven to avoid toxic fumes.
- Go to a designated public shelter, if your home loses power or heat during extreme cold.
- Protect yourself, from frostbite and hypothermia by wearing warm, loose fitting, lightweight clothing in layers.

Disaster destructs,
Preparedness protects.

b) When normal minimum temperature is less than 10°C; 'Cold Wave' – if the departure from normal is -4°C to -5°C and 'Severe Cold Wave' Departure from normal is -6°C or less.
c) When WCTn is 0°C or less, Cold Wave should be declared irrespective of normal minimum temperature of the station. However, this criterion is not applicable for those stations whose normal minimum temperature is below 0°C

Cold Wave conditions for coastal stations: For coastal stations the threshold value of minimum temperature of 10°C is rarely reached. However, the local people feel discomfort due to wind chill factor which reduces the minimum temperature by a few degrees depending upon the wind speed. For coastal stations, the "Cold Day" concept may be used following the criteria given below:

a) Actual minimum temperature of a station be reduced to WCTn
b) This WCTn should be used to declare "Cold Wave" or "Cold Day"
c) When minimum temperature departure is -5°C or less over a station, "Cold Day" may be described irrespective of threshold value of 10°C
d) However, when a threshold of 10°C is reached "Cold Wave" be declared
e) When a station satisfies both the Cold Wave and Cold Day criteria, then Cold Wave has a higher priority and must be declared

Cold Wave and Cold Day are area specific phenomena and may be ascribed for a Met Sub-division or a part thereof when at least two stations satisfy the criteria.

2.2.2.9 Thunderstorm, Lightning, Squall, Dust Storm, and Strong Wind

Thunderstorm/Lightning, Dust/Hailstorm, Squall, and Strong Wind are hazardous and cause risk to life and public property. These are potentially hazardous for aviation sector as well as to transport, power, communication and other socio-economic sectors. Thunderstorms have some important characteristic such as formation of Squall, strong updraft and down draft, towering cumulonimbus associated with turbulence and icing, in cloud electrification and associated lightning, localized heavy rain and hailstorm. As available data of last ten years, about 2,500 people died from lightning strikes and torrential rains in the country every year. India may also witness an increase in the severity and frequency of the dust storms and thunderstorms similar to what the northern Indian states experienced recently. Experts also believe that the severity and frequency of thunderstorm/dust storms is expected to rise in years ahead due to rising global temperature. The increase in occurrence and severity is a wake-up call for all agencies to take appropriate action for prevention, preparedness and mitigation in order to save lives, livestock, property and infrastructure.

10

Thunderstorms

Thunderstorms occur round the year in different parts of the country. However, their frequency and intensity is maximum in summer months (March to June). As the most important factor for occurrence of thunderstorm is the intense heating of the atmosphere at surface level and maximum heating takes place in summer months, the frequency of occurrence is maximum in summer months. A thunderstorm is said to have occurred, if the thunder is heard or lightening 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 spatial extent of around 2~20 km and temporal scale of a few hours. Considering the intensity, the thunderstorms in India are categorised as moderate and severe thunderstorms as follows:

Thunderstorms have some typical characteristics which lead to the formation of a squall, strong updraft and downdraft, towering cumulonimbus clouds associated with turbulence and icing, incloud electrification and associated lightning, localized strong rain and hailstorm. They have a devastating impact on agriculture and aviation sectors in addition to surface transport, power, communication and other socio-economic sectors. These may also lead to loss of human lives, assets/ property/ livelihoods, etc.

Lightning is yet another weather-related disaster associated with thunderstorms. Lightning occurs due to electrically charged regions in a cloud which is called intra-cloud lightning (IC) or between Cloud-to-Cloud (CC lightning), or between a cloud and the ground (CG lightning).

IMD data (1950-1980) shows that more than 80 thunderstorm days occur per year over the northeastern part of India, some parts of Kerala and Jammu & Kashmir. The eastern and northeastern parts of our country, i.e. Gangetic West Bengal, Jharkhand, Bihar, Odisha, and northeastern States, get affected by severe thunderstorms during the pre-monsoon months of March to May

IMD data (1950-1980) shows that more than 80 thunderstorm and lightning days occur over the northeast, and some parts of Kerala and Jammu &Kashmir each year. In India, more than 2,500 people die due to thunderstorm and lightning every year. The country may also witness in future an increase in the severity and frequency of thunderstorms and dust storms.

Lightning is yet another weather-related disaster associated with thunderstorms. Lightning occurs due to electrically charged regions in a cloud which is called intra-cloud lightning (IC) or between Cloud-to-Cloud (CC lightning), or between a cloud and the ground (CG lightning).

Thunderstorm Incidence Map

(http://www.bmtpc.org/DataFiles/CMS/file/VAI2019/th.html , accessed Oct 15, 2019)

BMTPC: Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA, GOI; Map is Based on digitised data of SOI;Thunderstorm data from IMD. Disclaimer: The maps are solely for thematic presentation.

- **Moderate thunderstorm**: It is called as moderate thunderstorm, if there is loud peals of thunder with frequent lightning flashes, moderate to Strong rains and maximum wind speed 29 to 74 kmph
- **Severe thunderstorm**: It is called as severe thunderstorm, if there is continuous thunder and lightning, Strong rains and maximum wind speed ≥ 75 kmph

Squall

The frequency and intensity of squall are maximum over eastern and northeastern states. Comparing different seasons, the frequency of squall is maximum in pre-monsoon season (March-May) in different parts of the country. However, there is a secondary maximum in the winter season over the northwest India. The intensity of squall is maximum in the month of May followed by April. A squall is defined as a sudden increase of wind speed by at least 29 kmph (16 knots) with the speed rising to 40 kmph (22 knots) or more and lasting for at least one minute. The squalls are of two types:

- Moderate squall: It is called as moderate squall, if surface wind speed (in gusts) is less than 80 kmph
- Severe squall: It is called as severe squall, if surface wind speed (in gusts) is greater than 80 kmph

Dust Storm

11

The northwest India experiences convective dust storms called "aandhi" locally during the pre-monsoon season. The frequency of dust storm is maximum over Rajasthan followed by Haryana, Punjab and west UP. The dust storm mainly occurs in the pre-monsoon season and it is maximum in the month of May in terms of frequency and intensity. The dust storms are of three types:

- Slight when the wind speed is less than 41 kmph and visibility is 500 to 1000 metres
- Moderate when the windspeed is 42 to 79 kmph and visibility is 200 to 500 metres
- Severe when the surface wind speed (in gusts) more than 80 kmph and visibility is less than 200 metres

Lightning

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Lightning is a high-current electric discharge that occurs in the earth's atmosphere and that has total path length of the order of few kilometers. The peak power and total energy in lightning are very high, the peak power that is dissipated by a lightning discharge is on the order of 100 million watts per meter of channel and the peak channel temperature approach 30,000 °C. Peak currents in a lightning discharge range from several to hundreds of kiloamperes (kA), with typical value being 40 kA. Prediction of lightning as to the precise time and location is very difficult. In the atmosphere, three types of discharges take place: a) Thundercloud (intra-cloud), b) One cloud to another (inter-cloud) and c) Cloud to ground (CG). Aircrafts can be hit by first two while the third type takes a toll on life and property on the ground.

2.2.2.10 Cloudburst and Hailstorms

Cloudburst[12]

13

A cloudburst is an extreme amount of precipitation in a short period, sometimes accompanied by hail and thunder, that can create flood conditions. It is not, as is sometimes understood, the breaking open

[12] This section relies on publications (reports, circulars, research papers) of IMD and NCMRWF.

of a cloud resulting in the release of huge amounts of water. According to the IMD, if rainfall of about 100 mm or above per hour is recorded over a place that is roughly less than 100 sq.km area, it is classified as a cloudburst event. By this definition, 50 mm rainfall in half an hour would also be classified as a cloudburst. To put this in perspective, India, in a normal year, gets about 1160 mm annual rainfall. A cloudburst would therefore account for 10-12 per cent of the annual rainfall of that area in just an hour. At times, a large amount of runoff from higher elevations is mistakenly conflated with a cloudburst. They are difficult to forecast because they occur over a very small area. Forecasts for a very small area are difficult to predict. However, using Doppler radars it is possible to forecast the possibility of cloudbursts about six hours and sometimes 12-14 hours in advance.

However, cloudbursts are infrequent as they occur only via orographic lift, i.e., occasionally when a warm air parcel mixes with cooler air, resulting in sudden condensation. Cloudbursts do happen in plains as well, but there is a greater probability of them occurring in mountainous zones; it has to do with the terrain. Hilly terrains aid in heated air currents rising vertically upwards, thereby, increasing the probability of a cloudburst situation. The rainfall itself does not result in the death of people, though sometimes, the raindrops are big enough to hurt people in a sustained downpour. It is the consequences of such heavy rain, especially in the hilly terrain, that causes death and destruction. Landslides, flash floods, houses and establishments getting swept away and cave-ins lead to the deaths. There is a paucity of past data on cloudbursts; in addition, since only some of them get counted – only those that result in death and destruction – there is a problem of accuracy as well. Under global climate change scenarios, the frequency of high intensity rainfall events is expected to increase and consequently frequency of cloudburst events may also increase.

Hailstorm[13]

14

India is among the countries in the world with the highest frequency of hail. There are about 29 hail days per year of moderate to severe intensity. The hailstorm activity that occurs usually in the months of April and May occurred during February-March in 2014. About 25% of total occurrence in the past recorded hailstones of 3-cm or more diameter. The hailstorms are mainly observed in the winter and pre-monsoon seasons with virtually no events after the onset of the southwest monsoon.

Hail is a solid, frozen form of precipitation that causes extensive damage to property and crop. Hot, humid afternoon hours during the summer are the most congenial for development of hailstorms, which usually form over a relatively small area and pass over within a very short period. At times, it can cause considerable crop damage in brief spell lasting a few minutes. Hail is often associated with thunderstorm activity and changing weather fronts. This is formed in huge cumulonimbus clouds, commonly known as thunderheads. The IPCC reports caution that there are indications that a warming climate would favour an increase in the intensity and frequency of extreme events such as heat waves and precipitation extremes. Hail and thunderstorms are extreme forms of weather events that deserve special attention in view of climate change. Hailstorms are of three types:

- Slight, when it is sparsely distributed, usually small in size and often mixed with rain
- Moderate, when it is abundant enough to whiten ground
- Strong, if it includes at least a proportion of large stones

As a thunderstorm moves along, it may deposit its hail in a long narrow band (often several kilometres wide and about 10 kilometres long) known as a hail-streak or hail-swath. If the storm should remain almost stationary for some time, substantial accumulation of hail is possible. Its size and shape depend on how fast the storm is moving and how strong the updrafts are inside the storm. A typical hail-streak is about 1.5 km wide and 8 km in length. However, these may vary from a few acres to large belts,

[13] This section relies largely on Bal et al 2014

about 16 km wide and 160 km long. The volume of hail reaching the ground falls at a speed of about 40 m/sec and is usually less than one-tenth the volume of rain produced by a thunderstorm.

The hail-related damage depends on the size of hailstones and number that fall per unit area during a hail fall, the wind force during the event and the type of area where it falls. The extent of crop-hail damages also varies depending on the stage of occurrence of hail during the crop growing season. Even a short episode of hail can cause severe injury to crops, fruit trees, both downgrading the quality and causing subsequent losses due to diseases like blight, mould, canker and fruit rots. One among the world's deadliest hailstorms recorded in history occurred on 30 Apr, 1888 in Uttar Pradesh killing at least 230 people, and over 1600 sheep and goats. According to the Commissioner of Agriculture, Maharashtra, the hailstorms damaged various horticultural crops over approximately 16 lakh acres.

Hail being a very short term and localized phenomena, its prediction well in advance to inform all stakeholders for adequate preventive measures is a major challenge for even the most technologically advanced and hail-prone countries like the USA. India, being situated in the tropical and subtropical region, the frequency is less compared to the mid-latitude and temperate countries. However, with climate change, the instances of severe weather aberrations are increasing.

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2.2.2.11 Glacial Lake Outburst Flood (GLOF)

see next page and then come here

A Glacial Lake Outburst Flood (GLOF) is a type of flood occurring when water dammed by a glacier or a moraine is released. When glaciers melt, they sometimes form lakes on mountaintops. The water in these glacial lakes accumulates behind loose naturally formed 'dams' made of ice, sand, pebbles and ice residue. Glacial lake volumes vary, from several MCM to hundreds of MCM of water. But these are inherently unstable and disturbances such as avalanches, falling boulders, earthquakes, or even simply the accumulation of too much water can breach the 'dam', unleashing sudden, potentially disastrous floods in nearby communities. A catastrophic failure of the containing ice or glacial sediment can release this water over periods of minutes to days. Peak flows as high as 15,000 cubic metres per second have been recorded in such events. GLOF events have killed thousands in many parts of the world and some of the largest events occurred in the Himalayas.

The Indian Himalayan Region (IHR), with geographical coverage of over 5.3 lakh kilometre square, extends over 2,500 kilometres in length between the Indus and the Brahmaputra river systems. While glacial lake hazards and glacial lake distributions are investigated in many glaciated regions of the world, relatively, there has been less attention to these in the Indian Himalayas. In physiographic terms, the IHR extends from the foothills in the south (Siwaliks) to Tibetan plateau in the north (Trans-Himalaya). Three major geographical entities, the Himadri (Greater Himalaya), Himanchal (Lesser Himalaya) and the Siwaliks (Outer Himalaya), extending almost uninterrupted throughout its length, are separated by major geological fault lines. The National Mission for Sustaining the Himalayan Ecosystem (NMSHE), one of the eight missions under the National Action Plan on Climate Change (NAPCC) is dedicated to sustainable development of the region, understanding climate change impacts and examining adaptation strategies for the region. The Himalayan states/UTs include—J&K, Ladakh, HP, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and two partial hill states, namely Assam and West Bengal.

The climatic change/variability in recent decades has made considerable impacts on the glacier lifecycle in the Himalayan region. Scientific studies have noted glacier retreat occurring in most parts of the Hindu Kush Himalaya, which has given rise to the formation of numerous new glacial lakes. Glacial lakes are an indirect indicator of glacier change and unstable lakes can present hazards to downstream locations. The Geological Survey of India (GSI) lists 9,575 glaciers in IHR, of which 267 are over 10 sq.km. One of the pioneering regional glacial lake inventories has provided a qualitative

2018 guidelines

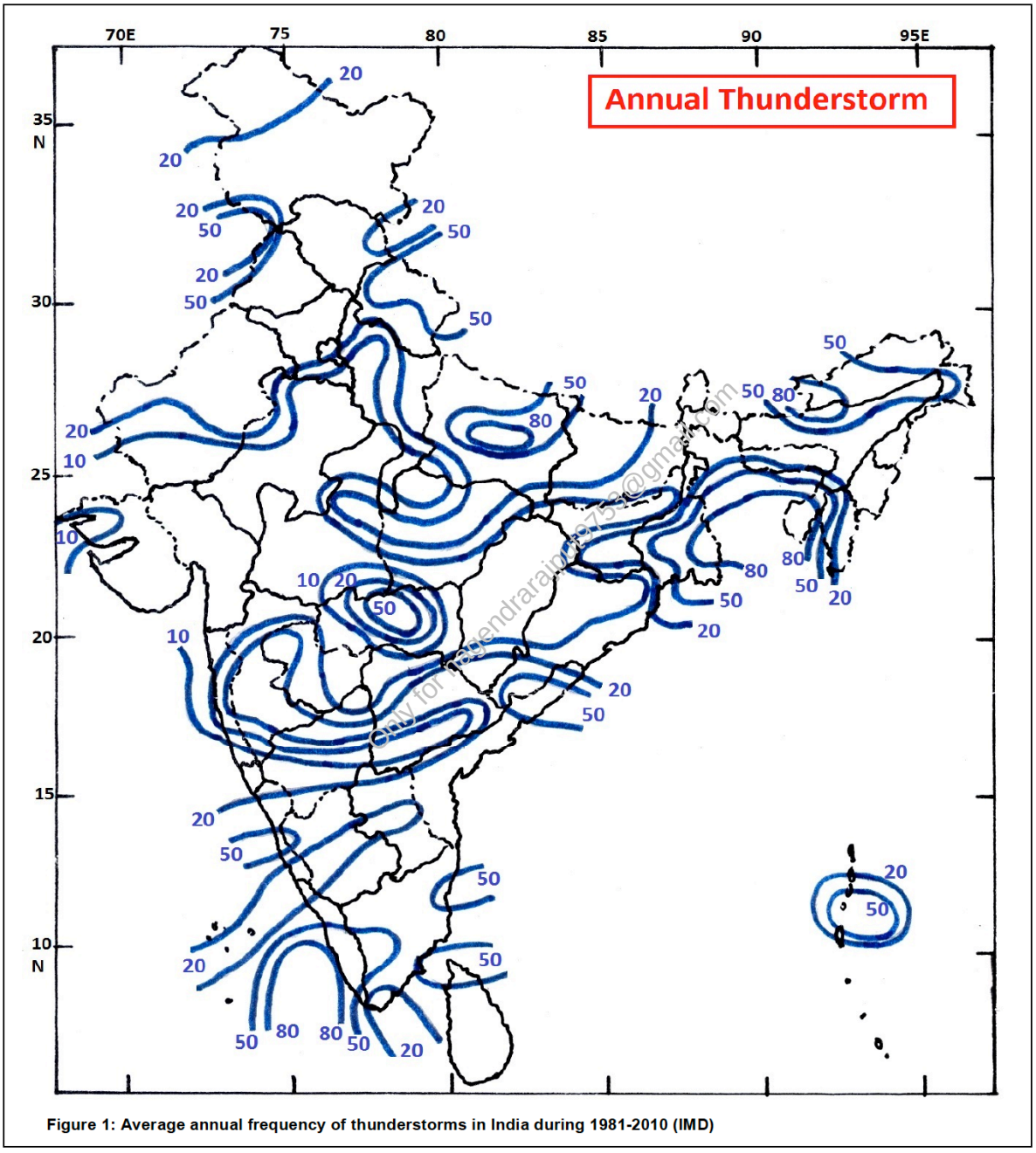

Figure 1: Average annual frequency of thunderstorms in India during 1981-2010 (IMD)

Genesis:
During May 2018, severe dust storms, thunderstorms and lightning hit several parts of India resulting in a large number of casualties/loss of lives and severe economic losses. These incidents as well as experiences from the past led to the realization that the formulation of national "Guidelines for preparation of Action Plan – Prevention and Management of Thunderstorm & Lightning/ Squall Dust/Hailstorm and Strong Winds" is a must for improving the capacity of the States to deal with these incidents in a scientific and planned manner.

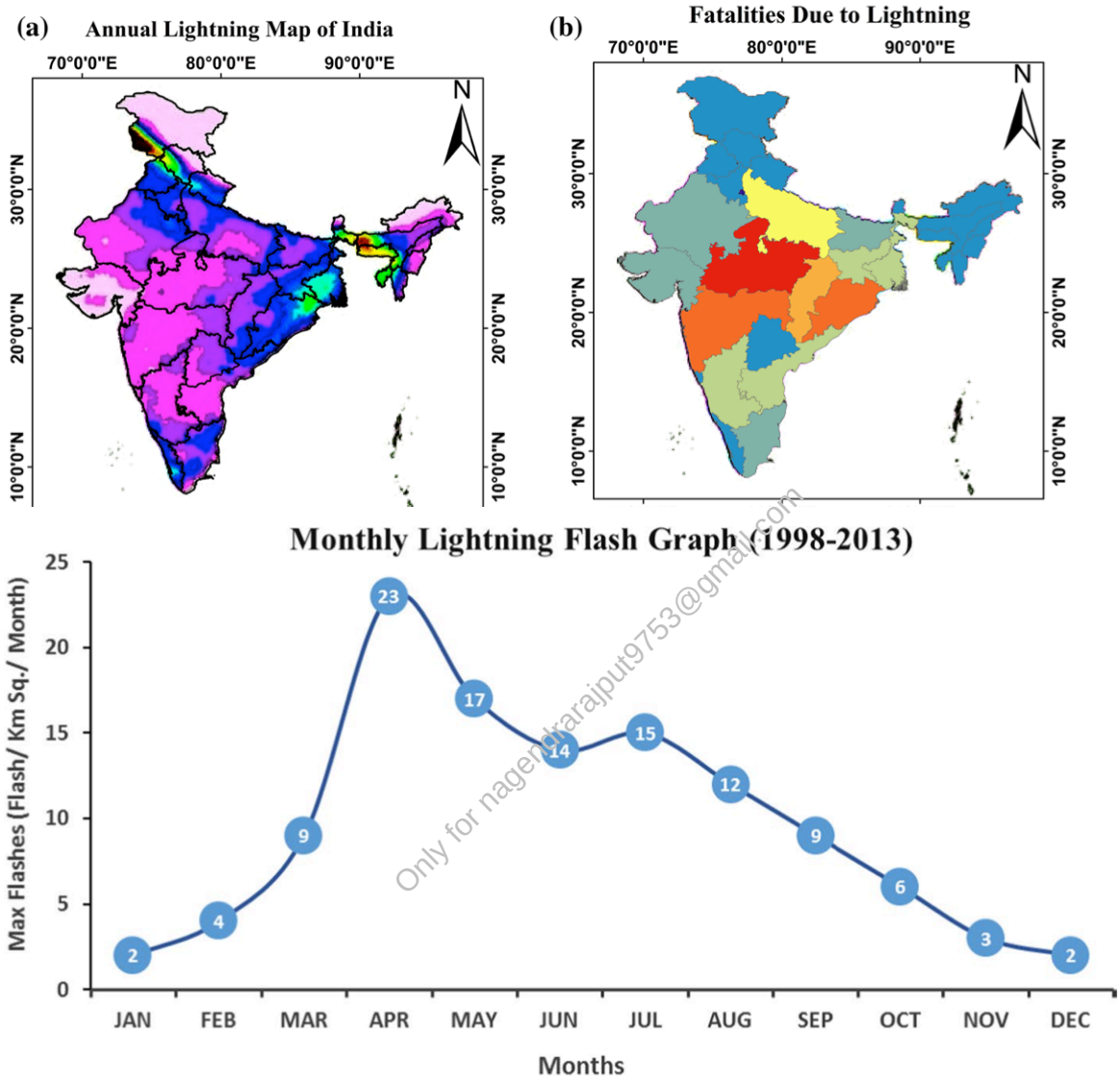

Fig. 4 Monthly variation of lightning flashes (flash/sq. km/month) over India in 1998–2013

Table 2 State-wise death due to lightning over India

State	Death
Andhra Pradesh	65
Arunachal Pradesh	0
Assam	24
Bihar	75
Chhattisgarh	165
Goa	0
Gujarat	50
Haryana	7
Himachal Pradesh	4
Jammu and Kashmir	3
Jharkhand	80
Karnataka	77
Kerala	111
Madhya Pradesh	313
Maharashtra	281
Manipur	0
Meghalaya	3
Mizoram	0
Nagaland	0
Orissa	255
Punjab	8
Rajasthan	60
Sikkim	2
Tamil Nadu	71
Tripura	7
Uttar Pradesh	160
Uttarakhand	4
West Bengal	128
A & N Islands	0
Chandigarh	0
D & N Havel	1
Daman and Diu	0
Delhi (UT)	1
Lakshadweep	0
Puducherry	0

Thunder and Lightning

Safety Tips :

- Keep ready an Emergency Kit with important medication. Postpone outdoor activities.
- Remember, rubber-soled shoes and rubber tires provide NO protection form lightning.
- Unplug any all electrical/ electronic equipment/appliances such as bubs, computers fans etc. and turn off air conditioners well before the storm arrives.
- Use your battery-operated Radio for news updates.
- Avoid contact with electrical equipments or cords.
- Do not lie on concrete/ marble floors and do not lean against concrete walls.
- Continue to listen to local radio and television stations for updated information or instructions, as access to roads or some parts of the locality may be blocked.
- Help people who may require special assistance, such as infants, children, women and elderly.
- Stay away from broken power lines and report them immediately.

Thunderstorm, Lightning, Dust storm, Hailstorm, Squall and Strong Winds

A high population density increases our vulnerability to various hazards. Thunderstorm & Lightning / Squall/ Dust Storm/Hailstorm and Strong Winds have emerged as major weather hazards in recent years affecting different parts of the country

Thunderstorm, Lightning, Dust storm, Hailstorm, Squall and Strong Winds have emerged as major weather hazards in recent years and have affected different parts of the country.

Thunderstorms have some typical characteristics which lead to the formation of a squall, strong updraft and downdraft, towering cumulonimbus clouds associated with turbulence and icing, incloud electrification and associated lightning, localized strong rain and hailstorm. *They have a* ***devastating impact on agriculture and aviation sectors in addition to surface transport, power, communication and other socio-economic secto****rs. These may also lead to loss of human lives, assets/ property/ livelihoods, etc.*

Lightning ***is yet another weather-related disaster associated with thunderstorms.***

Lightning is a high-energy luminous electrical discharge accompanied by thunder. Lightning occurs due to electrically charged regions in a cloud 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 also dangerous as they may hit aircrafts. 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 a 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) with its typical value being 40 kA. Predicting the precise time and location of lightning is very difficult. However, a season or a period of lightning occurrence is known for many regions.

IMD data (1950-1980) shows that more than 80 thunderstorm days occur per year over the northeastern part of India, some parts of Kerala and Jammu & Kashmir. The eastern and northeastern parts of our country, i.e. Gangetic West Bengal, Jharkhand, Bihar, Odisha, and northeastern States, get affected by severe thunderstorms during the pre-monsoon months of March to May

IMD data (1950-1980) shows that more than 80 thunderstorm and lightning days occur over the northeast, and some parts of Kerala and Jammu &Kashmir each year. ***In India, more than 2,500 people die due to thunderstorm and lightning every year.*** *The country may also witness in future an increase in the severity and frequency of thunderstorms and dust storms.*

Lightning is yet another weather-related disaster associated with thunderstorms. Lightning occurs due to electrically charged regions in a cloud which is called intra-cloud lightning (IC) or between Cloud-to-Cloud (CC lightning), or between a cloud and the ground (CG lightning).

lightning every year (Source: Annual Report, NCRB). It accounted for about 39 per cent of deaths from natural disasters in the country from 1967 to 2012. (Illias et al., 2014). During May 2018, severe dust storms, thunderstorms and lightning hit several parts of India, resulting in a large number of deaths and injuries across Rajasthan, Uttar Pradesh, Telangana, Uttarakhand and Punjab.

Thunderstorms:

A thunderstorm is said to have occurred if thunder is heard or lightning is seen. Usually, the thunder can be heard up to a distance of 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 temporal scale of a few hours. Considering their intensity, the thunderstorms in India are categorised 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 and occasional hailstorm, and maximum wind speed exceeding 74 kmp****h.*

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

Squall:

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

- M***oderate squall****: If the surface wind speed (in gusts) is up to 74 kmph.*
- S***evere squall:*** *If the surface wind speed (in gusts) is greater than 74 kmph.*

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The climatology of the spatial distribution of occurrence of a squall is almost the same as that of thunderstorms. The frequency and intensity of squall are maximum over eastern and northeastern 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.

Hailstorm:

India, with about 29 hail days *of moderate to severe intensity per year, is among those countries in the world which 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 convective cloud rather than storm as a whole. Hail occurs in the mature stage, if at all it occurs. Cells in which hails occur have updrafts of greater 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.*

Dust storm:

Northwest India experiences convective dust storms, locally called "aandhi", during the premonsoon season with maximum frequency and intensity in May. The frequency of dust storms is maximum over Rajasthan followed by Haryana, Punjab and West Uttar Pradesh. It is of three types:

- *Slight dust storm: If the wind speed is up to 41 kmph and visibility is less than 1,000 metres but more than 500 meters.*
- *Moderate dust storm: If the wind speed is between 42-74 kmph and visibility is between 200 and 500 metres.*
- *Severe dust storm: If the surface wind speed (in gusts) exceeds 74 kmph and visibility is less than 200 metres.*

Mitigation and Preparedness Measures

a. ***Enhanced understanding of preparedness and mitigation measures****: This will help us minimize the losses due to thunderstorms/ squall, etc.*

b. ***Hazard Resistant Construction:*** *United Nations Development Programme (UNDP) and NDMA, Ministry of Home Affairs, Government of India, released a "Manual on Hazard Resistant Construction in India" for the non-engineered buildings in July 2008. The popular load-bearing masonry building systems, prevalent in different parts of the country, are covered in the manual. Relevant building codes and guidelines of the Bureau of Indian Standards form the basis for this manual. In addition, the two decades of work carried out by the authors focusing on the promotion of suitable building technologies in different parts of the country and the on-site training of building artisans and engineers, as well as the post-disaster assessments of damages in various disastersprovide the backbone of this manual. It is hoped that this manual will contribute towards ensuring better structural performance in the face of potentially destructive natural hazards and thus bring safety to the people, rich and poor alike, in India.*

c. ***Laying underground electricity cables and telephone lines:*** *These are best suited, particularly for congested townships where thunderstorms/squall may cause falling of electricity*

and telephone poles, and snapping of cables.

d. ***Emergency Communication Systems:*** *Planning, updating and mobilization of existing radio communication resources in emergency situations and acquisition of satellite phones to make them available at the tehsil level to ensure prompt response in the event of occurrence of any disaster.*

e. ***Integrating Development schemes with Disaster Management Schemes:*** *This would enable the creation of disaster-resilient localities by way of recommendations by patwari/ gram pradhan that quality raw material and technology be used in all infrastructure/ construction projects.*

f. ***Technical, Social, Organizational and Administrative preparedness:*** *The most urgent need of the hour is to develop a DSS (Decision Support System) for thunderstorm nowcast, which is currently being done using the existing network of observations, radars, satellites and lightning data. To accomplish this, the DWR and lightning network could be expanded over all thunderstormprone areas across the country and information thus obtained could be merged with satellite observation to generate meaningful insights for different regions with a lead time of 1-2 hours. The nowcast alerts/warnings should be accompanied with actionable information (Do's and Don'ts) and potential impact (expected damage).*
Besides SDMAs and DDMAs, tehsil-level Disaster Management Group (TMG) at subdivision/ tehsil level should be formed with representatives of various line departments, including Agriculture, Forest, BSNL and other telecom service providers, Electricity Board, Revenue, P.W.D, Health, Police and Fire Brigade. Village Disaster Management Committees (VDMCs) should also be formed at the village level comprising local villagers. This would certainly strengthen the local response mechanisms to disasters.

g. ***Emergency Plan for Hospitals and Health Centres:*** *Emergency expansion plan for civil hospitals, community health centres, Primary Health Centres (PHCs) and additional PHCs, including schemes for mobile medical teams for a post-disaster situation, should be in place. A list of Army hospitals, Govt. Hospitals (both Centre and State), private hospitals and nursing homes in each district should be prepared. Phone numbers of all these medical facilities should be available in the District Control Room as well as in the SEOC. Based on the hazard assessment, emergency medicines, Operation Theatres and life-saving drugs should be kept ready. Vacant post of doctors and paramedical staff should be filled in all the government hospitals in order to make available the required number of medical workers at the time of an emergency. An Action Plan must be considered for training of doctors and paramedical staff on handling patient inflow and treating them in case of a disaster.*

h. ***Focusing on Research and Establishing a Forecasting Centre*** *for Thunderstorm and Squall to carry out the hazard zonation and vulnerability analysis for thunderstorm and squall with State-level knowledge institutions.*

i. ***Making Disaster Risk Reduction (DRR) a part of school and college curriculum****: Youth and children can be taught about extreme weather incidents and the Do's and Don'ts to be followed before, during and after a disaster. They act as agents of change and bring about greater awareness in the neighbourhood and society.*

about 16 km wide and 160 km long. The volume of hail reaching the ground falls at a speed of about 40 m/sec and is usually less than one-tenth the volume of rain produced by a thunderstorm.

The hail-related damage depends on the size of hailstones and number that fall per unit area during a hail fall, the wind force during the event and the type of area where it falls. The extent of crop-hail damages also varies depending on the stage of occurrence of hail during the crop growing season. Even a short episode of hail can cause severe injury to crops, fruit trees, both downgrading the quality and causing subsequent losses due to diseases like blight, mould, canker and fruit rots. One among the world's deadliest hailstorms recorded in history occurred on 30 Apr, 1888 in Uttar Pradesh killing at least 230 people, and over 1600 sheep and goats. According to the Commissioner of Agriculture, Maharashtra, the hailstorms damaged various horticultural crops over approximately 16 lakh acres.

Hail being a very short term and localized phenomena, its prediction well in advance to inform all stakeholders for adequate preventive measures is a major challenge for even the most technologically advanced and hail-prone countries like the USA. India, being situated in the tropical and subtropical region, the frequency is less compared to the mid-latitude and temperate countries. However, with climate change, the instances of severe weather aberrations are increasing.

2.2.2.11 Glacial Lake Outburst Flood (GLOF)

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A Glacial Lake Outburst Flood (GLOF) is a type of flood occurring when water dammed by a glacier or a moraine is released. When glaciers melt, they sometimes form lakes on mountaintops. The water in these glacial lakes accumulates behind loose naturally formed 'dams' made of ice, sand, pebbles and ice residue. Glacial lake volumes vary, from several MCM to hundreds of MCM of water. But these are inherently unstable and disturbances such as avalanches, falling boulders, earthquakes, or even simply the accumulation of too much water can breach the 'dam', unleashing sudden, potentially disastrous floods in nearby communities. A catastrophic failure of the containing ice or glacial sediment can release this water over periods of minutes to days. Peak flows as high as 15,000 cubic metres per second have been recorded in such events. GLOF events have killed thousands in many parts of the world and some of the largest events occurred in the Himalayas.

The Indian Himalayan Region (IHR), with geographical coverage of over 5.3 lakh kilometre square, extends over 2,500 kilometres in length between the Indus and the Brahmaputra river systems. While glacial lake hazards and glacial lake distributions are investigated in many glaciated regions of the world, relatively, there has been less attention to these in the Indian Himalayas. In physiographic terms, the IHR extends from the foothills in the south (Siwaliks) to Tibetan plateau in the north (Trans-Himalaya). Three major geographical entities, the Himadri (Greater Himalaya), Himanchal (Lesser Himalaya) and the Siwaliks (Outer Himalaya), extending almost uninterrupted throughout its length, are separated by major geological fault lines. The National Mission for Sustaining the Himalayan Ecosystem (NMSHE), one of the eight missions under the National Action Plan on Climate Change (NAPCC) is dedicated to sustainable development of the region, understanding climate change impacts and examining adaptation strategies for the region. The Himalayan states/UTs include—J&K, Ladakh, HP, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, and two partial hill states, namely Assam and West Bengal.

The climatic change/variability in recent decades has made considerable impacts on the glacier lifecycle in the Himalayan region. Scientific studies have noted glacier retreat occurring in most parts of the Hindu Kush Himalaya, which has given rise to the formation of numerous new glacial lakes. Glacial lakes are an indirect indicator of glacier change and unstable lakes can present hazards to downstream locations. The Geological Survey of India (GSI) lists 9,575 glaciers in IHR, of which 267 are over 10 sq.km. One of the pioneering regional glacial lake inventories has provided a qualitative

South Lhonak Lake Incidence

The South Lhonak lake in the Himalayan state of Sikkim breached on the night of October 3, 2023 resulting in a glacial lake outburst flood (GLOF) that ravaged four districts. At least 42 people died as a result and 77 more are still missing. More than a month after the disaster, the lake remains a potential hazard, say scientists.

An analysis of the International Centre for Integrated Mountain Development's (ICIMOD) latest data on glacial lake outburst floods (GLOF) since 1833 has suggested that over 70 per cent of the 700 GLOF outbreaks have happened in the past 50 years.
The year 1980 saw the highest number of GLOF events, 15, followed by 2015 (13). The years 1973, 1974, 2002 and 2010 all experienced 10 GLOF events.

But, according to ICIMOD, "the overall increase in GLOFs is mainly due to better observations and reporting, but the overall damage to infrastructure from these events has likely increased in the recent past".
A GLOF outburst, according to ICIMOD, "is sudden release of water from a lake fed by glacier melt that has formed at the side, in front, within, beneath, or on the surface of a glacier".
The report, Glacial lake outburst floods in High Mountain Asia documented in regional effort, also quantified the number of lives lost — over 7,000 have died due to GLOF outbursts since 1833 across the Hindu Kush Himalayan region.
Over half of the GLOF outbursts (54 per cent) were triggered due to mass movements like avalanches, rock falls and landslides while another 18 per cent were due to extreme rainfall events, it highlighted.
"This points to a need for better forecasting of precipitation at altitude as well as mapping of an increasingly unstable cryosphere," the report said.

Cryosphere, according to the National Oceanic and Atmospheric Administration, is the frozen water or ice water of the earth system.
GLOFs also tend to have a domino impact. According to the analysis, while eight GLOF events occurred in China, their impacts were felt in neighbouring countries like Nepal.
The report also cautioned how "without a major step up in both monitoring, mitigation and early warning for all, it is likely we will see more major examples of GLOFs such as South Lhonak."
According to ICIMOD, the GLOF outburst in the South Lhonak lake in Sikkim on the intervening night of October 3-4, 2023 was responsible for 102 deaths.

2020 guideleines GLOF and LLOF

Factors contributing to the hazards / risks of moraine-dammed glacial lakes include:

(a) large lake volume;
b) narrow and high moraine dam;
(c) stagnant glacier ice within the dam; and
(d) limited freeboard between the lake level and the crest of the moraine ridge.

Potential outburst flood triggers include avalanche displacement waves from
(i) calving glaciers;
(ii) hanging glaciers;
(iii) rock falls;
(iv) settlement and/or piping within the dam;
(v) melting ice-core; and
(vi) catastrophic glacial drainage into the lake from sub-glacial or englacial channels or supraglacial lakes.

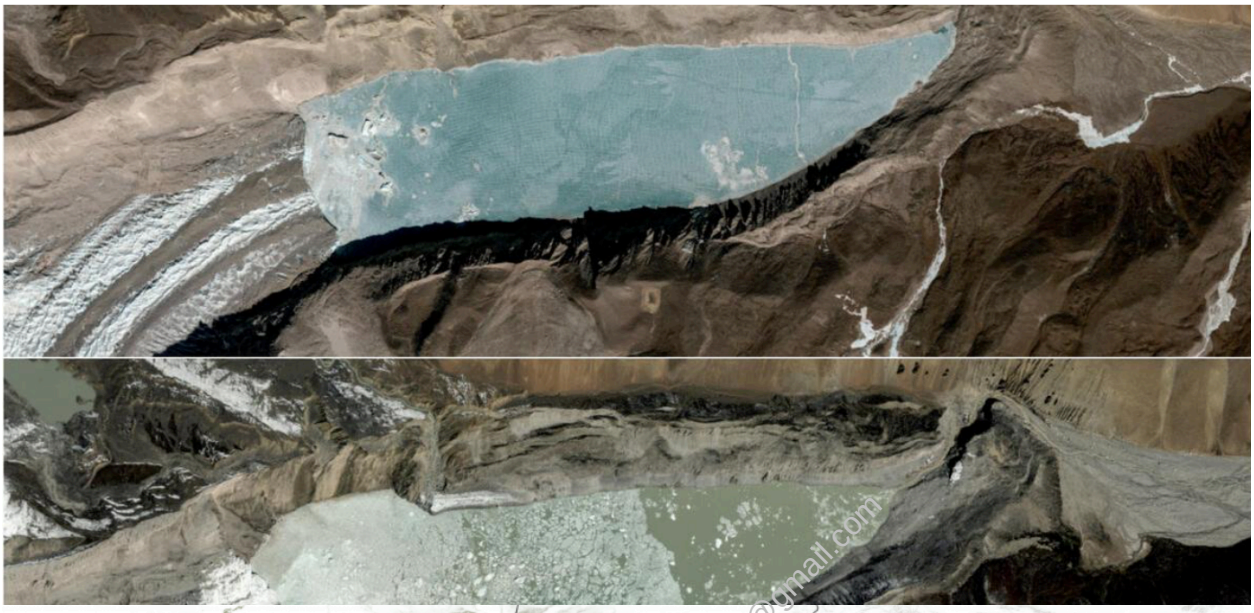
PREPAREDNESS
Given the rarity of GLOF and LLOF events in the IHR, not much is known to the community.

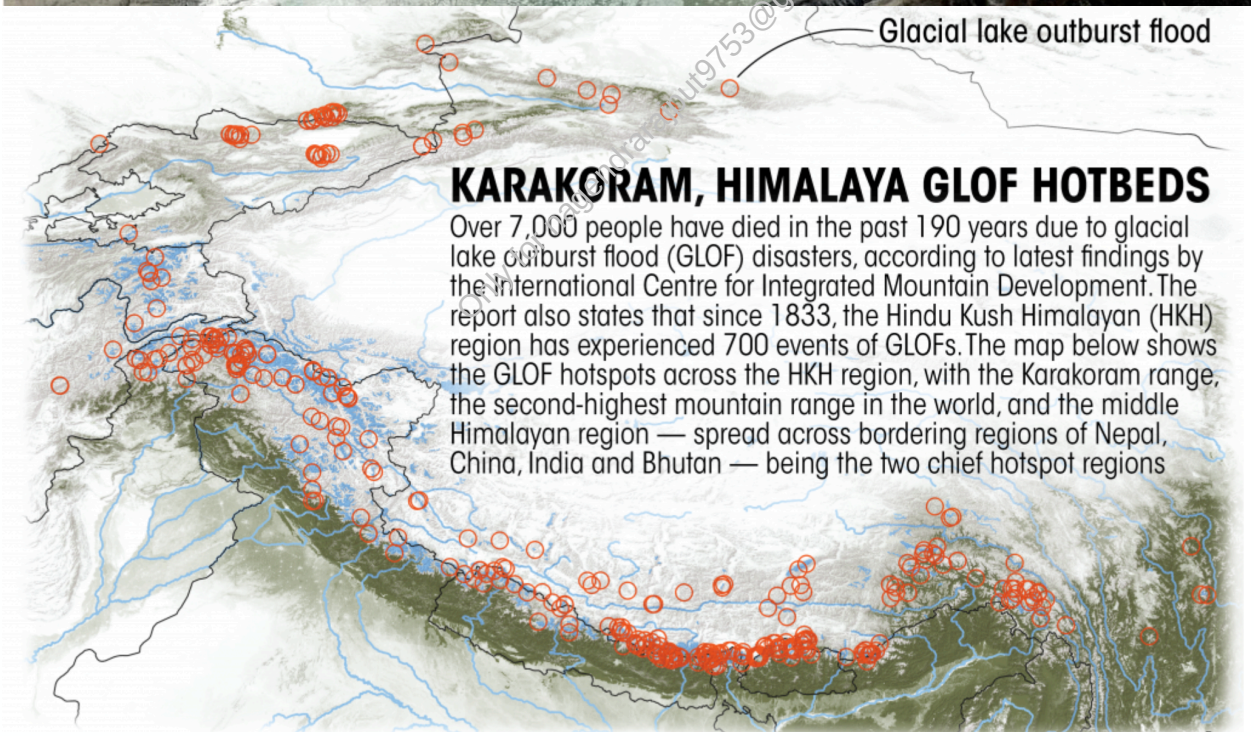
Structural support (embankments, artificial drainages, etc.) may be feasible to some extent.

AWARENESS AND PREPAREDNESS
In particular, attention should be given to the most vulnerable members of society, including women, children, disabled, elderly, and marginalised communities. If the potentially affected population is well prepared, this will reduce disaster risk, build resilience, and enhance sustainable development.

*The **main stakeholder** is the **community in regions vulnerable to GLOFs** as they are the first and the last responders to the disaster, as they will witness it firsthand and are the ones who have to deal with its long-term consequences. In addition, **travelers, tourists and pilgrims are target groups** for awareness raising campaigns and initiatives, as they are potentially at risk without local knowledge of historic events and the actual local situation.*

Frequent workshops with the potentially affected communities, including simulations and mock drills are recommended to increase preparedness. Further, disaster management plans should include overviews of people and assets at risk, access options, safe zones, medical facilities and other rescue and emergency materials, including documentation of hierarchies, responsibilities, deputies and contacts.





KARAKORAM, HIMALAYA GLOF HOTBEDS

Over 7,000 people have died in the past 190 years due to glacial lake outburst flood (GLOF) disasters, according to latest findings by the International Centre for Integrated Mountain Development. The report also states that since 1833, the Hindu Kush Himalayan (HKH) region has experienced 700 events of GLOFs. The map below shows the GLOF hotspots across the HKH region, with the Karakoram range, the second-highest mountain range in the world, and the middle Himalayan region — spread across bordering regions of Nepal, China, India and Bhutan — being the two chief hotspot regions

classification of 251 glacial lakes greater than 0.01 km^2 in area. These glacial lakes are present in J&K, Ladakh, HP, Uttarakhand, Sikkim and Arunachal Pradesh. Many of these glacial lakes present moderate to severe risks to the downstream locations. The hazard of Glacial Lake Outburst Flood (GLOF) can get aggravated in case of cloud burst situation in the area.

In Sikkim Himalaya many glacial lakes are in the process of formation. There are high chances of bursting of these lakes due to their formation in weak moraine structures. It may cause huge devastation in the downstream in the case of bursting. The GLOF hazard from South Lhonak glacial lake, located in the extreme North-western part and one of the fastest growing lakes in Sikkim Himalaya, is of particular concern. The lake is fast increasing in its size in an extremely abnormal way due to the melting of the South Lhonak glacier attached with the lake and addition melt water from adjoining North Lhonak glacier and main Lhonak glacier. The study of past satellite data of Lhonak glacier lake area revealed that the area of the lake has increased from 0.18 km^2 in 1976 to 1.26 km^2 by 2013[14]. The abnormal growth of the volume of the lake greatly increases the risk a GLOF event. Based on the current inventory and recognising the risk of GLOF events in the IHR, the CWC is monitoring 467 glacial lakes and water bodies with water spread area more than nearly 0.4 Sq.km (Singh and Gupta 2017).

16

2.2.2.12 Heat Wave

Heat wave is a period of abnormally high temperatures that leads to physiological stress, which sometimes can claim human life. The World Meteorological Organization defines a heat wave as five or more consecutive days during which the daily maximum temperature exceeds the average maximum temperature by five degrees Celsius. Different countries define heat wave differently in context of their local conditions. Heat Waves typically occur between March and June, and in some rare cases even extend until July. Heat waves are more frequent over the Indo-Gangetic plains of India. On an average, 5-6 heat wave events occur every year over the northern parts of the country. In the northern plains of the country, dust in suspension occurs in many years for several days, bringing minimum temperature much higher than normal[15] and keeping the maximum temperature around or slightly above normal.

Heat wave and Hot Day are area specific phenomena and may be ascribed for a Met Sub-division or a part thereof, when at least two stations satisfy the criteria. According to revised terminology of the IMD applicable from January 2016[16], in India, it will be considered as heat wave if the maximum temperature of a met-sub-station reaches at least 40°C or more in the plains, 37°C or more in coastal areas and at least 30°C or more for hilly regions. IMD defines heat wave[17] when departure from Normal is 4.5°C to 6.4°C and Severe Heat Wave when departure from normal is >6.4°C. Similarly, for the plains heat wave is when actual maximum temperature ≥ 45°C and Severe Heat Wave when actual maximum temperature ≥47°C. To declare a heat wave, the condition should be recorded in at least at two stations in a Meteorological sub-division for at least two consecutive days. A heat wave will be declared on the second day.

Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent globally due to climate change. India too is feeling the impact of climate change in terms of increased instances of heat waves that are more intense in nature with each passing year and have a devastating impact on human health thereby increasing the number of heat wave casualties. The

[14] Based on information posted on NMSHE website, http://knowledgeportal-nmshe.in/programme_details.aspx?C=57569ABD-ECC5-48B3-8F99-C0EBD6DFDC9F (accessed Sep 20, 2019)
[15] Normal is the long term (over 30 years) annual average
[16] Forecasting Circular No. 5/2015 (3.7), applicable from 1-Jan-2016
[17] Guidelines for preparation of Action Plan Prevention and Management of Heat Wave, NDMA, 2017

heat wave management technique

Colour Code Signals for Heat Alert and Suggested Actions

Colour Code	Alert	Warning	Impact	Suggested Actions
Green (No action)	Normal Day	Maximum temperatures are near normal	Comfortable temperature. No cautionary action required.	Normal activity
Yellow Alert (Be updated)	Heat Alert	Heat wave conditions at isolated pockets persists for 2 days	Moderate temperature. Heat is tolerable for general public but moderate health concern for vulnerable people e.g. infants, elderly, people with chronic diseases	(a) Avoid heat exposure. (b) Wear lightweight, light-coloured, loose, cotton clothes. (c) Cover your head
Orange Alert (Be prepared)	Severe Heat Alert for the day	(i) Severe heat wave conditions persists for 2 days (ii) Through not severe, but heat wave persists for 4 days or more	High temperature. Increased likelihood of heat illness symptoms in people who are either exposed to sun for a prolonged period or doing heavy work. High health concern for vulnerable people e.g. infants, elderly, people with chronic diseases.	(a) Avoid heat exposure– keep cool. Avoid dehydration (b) Wear lightweight, light-coloured, loose, cotton clothes (c) Cover your head (d) Drink sufficient water- even if not thirsty (e) Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. to keep yourself hydrated (f) Avoid alcohol, tea, coffee and carbonated soft drinks, which dehydrates the body (g) Take bath in cold water frequently. <u>In case of SUNSTROKE</u>: Lay the person in a cool place, under a shade. Wipe her/him with a wet cloth/wash the body frequently. Pour normal temperature water on the head. The main thing is to bring down the body temperature. Consult a Doctor immediately.
Red Alert (Take Action)	Extreme Heat Alert for the day	(i) Severe heat wave persists for more than 2 days. (ii) Total number of heat/severe heat wave days exceeding 6 days.	Very high likelihood of developing heat illness and heat stroke in all ages.	Along with suggested action for Orange Alert, Extreme care needed for vulnerable people.

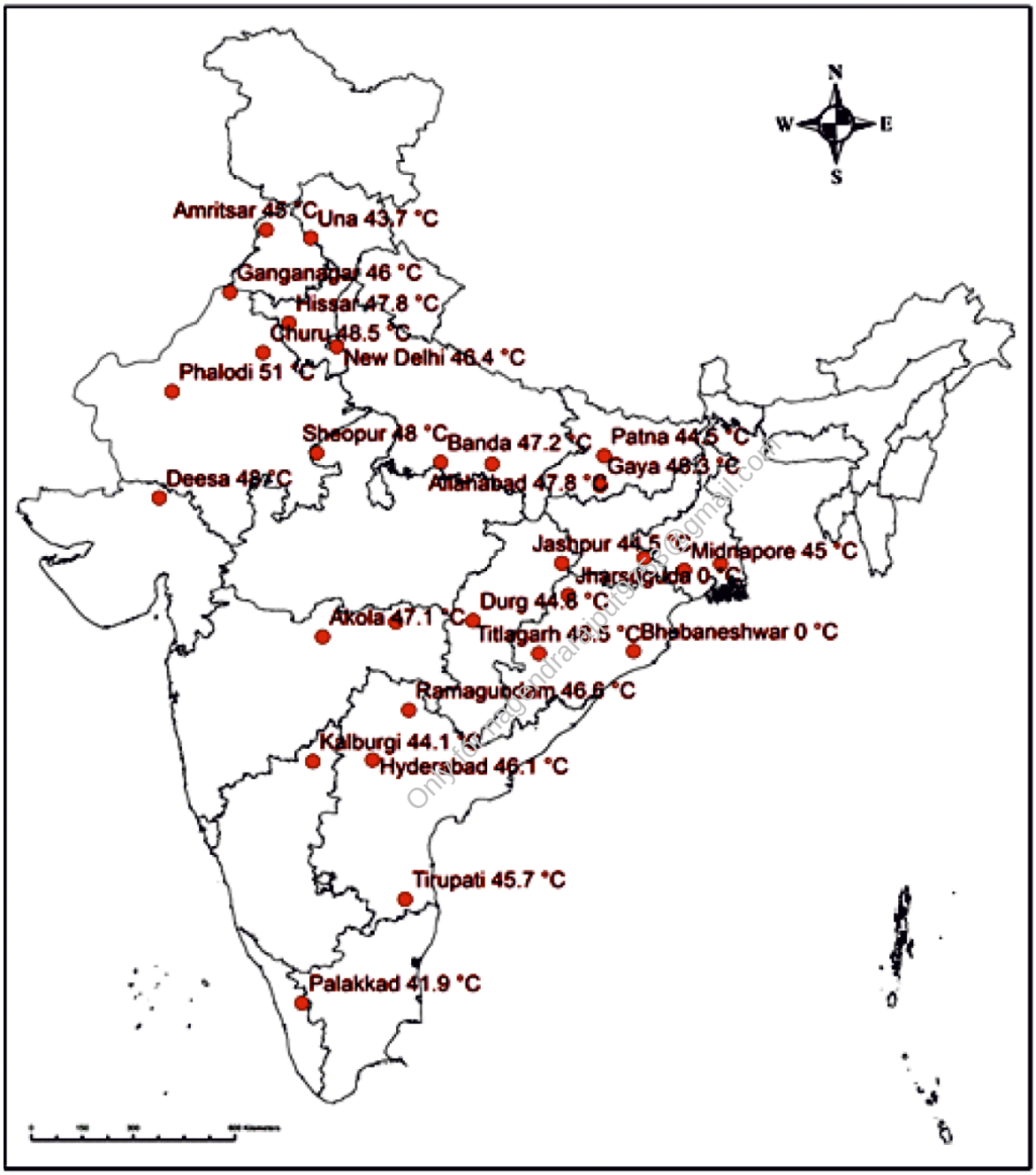
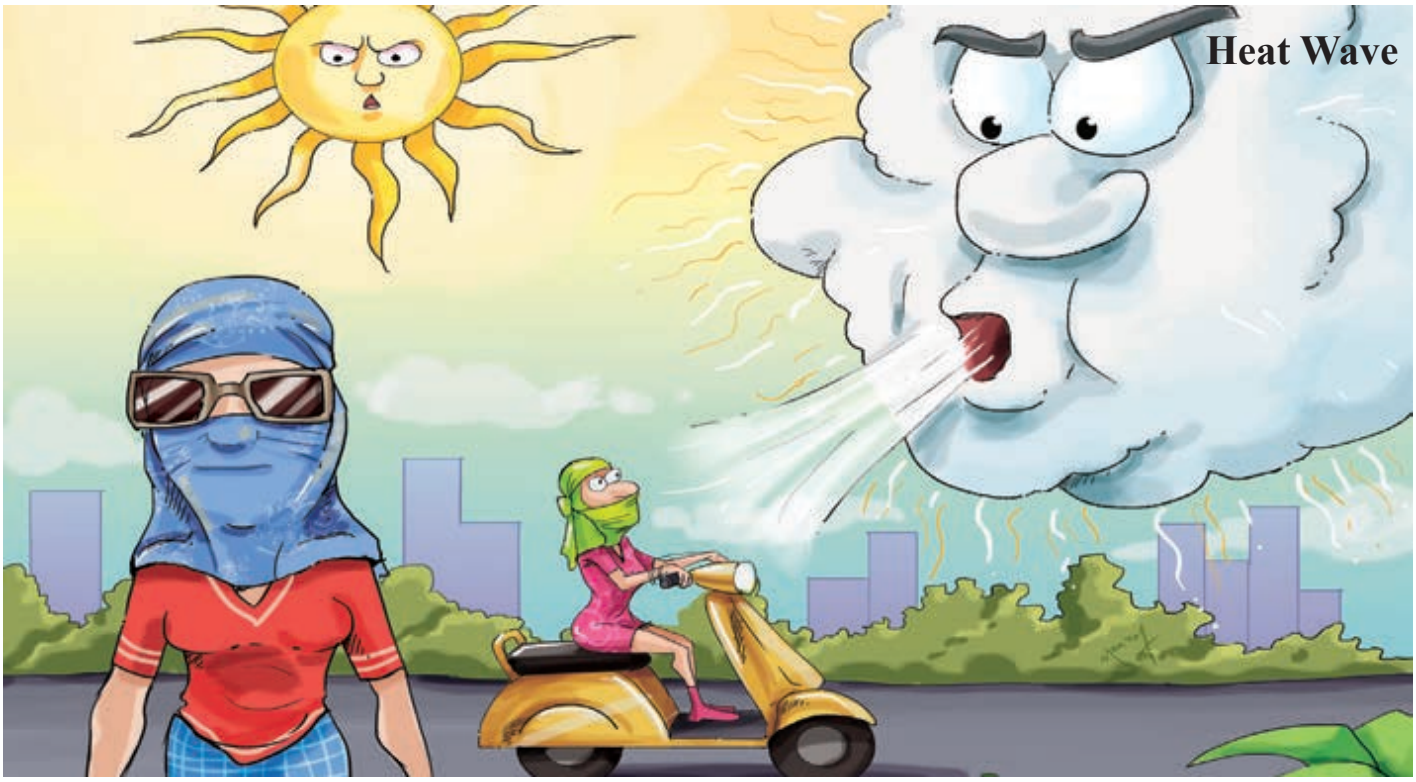


Figure 1: Higest ever recorded temperature at some station in the country



Heat Wave

Safety Tips :

- Install temporary window reflectors such as aluminum foil-covered cardboard, to reflect heat back outside.
- Cover windows that receive morning or afternoon sun with drapes, shades.
- Listen to local weather forecasts and make yourself aware of upcoming temperature changes.
- Know those in your neighborhood who are elderly, young, sick or overweight. They are more likely to become victims of excessive heat and may need help.
- Get trained in first aid to learn how to treat heat-related emergencies.
- Never leave children or pets alone in closed vehicles. Stay indoors as much as possible and limit exposure to the sun.
- Stay on the lowest floor out of the sunshine.
- Eat well-balanced, light and regular meals.
- Drink plenty of water; even if you do not feel thirsty.
- Persons with epilepsy or heart, kidney, or liver disease; are on fluid-restricted diets; or have a problem with fluid retention should consult a doctor before increasing liquid intake.
- Protect face and head by wearing a hat or cloth.

- Establish Early Warning System and communication systems
- Developing inter-agency response plan and coordination in field
- Preparedness at the local level for health eventualities
- Health care system capacity building
- Public awareness and community outreach
- Collaboration with private, non-government and civil society
- Assessing the impact – feedback for reviewing and updating the plan

health impacts of Heat Waves typically involve dehydration, heat cramps, heat exhaustion and/or heat stroke. The signs and symptoms are as follows:

- Heat Cramps: Edema (swelling) and Syncope (Fainting) generally accompanied by fever below 39°C (102°F)
- Heat Exhaustion: Fatigue, weakness, dizziness, headache, nausea, vomiting, muscle cramps and sweating
- Heat Stroke: Body temperatures of 40°C (104°F) or more along with delirium, seizures or coma, which is a potentially fatal

This unusual and uncomfortable hot weather can impact human and animal health. It can cause major disruption in community infrastructure such as power supply, public transport and other essential services. Heat wave is considered a "silent disaster" as it develops slowly.

2.2.3 Human-induced Hazards

1

2.2.3.1 Chemical (Industrial) Disasters

With rapid economic development, there has been spread of industries from small to large across the country. There is relatively higher presence of industrial sector along the west coast, largely due to the proximity to raw materials and ports. The states with very large number of chemical industries are Gujarat, Maharashtra, Uttar Pradesh (UP), Tamil Nadu (TN), MP, and Punjab. Due to the regional concentration of chemical companies in certain pockets, the chemical hazard has increased many folds. The growth of industries has led to an increase in the risk of occurrence of incidents associated with hazardous chemicals (HAZCHEM) and hazardous materials (HAZMAT)[18]. These events occur due to mishaps or failures in industry and negligence in following international codes and standards for chemical handling which affects the industrial functioning, and productivity. While the common causes for chemical accidents are deficiencies in safety management systems or human errors, natural calamities or sabotage may also trigger such accidents. Chemical/ industrial accidents are significant and have long term impact on the community and environment. It leads to injuries, pain, suffering, loss of lives, damage to property and environment. Hence, a robust plan and mitigation measure needs to be adapted to overcome the hazard. The suggestions from several industry associations have recommended the implementation of the updated and relevant International Organization for Standardization (ISO) and Occupational Health and Safety Assessment Series (OHSAS) standards to production and storage of chemicals. There are specific norms applicable to industries producing, storing or handling hazardous chemicals.

2.2.3.2 Nuclear and Radiological Emergencies (NRE)

2

A nuclear disaster is construed as potentially a low probability event, however very high in damage impact, could be caused by detonation of nuclear warhead or explosion of an Improvised Nuclear Device (IND) with associated release of large amounts of devastative energy due to Blast, Thermal and Radioactive material. Secondary effects occurring later might result in fall out of radioactive dust. The nuclear and radiological emergencies could be due to accidents at operating nuclear facilities / incidents in public domain that could potentially release radioactive materials. The cause of these events could potentially arise from nuclear facility/ malicious acts of radioactivity dispersal by explosion of Radiological Dispersal Device (RDD). The occurrence of these kinds of emergencies could be of probability marginally higher but based on the scale of the accident/ incident, the potential impact of damage will be restricted to less domain.

[18] National Disaster Management Guidelines – Chemical Disasters, NDMA (2007)

2. **Mobile Radiation Detection Systems(MRDS)** to handle Radiological Hazards in Metros/Capital Cities/Big Cities in India:- To detect unclaimed radioactive materials/substances and save public from its hazardous effects,NDMA has chalked out a plan to provide States/UTs Mobile Radiation Detection Systems to be deployed in Metros/all Capital Cities and Big Cities in India and also train personnels as 'Trainer of Trainers'.

Nuclear weapons, a major accident in a nuclear power plant or an accidental exposure of radiation, due to accident with the radioactive material during transportation, faulty practices, and mechanical failure in a radiation facility can lead to nuclear or radiological emergency. Even though such situations may not arise easily, everyone needs to be prepared to face such emergencies. All organizations dealing with nuclear and radiological material have an inherent culture of safety, follow best safety practices in the sector, and they apply high standards to ensure minimum risk. However, nuclear emergencies can still arise due to factors beyond the control of the operating agencies from human error, system failure, sabotage, extreme natural events like earthquake, cyclone, flood, tsunami or a combination of these. Such failures, even though of very low probability, may lead to on-site or off-site emergencies. To counter this, proper emergency preparedness plans must be in place so that there is minimum loss of life, livelihood, property, and impact on the environment.

A Nuclear and/or Radiological Emergency (NRE) is an incident resulting in, or having a potential to result in, exposure to and/or contamination of the workers or the public, exceeding the respective permissible limits (see NDMA's guidelines for NRE[19]). These emergencies are classified into five broad groups as follows:

1) An accident taking place in any nuclear facility of the nuclear fuel cycle including the nuclear reactor, or in a facility using radioactive sources, leading to a large-scale release of radioactivity in the environment
2) A 'criticality' accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place inadvertently leading to bursts of neutrons and gamma radiation
3) An accident involving radioactive material package during its transportation
4) The malevolent use of RDD or IND by terrorists
5) A large-scale nuclear disaster resulting from a nuclear weapon attack, which would lead to mass casualties and destruction of large areas and properties. Unlike a nuclear emergency, the impact of a nuclear disaster is beyond the coping capability of local authorities and calls for handling at the national level

In this context, it may be mentioned that the International Atomic Energy Agency (IAEA) classifies the above emergency scenarios under two broad categories – a) nuclear and b) radiological:

a) A nuclear emergency refers to a situation in which there is, or is presumed to be, a hazard due to the release of energy along with radiation from a nuclear chain reaction (or from the decay of the products of a chain reaction). These covers accidents in nuclear reactors, 'criticality' situations in fuel cycle facilities, nuclear explosions, etc.
b) All other emergency situations which have the potential hazard of radiation exposure due to decay of radioisotopes, are classified as radiological emergencies.

While the overall objective is to prevent NRE, there is also the need to adequately prepare for such emergencies. An NRE must be managed through very well planned and established mechanisms – structural and non-structural – in a manner that will minimize risks to health, life and the environment. Eight nuclear/ radiological emergency scenarios envisaged in the disaster planning are listed below (see NDMA's guidelines on NRE[20] for a brief description of each):

1) Accidents in Nuclear Power Plants and other facilities in the Nuclear Fuel Cycle
2) 'Criticality' Accidents

[19] National Disaster Management Guidelines – Management of Nuclear and Radiological Emergencies, NDMA (2009)
[20] ibid

3) Accidents during transportation of radioactive materials
4) Accidents at facilities using radioactive sources
5) Disintegration of satellites during re-entry
6) Nuclear/Radiological terrorism and sabotage at nuclear facilities
7) State-sponsored nuclear terrorism
8) Explosion of nuclear weapons

3

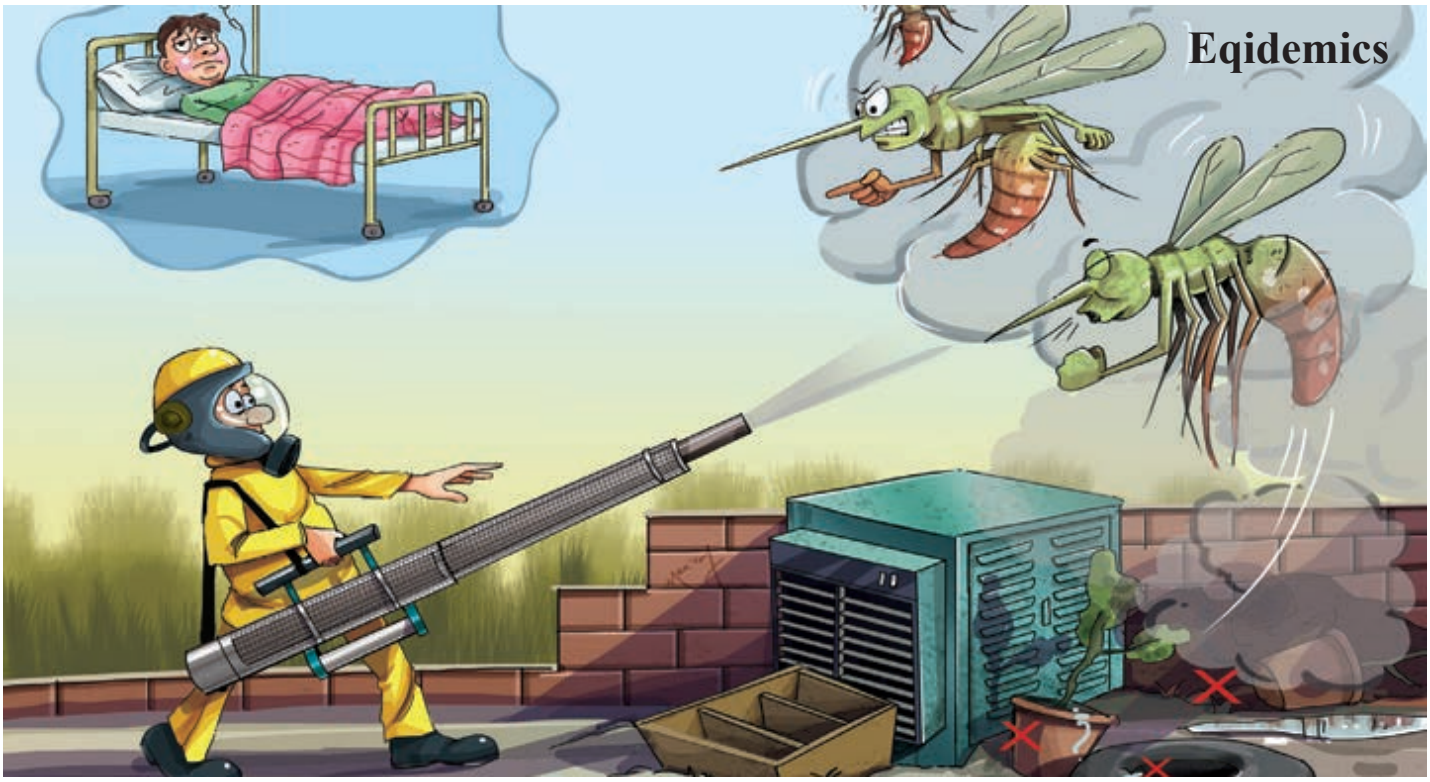
2.2.3.3 Biological and Public Health Emergencies (BPHE)

Disasters related to this sub-group are biological emergencies and epidemics, pest attacks, cattle epidemics and food poisoning. Biological emergency is one caused due to natural outbreaks of epidemics or intentional use of biological agents (viruses and microorganisms) or toxins through dissemination of such agents in ways to harm human population, food crops and livestock to cause outbreaks of diseases. This may happen through natural, accidental, or deliberate dispersal of such harmful agents into food, water, air, soil or into plants, crops, or livestock. Apart from the natural transnational movement of the pathogenic organisms, their potential use as weapons of biological warfare and bioterrorism has become far more important now than ever before. Along with nuclear and chemical agents, many biological agents are now considered as capable of causing large-scale mortality and morbidity.

Handling exotic pathogens warrants suitable infrastructure, notably, high containment laboratories of bio-safety levels 3 and 4; recruitment of highly committed, dedicated and trained professionals; continuous availability of diagnostic reagents; enhancement of skills at various echelons of health professionals in early identification of such infections, investigation of outbreaks and institution of specific control measures. Current system of surveillance and mechanism to control the outbreak of endemic diseases are through the National Programme for Surveillance of Communicable Diseases.

Natural outbreaks of disease may become epidemics and assume disastrous proportion if not contained in the initial stages. Pest infestations have recurred as major disasters for the agrarian economy of India since time immemorial. Locust swarms coming from Central Asia used to be a major cause for concern. Besides such consolidated events, infestation of localized pests is a threat to plant as well as human life. A major factor responsible for deterioration and the loss of food grains, their products and the economic losses besides health hazards is the contamination caused by rodents and insects. Pest control is achieved primarily through chemical methods subject to safety standards and regulatory norms for the safe use of such chemicals.

The growth of human society has rested largely on the cultivation of crops and domestication of animals. As crops and animals became necessary to sustain a divergent social structure, the depletion of these resources had far-reaching consequences. Along with the growth of societies, crop and animal diseases acquired more and more importance. Infectious agents are constantly evolving, often acquiring enhanced virulence or epidemic potential. As large number of people now travels within and across national boundaries, the likelihood of fast global spread of epidemics has increased dramatically making localised outbreaks into national epidemics and global pandemics. As our society is in a state of flux, novel pathogens emerge to pose challenges not only at the point of primary contact but also in far removed locations. The increased interaction between humans and animals has increased the possibilities of zoonotic diseases emerging in epidemic form. The Biological DRR covers the legal frameworks and institutional aspects needed for addressing safety and security of microbial agents, managing epidemics, containing biological terrorism (BT), managing threats to livestock, and all forms of agriculture.



Epidemics

Safety Tips :

- Store atleast two week supply of water and food.
- Periodically check availability of your regular prescription medicines
- Have non-prescription medicines and other health supplies in hand, including pain relievers, stomach remedies, cough and cold medicines, fluids with electrolytes and vitamins.
- Volunteer with local groups to prepare and assist during emergency response.
- Keep your surroundings clean and do not let the water be stagnant.
- Avoid close contact with people who are sick. When sick, keep distance from others to protect them from getting sick.
- If possible, stay at home; keep away from work, school etc. when you are sick. This will help prevent others from getting infected.
- Cover your mouth and nose with a tissue while coughing or sneezing. Washing your hands often will help protect you from harmful germs.
- Avoid touching your eyes, nose or mouth. Germs are often spread when a person touches something that is contaminated with germs and then touches his or her eyes, nose or mouth.

Desert locusts fly with the wind and can travel 100-150 km in a day. The Bombay locust (*Nomadacris succincta*) was a major pest in India and South-Eastern Asia in the 18th and 19thcenturies but has seldom swarmed since the last plague in 1908. The desert locust swarms from as far as Africa sometimes can reach India and Pakistan crossing the Indian Ocean. The Locust Control and Research Division under MAFW Keeps constant vigil through field surveys to prevent crop losses due to locust attack in approximately two lakhs sq.km of Scheduled Desert Area in the States of Rajasthan and Gujarat. Locust Watch under FAO monitors the locusts worldwide and issue early warnings to countries about locust swarms. After receiving warning, Government takes urgent measures for monitoring and control.

Directorate of Plant Protection Quarantine and Storage under the MAFW with sub-offices across India, is the apex organization responsible for taking measures related to plant protection. Such measures are important in the overall crop production programmes for sustainable agriculture. Plant protection activities encompasses activities aimed to minimizing crop losses due to pests through integrated pest management, plant quarantine, regulation of pesticides as well as locust warning and control.

To effectively tackle the issue of livestock health, the Department is supplementing the activities of the State Governments/ Union Territories through 'Livestock Health & Disease Control Scheme', which has the following components:

1) Assistance to States for Control of Animal Diseases
2) Professional Efficiency Development
3) National Project on Rinderpest Surveillance and Monitoring
4) Foot and Mouth Disease Control Programme
5) National Animal Disease Reporting System
6) Peste des Petits Ruminants Control Programme
7) Brucellosis Control Programme
8) Establishment and Strengthening of existing Veterinary Hospitals and Dispensaries
9) Classical Swine Fever Control Programme

4

2.2.3.4 Accidents – Rail, Air, Road and Water

The fast pace of development brings with it increasing frequency of various types of accidents as more and more people are involved in diverse economic activities. The number of air accidents, cases of boat capsizing, building collapses, fires in built environments – residential, commercial and industrial, festival related incidents involving large number of people, forest fires, emergencies in mines (flooding, collapse, etc.), oil spills, rail accidents, road accidents, stampedes, transportation of hazardous material (HAZMAT) related accidents etc. are increasing. While all these are matters of utmost concern, not all of them fall within the purview of the NDMP. Certain specific agencies such as the Indian Coast Guard have the primary responsibility of addressing incidents of oil spills and ships in the coastal waters. While the cases of fires in the built environment and forests are included in the plan, local authorities address them in accordance with the relevant emergency management systems. The primary way to reduce risks is through mainstreaming risk reduction in development and governance. As part of the overall DRR plan, systems for disaster preparedness and response are being strengthened at all levels, which in turn will help in reducing the number of accidents and improve the capacity to respond.

5

2.2.3.5 Emergencies Associated with Mass Gatherings

Throughout the country, frequently, there are various kinds of events that attract crowds large and small, at varying types and styles of venue. The degree and quality of preparedness to cope with

expected or unforeseen emergencies arising from such events vary greatly. Inadequate planning can increase risks associated with insufficient or ineffective spectator management or service provision. The evidence lies in the large number of public events where multiple injuries, illness and deaths have occurred. Emergencies and disastrous incidents associated with mass gatherings is a world-wide phenomenon.

During festivals or events attracting mass gathering - railways, roadways and airways etc. may experience unexpected temporary surge in number of people at such locations. Agencies responsible for operation and management at such places would need to include "crowding" and 'crowd behaviour' as hazard risk while formulating strategic plan for public safety. Accordingly, it will be necessary to pay attention to implementing special arrangement necessary for managing the crowds and crowd behaviour. For the benefit of the state governments, local authorities and other agencies, NDMA has published a guideline on mass gatherings[21].

Depending on the event, there could be surge in number of people at railway stations, bus terminals and airports. Framework suggested in this document paves way in formulating public safety plan by agencies like railways, bus transport and airways. These plans are to be developed in consultation with local authorities and event administrator/ organiser. As crowd disasters are local events, disaster management is primarily the responsibility of the organizers and local/district administration with support, guidelines from the state and the national authorities.

While planning events, organisers tend to overlook likely emergencies that could arise or fail to consider major emergencies and the worst-case scenarios. It is necessary to recognise that such risks are inevitably associated with large events, and therefore call for appropriate planning and preparation. Planning for public events requires cooperation between event organisers and relevant government, private and community organisations. Quite simply, the decisions of one party in the planning stage can have an impact on the preparedness of another, so a sharing of knowledge and information is imperative prior to the event. While event promoters or managers have primary responsibility for planning and preparation, the involvement of health professionals and emergency managers in the pre-event planning phase may contribute to a safer, and therefore more successful, event.

The NDMA guideline lists six major causes and triggers for crowd disasters which are summarised below, but are described in detail in the guideline:

1. Structural – The infrastructure, conditions and arrangements at the venue may not be adequate (collapse of barricades, fencing, temporary structures, insufficient exit, difficult terrain, slippery/muddy roads, etc.)
2. Fire/Electricity – Risky practices involving fire and electricity ranging from makeshift facilities, shops, cooking, careless use of easily inflammable materials, non-availability or malfunctioning fire extinguishers, illegal electric connections, and many such possibilities
3. Crowd Control – Crowds exceeding the capacity of the venue, poor management resulting in confusion and failure of all orderliness, not having enough emergency exits, inadequacy of systems to effectively communicate with the crowd and similar problems
4. Crowd Behaviour – There are numerous issues known to be associated with the behaviour of crowds which is different from what is expected from an individual that tend to worsen emergency situations that may include unruly, irresponsible and angry responses.

[21] Managing crowd at events and venues of mass gathering, NDMA, 2014.

5. Security – Under deployment of security personnel to regulate to control crowd, flaws in the planning of security arrangements
6. Lack of Coordination between Stakeholders – Significant coordination gap between agencies associated with the organising of the event and authorities

The experience shows that there is need for properly integrated approach for the crowd management which the state and local authorities must recognise and implement. The state governments must review existing norms and regulations and amend them if required to manage the emergencies arising from mass gatherings.

2.2.4 Fire Risk

2.2.4.1 Fires in Built Environment

Fires can start due to human activities or from natural causes. Forest fires can start from either natural causes or human activity or from a combination of both. The most common fires are the residential and non-residential structural fires caused usually by human activities. Most industrial and chemical fires are triggered by human activity. They are sometimes caused by human errors, faulty designs, or mechanical failures. Fire can also be the secondary effect of a disaster like earthquake. Secondary fires after a disaster like earthquakes constitute a substantial and heavy risk. Damage to natural gas systems during an earthquake can lead to major fires and explosions. Damages to electrical systems during a disaster can ignite major fires. The growth of fire-services in the country has been on an ad-hoc basis and needs to be professionalized. Varying risk scenarios need different types of equipment. The risk varies with geographical location such as hilly area, coastal-area, desert–area, and with different types of residential (medium/ low-rise/ high-rise) buildings, industrial, commercial area or a combination of these. There is considerable need for skill upgrade of the staff and modernization of the entire fire service system. The NDMA guideline[22] on fire services notes that the Standing Fire and Advisory Council (SFAC) has stressed the urgent need to strengthen the Fire and Emergency Services (F&ES) and overcome major shortcomings in the response and its capabilities.

2.2.4.2 Forest Fire Risk

India is one of the richest areas of biodiversity in the world having nearly seven lakh square kilometres of forest cover. Increasing human interference is a major cause for the incidents of the forest fires[23]. Despite its natural and essential roles, fire has negative consequences when it conflicts with the public interest. Examples of negative impacts include loss of homes, property and critical infrastructure, damage to domestic watersheds and destruction of commercially valuable timber. Smoke from forest fires can also interfere with road and air transportation, inhibit tourism, and cause serious public health problems. It is also a threat to human settlements dwelling within or adjacent to the forests.

Forest fires in India are generally ground fires. As per Forest Survey of India (FSI), which has been conducting field investigations since 1965, human activities trigger nearly 95 per cent of the forest fires in India. Forest fire is a major cause of injury and loss to forests. Area affected by forest fire annually is nearly 35 million hectares. In general, all over the world the main causes of forest fires are anthropogenic. The data on forest fires in India is very weak and needs to be improved. FSI's 1995 data considers nearly 50 per cent of the forest areas as fire prone with 43 per cent having occasional fire incidents. According to this assessment, very high, high, and frequent forest fires occur in 0.84 per cent, 0.14 per cent and 5.16 per cent of the forest areas respectively. The states with frequent

[22] NDMA Guideline on Scaling, Type of Equipment and Training of Fire Services
[23] Satendra and Kaushik (2014) This section is based largely on this document.

Fire

Safety Tips :

- In case of fire, dial 101 (or the special number for FIRE SERVICE in your area/town).
- Learn at least two escape routes and ensure they are free from obstacles.
- Remain calm, unplug all electrical appliances.
- Keep bucket of water and blankets ready.
- If clothes catch fire, Stop, Drop and Roll.
- In case of uncontrolled fire, wrap the victim in a blanket, till the fire ceases/stops.
- Don't burn crackers in crowded, congested places, narrow lanes or inside the house.
- Don't cover crackers with tin containers or glass bottles for extra sound effect.
- Avoid wearing long loose clothes, as they are fast in catching fire.
- Don't remove burnt clothing (unless it comes off easily).
- Don't apply adhesive dressing on the burnt area.
- Don't throw lighted cigarette butts.

3.7 Types of forest fire

Forest fires are not always same; they may differ, depending upon its nature, size, spreading speed, behavior etc. Basically forest fires can be sub grouped into four types depending upon their nature and size –

3.7.1 Surface fires

Fig.-3.2: Surface Fire

Surface fire is the most common forest fires that burn undergrowth and dead material along the floor of the forest. It is the type of fire that burns surface litter, other loose debris of the forest floor and small vegetation. In general, it is very useful for the forest growth and regeneration. But if grown in size, this fire not only burns ground flora but also results to engulf the undergrowth and the middle storey of the forest. Surface fires spread by flaming combustion through fuels at or near the surface- grass, dead and down limbs, forest needle and leaf litter, or debris from harvesting or land clearing. This is the most common type of fire in timber stand of all species. It may be a mild, low-energy fire in sparse grass and pine needle litter, or it may be a very hot, fast moving fire where slash, flammable under story shrubs or other abundant fuel prevails. A surface fire if spread may burn up to the taller vegetation and tree crowns as it progresses (Fig.-3.2).

3.7.2 Underground fires

The fires of low intensity, consuming the organic matter beneath and the surface litter of forest floor are sub-grouped as underground fire. In most of the dense forests a thick mantle of organic matter is found on top of the mineral soil. This fire spreads in by consuming such material. These fires usually spread entirely underground and burn for some meters below the surface.

This fire spreads very slowly and in most of the cases it becomes very hard to detect and control such type of fires. It may continue to burn for months and destroy vegetative cover of the soil. The other terminology for this type of fire is *Muck fires*.

3.7.3 Ground fires

Fig.-3.3: Ground Fire

These fires are fires in the sub surface organic fuels, such as duff layers under forest stands, Arctic tundra or taiga, and organic soils of swamps or bogs. There is no clear distinction between underground and ground fires. The smoldering underground fire sometime changes into ground fire. This fire burns root and other material on or beneath the surface i.e. burns the herbaceous growth on forest floor together with the layer of organic matter in various stages of decay. They are more damaging than surface fires, as they can destroy vegetation completely. Ground fires burn underneath the surface by smoldering combustion and are more often ignited by surface fires. Thus a ground fire consumes the organic material beneath the surface litter of the forest floor. A true ground fire spreads by a slowly smoldering edge with no flame and little smoke. These fires are often hard to detect and are the least spectacular and slowest moving. Fighting such fire is very difficult (Fig.-3.3).

3.7.4 Crown fires

Crown fire is the most unpredictable fires that burn the top of trees and spread rapidly by wind. In most of the cases these fires are invariably ignited by surface fires. This is one of the most spectacular kinds of forest fires which usually advance from top to down of trees or shrubs, more or less interdependent of surface fires. In dense conifer stands with a brisk wind, the crown fire may race ahead of the supporting

surface fire (Fig.-3.4). Since it is over the heads of ground force it is uncontrollable until it again drops to the ground, and since it is usually fast moving, it poses grave danger to the fire fighters becoming trapped and burned.

Fig.-3.4: Crown Fire

3.7.5 Firestorms

Among the forest fires, the fire spreading most rapidly is the firestorm, which is an intense fire over a large area. As the fire burns, heat rises and air rushes in, causing the fire to grow. More air makes the fire spin violently like a storm. Flames fly out from the base and burning ember spew out the top of the fiery twister, starting smaller fires around it. Temperatures inside these storms can reach around 2,000 degrees Fahrenheit (Fig.3.5).

Fig.-3.5: Fire storm

Along with nature and behavior, the forest fires can also be categorized according to human management action. On this basis, fires in forest may be categorized as *management ignited fires* and *prescribed natural fires*. Management ignited prescribed fires are ignited in order to meet a land management plan objectives, such as debris removal or wildlife habitat improvement. Prescribed natural fires are those that are allowed to burn under an approved plan and preserve the natural role of fires in the ecosystem. Besides these, the fire may further be categorized based on their peculiar behaviour. There is specialized vocabulary used by the wild fire community for describing different types of fire behavior.

- A fire is said to be **running** when it is spreading rapidly

- It is **creeping** when it is spreading slowly with low flames
- A fire is **smoldering** when it burns without a flame and is barely spreading.
- A fire is said to be **spotting** when it is producing sparks or embers that are carried by the wind or by the combustion column caused by the fire and start new fires beyond the main fire. The new ignition points are called spot fires.
- A fire is **torching** when it moves from one crown to another fire into the crowns of individual trees, but not necessary from one crown to another.
- It is **crowning** when it spreads from tree to tree usually in conjunction with, but sometimes completely independent of the surface fire.
- A **flare-up** is a sudden acceleration of fire spread or intensity, of relatively short duration for a portion of the fire.
- A **blowup,** on the other hand is a dramatic change in the behavior of the whole fire, the point of rapid transition to a severe fire.

3.8 Why forests fire?

3.8.1 More than ninety five percent forest fires are caused either by negligence or unknowingly by the human being. The rest of the fires are caused by natural reasons i. e. lightning, extreme rise in the temperature etc., which are very rare. In general all over the world the main causes of forest fires are anthropogenic. According to FAO report "Fire Management- Global Assessment 2006", regional estimates of human induced forest fires as follows:

a. Mediterranean- 95%
b. South Asia 90 %
c. South America 85 %

d. North America 80 %

e. Balkan countries 59 %

The natural causes of forest fires are common in remote areas only.

Out of three essential components of fire triangle, two components i.e. fuel and oxygen are naturally available in forest. It is the third component i.e. heat that really initiates fire in the forest. Heat may be supplied by either natural or artificial reasons. Depending upon the source of the heat, the causes for forest fire may be classified as natural or artificial. While lightening, volcanic explosion, friction of rolling stone etc. are the natural causes for forest fire; the anthropogenic causes may be subdivided into two categories i.e. deliberate causes and unintentional or accidental causes.

Natural	**Anthropogenic**	
	Deliberate causes	**Accidental causes**
1. Lightning	1 Shifting Cultivation	1 Collection of Non Timber Forest Produce
2. Friction of rolling stone	2 To flush growth of *tendu* leaves	2 Burning farm residues
3. Rubbing of dry bamboo clumps	3 To have good growth of grass and fodder	3 Driving away wild animals
4. Volcanic explosion	4 To settle score with forest department or personal rivalry	4 Throwing burning *bidi*/ cigarettes
.	5 To clear path by villagers	5. Camp fires by picnickers
.	6 To encroach upon the forest land	6. Sparks from vehicle –exhaust
.	7. For concealing illicit felling	7. Sparks from transformers
.	8. Tribal traditions/ customs	8. Uncontrolled prescribed burning
	.	9. Resin tapping

. . .		10. Making charcoal in forests 11 Extracting wine in forest 12. Sparks from cooking near the forest 13 Heating coal tar for road construction in forest

3.8.2 Natural causes

Natural causes, that originate the Forest Fire, can be summarized as follows: -

- Lightning during thunderstorms may lead to the occurrence of forest fires. Many forest fires start from natural causes such as lightning which set trees on fire. Periodic lightning induced fires have been recorded throughout history from India, Southeastern and Central United States, Australia, Finland and Eastern and Southern Africa (Kaushik, 2004). Natural or prescribed fire sometimes may become a potential hazard to the forest by causing damage to vegetation and wildlife, and releasing huge amount of particulate and gaseous pollutants into the atmosphere.

- In dry season, friction leading to sparks by rolling stones in the mountainous areas may lead to forest fires. This occurs only when there is considerable combustible material present on the floor. Even small sparks are enough to generate a fire, which may be fanned by strong winds. A devastating forest fire taking lives of four innocent ladies in Gwar village, located 40 km towards north-east from Rudraprayag district of Uttarakhand in February 2001 is an example of such fire. In this region there was no winter rainfall from December, 2000 and thus there was lack of moisture both in the soil and air, resulting in less decomposition of senescent leaves. The dry grass worked as a fuel, fast blowing wind supplied oxygen in plenty resulting in speedy spread of

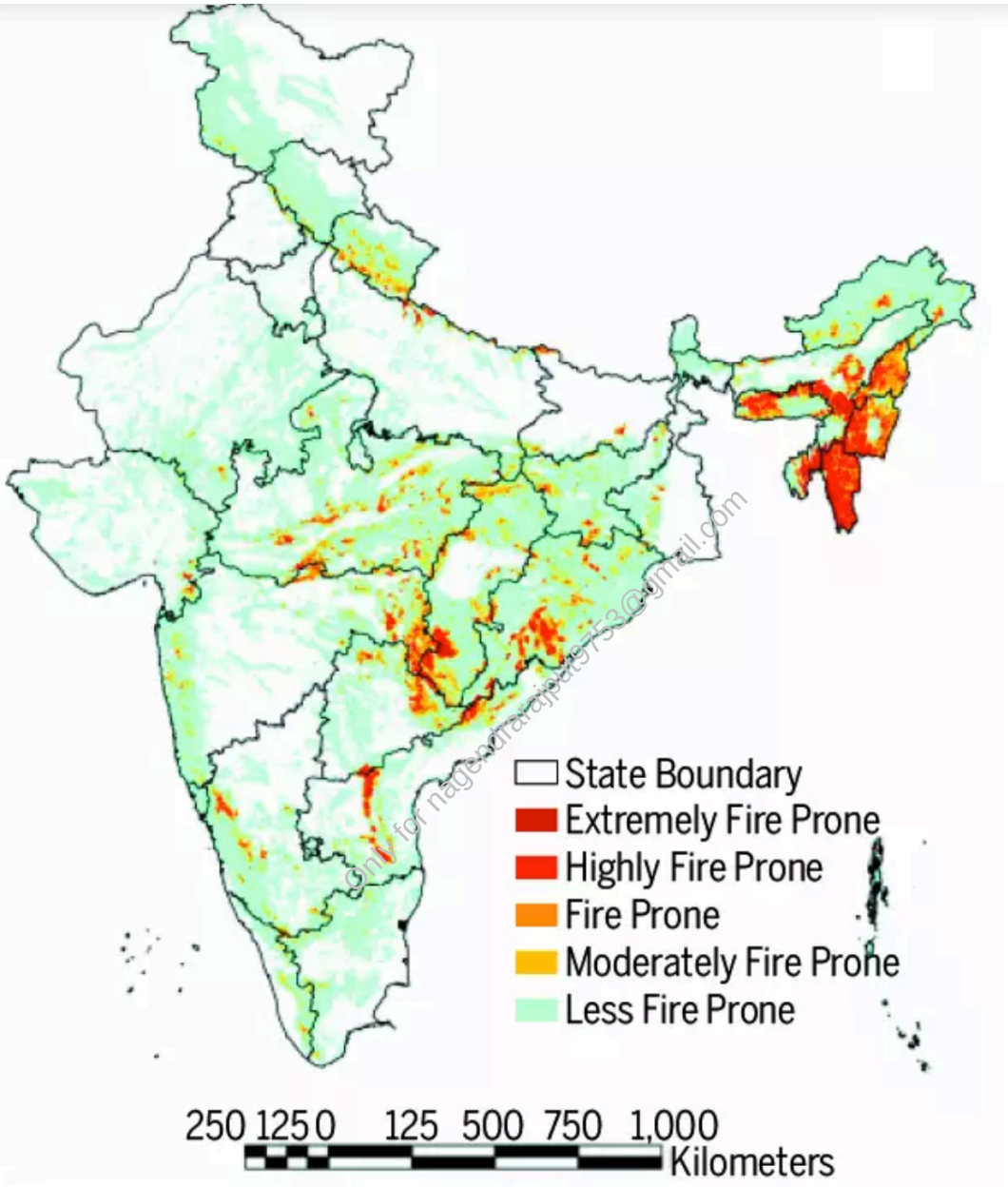
115% rise in forest fires this month

Around 42,799 forest fires have been detected between March 1 and March 12, according to the satellite-based forest fire monitoring by Forest Survey of India (FSI).

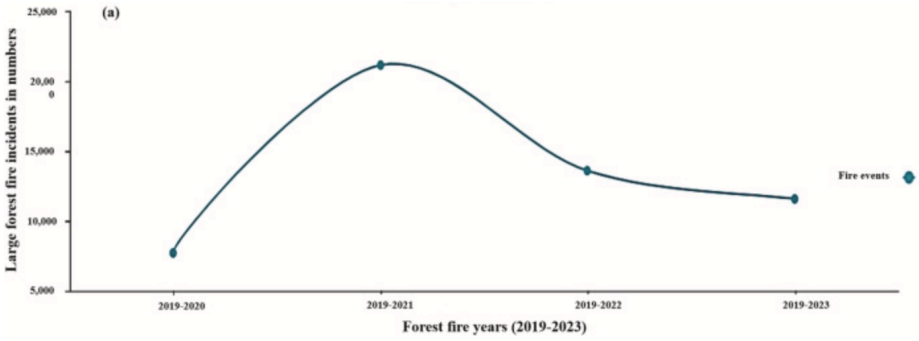
New Delhi: India has seen a 115% increase in forest fires in the first 12 days of March on the back of almost no rains in February, and hotter-than-normal temperatures.

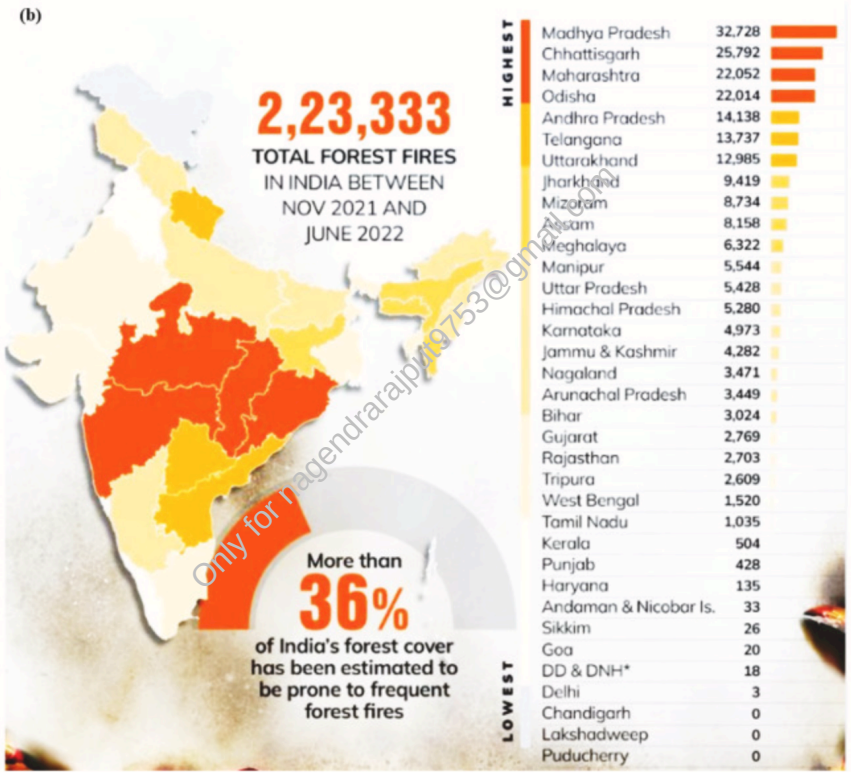
Around 42,799 forest fires have been detected between March 1 and March 12 according to the satellite-based forest fire monitoring by Forest Survey of India (FSI); the number is up from 19, 929 last year.

https://www.moneycontrol.com/news/environment/explainer-why-wildfires-are-on-the-rise-in-india-12137301.html



Map Showing fire prone forest areas under different fire prone classes





Forest Fire

Safety Tips :

- Try to maintain FOREST BLOCKS to prevent day litter from forests during summer season.
- Try to put the fire out by digging or circle around it by water, if not possible to call a Fire bridge.
- Move farm animals & movable goods to safer places.
- During fire listen regularly to radio for advance information & obey the instructions cum advice.
- Teach the causes and harm of fire to your family and others. Make people aware about forest fire safety.
- Do not be scared when a sudden fire occur in the forest, be calm & encourage others & community to overcome the problem patiently.
- Do apply seasonal mitigation measures i.e., fuel reduction etc.
- Don't throw smoldering cigarette butts or bidi in the forests.
- Don't leave the burning wood sticks in or near the forest.
- Don't enter the forest during the fire.
- Discourage community to use Slash & Burn method.

occurrence of forest fires are: 1) Andhra Pradesh 2) Himachal Pradesh 3) Karnataka 4) Manipur 5) Madhya Pradesh 6) Nagaland 7) Orissa 8) Rajasthan 9) Telangana 10) Uttar Pradesh and 11) Uttarakhand.

The moist deciduous forest is the most vulnerable to fire in India. Nearly 15 per cent of this ecosystem is frequently disturbed by fire and 60 per cent is occasionally affected. In the case of wet/semi—evergreen forests, fire occur somewhat frequently in nine per cent, and occasionally in additional 40 per cent. In the North-Eastern region of India, recurrent fires annually affect up to 50 per cent of the forests. The coniferous forests in the Himalayan region are also very fire prone with many wildfires occurring during the winter drought. The proportion of the forest areas prone to forest fire ranges greatly across different states.

The traditional view of fire as a destructive agent requiring immediate suppression has given way to the view that fire can and should be used to meet land management goals under specific ecological conditions. The impact of the fire is diverse on the forest ecosystem. Besides directly damaging the forest, the fire also adversely affects forest regeneration, microclimate, soil erosion, and wildlife etc. In most of the cases, the forest fire causes retrogression of forest vegetation. Forest fire is one of the major degenerating factors, which extensively damages the growing stock and its generations and making area vulnerable to erosion. It has wide-ranging adverse ecological, economic and social implications.

2.3 Regions/Areas Involving Multiple States Requiring Special Attention

While suggesting a holistic approach to DM, the High Power Committee[24] discussed three cases that merit special consideration on the geo-physical considerations: a) Himalayan region b) Coastal tracts, and c) Riverine areas. From the point of view of administrative and logistical perspectives, the North-East Region also requires specialized approach. Similarly, the Union Territories, remote Islands and offshore marine assets need to be treated differently given the specific administrative and logistical challenges. Therefore, there are six special categories:

1) Himalayan Region spanning more than one State
2) Coastal Tracts covering more than one State and UTs
3) Riverine Areas spread over one or more States
4) North East Region consisting of all eight States
5) Union Territories, Islands and Marine Assets located in one or more State and UTs
6) Arid and Semi-Arid Regions

2.3.1 Himalayan Region

The Himalayan region of India, characterized by a wide variation in topography, geology, soil, climate, flora, and fauna, and various ethnic groups with varied socio-cultural traditions, is a unique geographical entity of our country (see also the description in section 2.2.2.11). Human activities in this region are the prime cause of environmental degradation within this region. The effects of human activities on environment may be direct or indirect, small or big, slow or fast, predictable or

[24] The High Powered Committee was constituted in August 1999 to make recommendation for institutional reforms and preparation of Disaster Management Plans at the National, State and District levels at the behest of the Prime Minister by the Ministry of Agriculture.

unpredictable depending on the nature, intensity, and frequency of the disturbance to natural ecosystem.

2.3.2 Coastal Areas

India has a coastline encompassing the mainland and various islands exceeding 7,500 km. Natural disasters, primarily cyclones usually accompanied by storm surges as well as coastal shoreline changes affect the coastal tracts, regularly inflicting widespread miseries. The hazards in coastal areas include 1) Geological and shoreline changes 2) Rip currents 3) Cyclones 4) Sea level rise 5) Coastal flooding 6) Storm surges and flooding 7) Flooding from heavy rainfall events, 8) Saline ingress and 9) Tsunamis. As per historical records, the risk of tsunami is very low in most parts of the coast. However, some coastal tracts are likely to experience it, as was the case in 2004. The damages resulting from such disasters have increased significantly in recent past. One of the main reasons for this is the growing population pressure in the coastal regions. Along with rising urbanization in coastal areas, there is increasing human habitation in risky stretches of the coast. The risks from global climate change, especially the higher frequency and intensity of extreme weather events including cyclones and the sea level rise, increase the risk profile of the coastal areas. Often coastal disasters affect more than one state at a time and the response can be considerably improved by proactive inter-agency cooperation among centre and the affected states.

2.3.3 Riverine Regions

The communities settled in river basins and are predominantly dependent on agriculture. They are subjected to extremes of rainfall - very high rainfall and very low rainfall. They are therefore most vulnerable to riverine flooding and food shortages during droughts. These are two of the main problems i.e. floods and food insecurity. The major river systems in the country can be broadly classified into two groups viz. Rivers of the Himalayan Region and Rivers of Peninsular India. The Himalayan Rivers are fed by the melting snows and glaciers of the great Himalayan range during spring and summer as well as by rains during monsoons. They are often uncertain and capricious in their behaviour. The peninsular rivers that originate at lower altitudes, flow through more stable areas, and are more predictable in their behaviour. Their flows are characterized by heavy discharges during monsoons followed by very low discharges during the rain less months. From the point of view of the flooding, the riverine regions can be grouped into four as under:

a) Brahmaputra region drained by Brahmaputra-Ganga system
b) Ganga region drained by River Ganga
c) North West drained by Indus and tributaries and
d) Central India and Deccan region drained by river like Narmada and Tapi

Disaster situations involving major rivers affect more than one state at a time and the response can be considerably improved by proactive inter-agency cooperation among centre and the affected states, which may require a river-basin oriented approach. Heavy rainfall and floods have underscored the importance of multi-agency cooperation, need for reliable flood forecasting, ability for making reasonably accurate quantitative rainfall forecast, information at the river basin level and modern MIS for all major dams.

2.3.4 North East Region (NER)

North East Region of India is highly prone to earthquake, floods and landslide. Some areas are also vulnerable to forest fire. The NER comprises eight states: 1) Arunachal Pradesh 2) Assam 3) Manipur 4) Meghalaya 5) Mizoram 6) Nagaland 7) Sikkim and 8) Tripura. Recognizing the special needs and

Boat safety guidelines 2017 (Imp.)

Background of Boat Accidents
In many of the navigable waterways in India, boats usually run without life jackets or inflated tubes and engines - mostly local made or impoverished versions, are not checked for fitness. It is observed that the safety of the boatman, operating conditions of boats and boat making docks, inconsistent or nonexistent ferry ghat infrastructures have not been outlined much in the rules and ferry acts available.
There is an overall paucity of control measures over the private boat operating services in major water channels. Such boats do have little safety measures, yet daily passengers have no other means than to travel in such dangerous conditions.
The following prime factors contribute to boat/ferry accidents in most of the inland waterways -
• Understaffing/Unqualified crew
• Severe overcrowding
• Ageing vessels
• Lack of regulatory standards
• Faulty boat design and stability

OPERATORS DISTRACTION
The person operating the boat or personal watercraft divert attention to other issues while driving boats may cause accidents
• RECKLESS OPERATION OF THE BOAT
Many a times, boats accidents occur due to over speeding of boats or watercrafts. In addition negligence in boat operations also cause accidents.
• UNRULY OR RAMPANT PASSENGERS
Sometimes unruly passengers in boats/ferries create ruckus or chaos on board, and may slips and hits their head, falls overboard, etc. This also cause accidents due to imbalance.
• RECKLESS SKIERS
Reckless skiers performing illegal or dangerous stunts around boats may cause imbalance of boats or distraction by boat operator that may cause accidents.
• DRIVING UNDER THE INFLUENCE OF ALCOHOL
When a person has been drinking they are far more likely to fall overboard and drown. Alcohol also leads to a lack of judgment which results in many of the other factors listed here as contributing to boat accidents. Person may be injured because of someone else's operating their boat or watercraft under the influence of alcohol.
• FAILURE TO POST A PROPER LOOKOUT
Many boating accidents, especially collisions occur because no one is watching for obstacles, other boats, etc.
• INEXPERIENCED OPERATOR
Just as car accidents are more common among new
EQUIPMENT FAILURE
Boat accident may also be caused due to the failure of equipments on board of boats or personal watercrafts
POOR WEATHER CONDITIONS
This is a major contributor to many serious boating accidents, especially accidents that involve the loss of the vessel. It is important to pay attention to weather advisories so that you are not caught in conditions

context, the Government of India has categorized eight North Eastern states as Special Category states with the Ministry of Development of North Eastern Region (MDONER) paying special attention to the region. Barring Assam, the other States are hilly. The seven States of the North-Eastern Region barring Sikkim forming a compact region is linked to the rest of India through the 26-km long Siliguri Corridor commonly known as Chicken's Neck. About 98 per cent of the NER's border is bounded by other countries and the infrastructure deficit in the region, particularly connectivity in all forms, is acute. For DM too, the region needs to be treated in an integrated manner considering the special conditions.

2.3.5 Union Territories, Islands and Marine Assets

The UTs, islands and marine assets pose challenges in disaster governance somewhat different from that of the states having a SDMA. The nine UTs governed almost directly by the Union Government, without the administrative system characteristic of a full-fledged state in the Indian Union are:

1. Andaman and Nicobar Islands
2. Chandigarh
3. Dadra and Nagar Haveli
4. Daman and Diu
5. Jammu & Kashmir (J&K)
6. Ladakh
7. Lakshadweep
8. National Capital Territory of Delhi
9. Puducherry

Out of the UTs, J&K, Puducherry and the National Capital Territory of Delhi, having their own Legislative Assemblies, are like quasi states without the same autonomy as of full-fledged states. The Central Government is directly responsible for all aspects of governance in the remaining UTs without own legislatures. The UT Division of the MHA is responsible for all the legislative and constitutional matters in the UTs.

There are more than 1,200 islands (including uninhabited) within the territorial limits of India of which some are very remote from the mainland. In addition, there are many offshore assets that are involved in scientific activities, prospecting for oil and gas, or linked to oil and gas production. While, some of disaster situation in many islands and marine assets can be managed by the respective state or UT, in a few cases specialized approach will be needed considering the resources the islands or the offshore facilities have. They are all at risk from multiple hazards especially that of sea surges, high velocity wind, cyclones, earthquakes, and tsunami.

2.3.6 Arid/Semi-Arid and Drought-Prone Regions

A long stretch of land situated to the south of Tropic of Cancer and east of the Western Ghats and the Cardamom Hills experiences Tropical semi-arid climate. It includes Karnataka, interior and western Tamil Nadu, western Andhra Pradesh and central Maharashtra. Being situated in the rain-shadow area, the annual rainfall is low (40 to 75 cm) and drought-prone. Most of western Rajasthan has the arid (desert) climate characterized by scanty rainfall. Most of the drought-prone areas are found in arid and semi-arid regions of the country having low average annual rainfall. Broadly, the drought-affected areas in India can be divided into two tracts[25]. The first tract comprising the desert and the semi-arid regions covers an area of 0.6 million sq. km that includes parts of Gujarat, Rajasthan,

[25] Hydrology and Water Resources Information System for India, http://117.252.14.242/rbis/rbis.htm (accessed Sep 20, 2019)

Haryana, Punjab, UP, and MP. The second tract comprises the regions east of the Western Ghats up to about 300 km from coast falling in the rain shadow area of the Western Ghats. This thickly populated region experiences periodic droughts. Besides these two tracts, several parts of states such as TN, Gujarat, UP, Chhattisgarh, Jharkhand, West Bengal, and Odisha also experience drought. While Rajasthan is one of the most drought prone areas, drought is very frequent in large parts of Andhra Pradesh and Telangana. The agriculture in these regions is mostly rainfed. All these drought-prone, arid/semi-arid regions with low and uncertain rainfall need long-term water resource management strategies coupled with better management of dryland farming to effectively cope with recurring droughts. Special attention on comprehensive monitoring of the hydro-meteorological as well as agro-economic conditions is needed along with meaningful forecasting methods that can help local authorities in coping with the likelihood of drought.

2.4 Climate Change

2.4.1 Climate and Human-Induced Climate Change

For a sufficiently large geographic region, the term climate, as defined by the World Meteorological Organization, may be understood as the average weather for the region, or more rigorously in terms of the statistical properties (mean and variability) of relevant weather-related variables, with the period for averaging being 30 years or more. Climate projections relate to the slow evolution of the coupled systems of atmosphere, ocean, land, and cryosphere. They are usually expressed in probabilistic terms (e.g. probability of warmer or wetter than average conditions) usually for months or seasons. The climate projections never forecast specific weather events. The term "normal" used in climate are the averages or expected values typical of a region primarily based on analysis of historical data (i.e., long-term data).

The term climate change relates to significant deviations seen in long-term averages of the weather variables in a region (or the whole Earth). In the absence of human-induced changes to the Earth's atmospheric system, such changes are not expected to occur over a short period as has been observed. In fact, if at all such patterns as global studies show are to happen through natural climate variability alone, that could take hundreds or perhaps millions of years. The anthropogenic activities such as industrialization, urbanization, deforestation, agriculture, change in land use pattern and other changes cause emission of greenhouse gases which hastens the rate of climate change. The United Nations Framework Convention on Climate Change (UNFCCC) makes a distinction between Global Anthropogenic Climate Change (GACC) attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. The UNFCCC in its Article 1, defines GACC as[26]:

> 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.

Anthropogenic drivers for climate change are now widely recognised among the scientific community as playing the major role in magnifying the disaster risks globally. The knowledge and understanding on climate change hold the key to the unprecedented changes in the disaster risk scenarios facing the world today. A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather

[26] United Nations Framework Convention on Climate Change http://unfccc.int/cop4/conv/ftconv.html (accessed Sep 20, 2019)

and climate events. Extreme and non-extreme weather or climate events affect vulnerability to future extreme events by modifying resilience, coping capacity, and adaptive capacity.

The year 2016 made history, with a record global temperature, exceptionally low sea ice, and unabated sea level rise and ocean heat, according to the World Meteorological Organization (WMO). Extreme weather and climate conditions have continued into 2017. WMO issued its annual statement on the State of the Global Climate ahead of World Meteorological Day on 23 March which stated that the globally averaged sea surface temperatures were the warmest on record, global sea levels continued to rise, and Arctic sea-ice extent was well below average for most of the year. Because of climate change, the occurrence and impact of extreme events has risen. 'Once in a generation' heatwaves and flooding are becoming more regular. Sea level rise has increased exposure to storm surges associated with tropical cyclones.

2.4.2 IPCC Fifth Assessment Report

According to IPCC's Fifth Assessment Report[27] (AR5) based on many independent scientific analyses, new evidence, theoretical studies and computer simulations, there is greater certainty that the build-up of Greenhouse Gas in Earth's atmosphere is changing the world's climate and creating increasingly extreme and unpredictable weather. Because of these changes, the probability of extreme weather events is increasing. According to AR5, the computed linear trend of the globally averaged combined land and ocean surface temperature data show 0.85°C [0.65°C to 1.06°C][28] warming over the period 1880 to 2012, when multiple independently produced datasets exist. In the period 1901-2012, climate has shown a warming of 0.89°C [0.69°C to 1.08°C], which is mainly attributed to anthropogenic activities (IPCC 2013). Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In the case of India, increasing temperature trends of the order of 0.60°C during last 112 years (IMD 2012, Rathore et al. 2013) and increase in heavy rainfall events and decrease in low and medium rainfall events (Goswami et al. 2006) have been observed.

A world with 4°C rise in temperature would be one of unprecedented heat waves, severe drought, and major floods in many regions, with serious impacts on ecosystems and associated services. Deltaic regions and coastal cities are particularly exposed to compounding climate risks resulting from the interacting effects of increased temperature, growing risks of river flooding, rising sea-level and increasingly intense tropical cyclones, posing a high risk to areas with the largest shares of poor populations. As per India's National Action Plan on Climate Change, parts of Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Northern Karnataka, Northern Andhra Pradesh, and Bihar are likely to be more vulnerable in times of extreme events.

As a component of the fifth assessment cycle, the IPCC Special Report (SREX) on Managing the Risks of Extreme Events to Advance Climate Change Adaptation (IPCC 2012) provides projections on changing weather and climate extremes. Severe risks, such as flooding, and drought may increase significantly due to small increments in annual average temperature. With extremes of rainfall and drought projected to increase with warming, these risks are expected to be much higher in a 4°C world as compared to the 2°C world. In a 2°C world, the river basins dominated by a monsoon regime, such as the Ganges and Nile, are particularly vulnerable to changes in the seasonality of runoff, which may have large and adverse effects on water availability (IPCC 2012). The AR5 states that changes in cases of extreme weather and climate events have been observed since about 1950. The data indicates that globally, while the number of warm days and nights has increased, that of cold days and nights has decreased. Besides, the frequency of heat waves appears to have increased in large parts of Europe,

[27] IPCC (2013)

[28] The estimated values have 90 per cent likelihood of being within the uncertainty intervals given in square brackets, which is not always symmetric about the reported best estimate.

Asia and Australia. There are more land regions where the number of heavy precipitation events has increased than where it has decreased.

The climate change actions and DRR share common goals, with both aiming to reduce the vulnerability of communities. The global climate change alters the frequencies, geographic distribution and intensities of almost all the hydro-meteorological hazards such as floods, cyclones, droughts, cold wave, and heat wave in unpredictable ways aggravating the existing uncertainties associate d with these hazards. While it is not possible to establish direct one to one functional relationship between specific extreme weather events and any of the specific climate change parameters expressed in global terms (deviations long-term global averages), it is certain that the global climate change does increase disaster risk significantly, although not amenable to precise forecasts. That emphasises the need for more comprehensive approach to DRR.

2.4.3 India and Climate Change

Over a century of observations on atmospheric parameters (like temperature and precipitation), and relatively recent observations on cyclones and sea-level show significant climate anomalies over the Indian region. These changes are likely to increase the frequency of extreme weather events and worsen the hydro-meteorological hazards. Apart from the observed trends, significant climatic anomalies are also projected over Indian region in terms of temperature, precipitation, storms, cyclones, sea-level rise and coastal inundation. An all-round warming over the India sub-continent associated with increasing greenhouse gas scenario. The annual mean surface air temperature rise is expected to range between 1.7 – 2 °C and the seasons may get warmer by around 2°C towards 2030's. The variability of seasonal mean temperature may be more in winter months. The warming in night temperatures is expected to be more over south peninsula, central and northern India, whereas that of daytime warming is expected to be more over central and northern India. This section is based on the several official studies and reports, notably:

a) India's submission of NDC to the UNFCCC in accordance with Article 4, paragraph 12 of the Paris Agreement, 2015[29]
b) India's Progress in Combating Climate Change - Briefing Paper for UNFCCC COP 20 Lima, PERU
c) IMD Report of 2013 (ESSO/IMD/EMRC/02/2013) - State level climate change trends in India. (Rathore et al. 2013)
d) INCCA Report #2 – Climate Change and India: A 4x4 Assessment - A Sectoral and Regional Analysis for 2030s

A World Bank report (2012) – 'Turn Down the Heat' – warns that parts of South Asia have become drier since the 1970s with an increase in the number of droughts. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh. Crop yields are expected to fall significantly because of extreme heat by the 2040s. One of the notable changes in the rainfall pattern is the increase in the frequency of high intensity rainfall events. It has been noted that most Himalayan glaciers - where a substantial part of the moisture is supplied by the summer monsoon - have been retreating over the past century. These changes can have

[29] Interim NDC Registry - http://www4.unfccc.int/ndcregistry/Pages/Party.aspx?party=IND (accessed Sep 20, 2019)

consequences on the flows of the Indus, Ganges, and Brahmaputra rivers, which in turn could significantly impact irrigation.

The sub-continent is expected to see relatively larger rise in sea levels than higher latitudes and India being close to the equator this has ramifications for the coastal regions of India. Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality, contaminating drinking water, and possibly causing a rise in diarrhoea cases and cholera outbreaks, as the cholera bacterium survives longer in saline water. Seasonal water scarcity, rising temperatures, and intrusion of sea water would threaten crop yields, jeopardizing the country's food security.

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2.4.4 Temperature

Indian annual mean temperature showed significant warming trend of 0.51°C per 100 years, during the period 1901-2007 (Kothawale et al., 2010). Accelerated warming has been observed in the recent period 1971-2007, mainly due to intense warming in the recent decade 1998-2007. This warming is mainly contributed by the winter and post-monsoon seasons, which have increased by 0.80°C and 0.82°C in the last hundred years respectively. The pre-monsoon and monsoon temperatures also indicate a warming trend. Mean temperature increased by about 0.2°C per decade (i.e. 10 years) for the period 1971-2007, with a much steeper increase in minimum temperature than maximum temperature. In the most recent decade, maximum temperature was significantly higher compared to the long-term (1901-2007) mean, with a stagnated trend during this period, whereas minimum temperature showed an increasing trend, almost equal to that observed during 1971-2007.

The all-India mean annual maximum and minimum temperatures increased by 0.71°C and 0.27°C per hundred years (1901-2007) respectively. Additionally, warmer nights have increased, and colder nights have decreased almost over the entire country. The number of cold days and nights has been decreasing and that of hot days and nights have been increasing almost over all the regions of the country. Significant influence of El Niño Southern Oscillation events on temperature anomalies observed across India.

State wise averaged annual mean maximum temperature time series has shown increasing trends over many States/UTs of India except Bihar, Chhattisgarh, Delhi, Haryana, J&K, Ladakh, Meghalaya, Punjab, Tripura and UP (Rathore et al, 2013). The increasing trends were significant over Andaman and Nicobar, AP, Arunachal Pradesh, Assam, Goa, Gujarat, HP, Jharkhand, Karnataka, Kerala, Lakshadweep, MP, Maharashtra, Manipur, Mizoram, Orissa, Rajasthan, Sikkim, T N and Uttarakhand.

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2.4.5 Impact on Indian Monsoon

Extreme rainfall amounts are increasing at many places in India. Majority of the locations have reported highest 24-hour rainfall during 1961-1980 with an alarming rise in their intensity during 1980-2009. Many stations have experienced 40-370% rise in their rainfall intensities. All-India monsoon rainfall series based on 1871-2009 indicates that the mean rainfall is 848 mm with standard deviation of 83 mm (MOEF CC 2010). The Indian monsoon shows well defined epochal variability with each epoch of approximately 3 decades. Though it does not show any significant trend, however, when averaged over this period, a slight negative trend i.e. -0.4mm/year is seen. The all-India, northwest, west coast and peninsular India monsoon rainfall shows a slightly higher negative trend, though not significant, than for the total period. However, pockets of increasing/ decreasing trends in 36 meteorological sub - divisions over India are seen (MOEFCC 2010).

For the Indian Summer Monsoon Rainfall (ISMR), i.e., the monsoon season (June to September), Rajeevan et al. (2008) showed that extreme rain events have an increasing trend between 1901 and 2005, but the trend is much stronger after 1950. Sen Roy (2009) investigated changes in extreme hourly rainfall in India, and found widespread increases in heavy precipitation events across India, mostly in the high-elevation regions of the north-western Himalaya as well as along the foothills of the Himalaya extending south into the Indo-Ganges basin, and particularly during ISMR between 1980 and 2002. Heavy precipitation increased in India (Rajeevan et al., 2008) especially during the monsoon seasons (Sen Roy, 2009; Pattanaik and Rajeevan, 2010).

The state/area-specific average annual rainfall show increasing trend over AP, Bihar, Gujarat, Haryana, J&K, Ladakh, Jharkhand, Lakshadweep, Manipur, Meghalaya, Mizoram, Orissa, Rajasthan, TN, Tripura and West Bengal during 1951-2010 (Rathore et al, 2013). However, annual rainfall has decreased over Andaman and Nicobar, Arunachal Pradesh, Assam, Chhattisgarh, Delhi, Goa, H P, Karnataka, Kerala, MP, Maharashtra, Nagaland, Punjab, Sikkim and UP. The highest increase and decrease in annual rainfall were observed over Meghalaya (+14.68 mm/year) and Andaman and Nicobar (-7.77 mm/year) respectively. However, annual rainfall trends have been significantly increasing over West Bengal (+3.63 mm/year) and significantly decreasing over Andaman and Nicobar (-7.77 mm/year) and Uttar Pradesh (-4.42 mm/year).

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2.4.6 Storm and Cyclones

The storm frequency has decreased despite higher sea surface temperature in the past century. 1961 onwards, the cyclone frequency shows a significant decreasing trend for all the months and seasons (except post-monsoon period) over the Indian region (MOEFCC 2010). Cyclone intensity however is seen to be increasing during this period which may have significant implications. Cyclonic disturbances over Arabian Sea may be less in future as compared to the present simulations. However, such systems are expected to be more intense in the future under global warming. The frequency of cyclones during the post-monsoon season in future (2071-2100) could be much higher than that during the baseline period (1961-1990).

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2.4.7 Sea-Level Rise

Global average sea-level rose at an average rate of about 1.8 and 3.1 mm/year over 1961-2003 and 1993-2003, respectively (MOEFCC 2010). Between 1993 and 2003, the sea level rose by 0.33 m with an uncertainty of ±1 mm/year. Over the Indian region sea-level rise is less understood. The mean sea-level rise along the Indian coasts (on an average) based on observations is estimated to be about 1.3 mm/year. Global average sea level rise at the end of the 21st century (2090 –2099) for different climate scenarios is expected to be 0.18 - 0.59 m which may be used as first approximation of seal level rise along the Indian coast for nest few decades and towards the end of the century.

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2.4.8 Coastal Inundation due to Sea Level Rise

Coastal inundation due to sea level rise is a concern for several locations along the Indian coasts. The east coast of India is more vulnerable than the west coast, because the former is low-lying and more prone to the occurrence of cyclones than the latter (MOEFCC 2010). The central west coast of India is least vulnerable, by virtue of a steep onshore topography and low occurrence of cyclones. Coastal areas projected to be highly vulnerable to inundation due to sea-level rise include the Nagapattinam and Paradip areas along the east coast and the Kochi areas along the west coast.

The apex body for the conservation and protection of cultural heritage is the Ministry of Culture (MOCU), which acts through the Archaeological Survey of India. Several national legislations apply to cultural heritage such as:

- Ancient Monuments and Archaeological Sites and Remains (AMASR) ACT 2010, 1958
- Ancient Monuments and Archaeological Sites and Remains Rules, 1959
- Antiquities and Art Treasures Act, 1972 and The Antiquities and Art Treasures Rules, 1973
- State legislations applicable to State Archaeology Monuments and Sites.

With respect to cultural heritage sites and precincts, a localised hazard may also cause an emergency that is beyond the identified coping capacity. Disaster may severely impact the emergency infrastructure and response, which may affect the response for protecting the heritage site or precinct. Therefore, building capacity within the site or precinct is an important aspect of disaster risk reduction.

The framework for disaster risk reduction comprises of a four-pronged approach, a) Elimination or prevention of the hazard b) Reducing vulnerability c) Reducing exposure and d) Building Capacity. With respect to disaster risk reduction for cultural heritage sites and precincts, certain aspects need to be considered: a) Preserving and retaining cultural heritage values b) Retaining authenticity c) Using traditional technologies and skill and indigenous knowledge systems d) A degree of acceptable risk should be established for the cultural heritage site or precinct and such a threshold should inform risk reduction interventions.

2.8 Global Catastrophic Risks

A global catastrophic risk comes from very rare event that will have severe impacts on a global scale, even crippling or posing a threat to the whole of humanity (GCF 2018). An event that could cause human extinction or permanently and drastically curtail humanity's potential is known as an existential risk. Potential global catastrophic risks include anthropogenic risks, caused by humans (technology, governance, climate change), and non-anthropogenic or external risks. Examples of anthropogenic risks are global war including nuclear holocaust or the failure to manage a natural pandemic. Examples of non-anthropogenic risks are an asteroid impact event or a super-volcanic eruption. The 1815 eruption of Mount Tambora was the most powerful in human recorded history. The ash released dispersed around the world lowering global temperatures in an event sometimes known as the Year Without a Summer in 1816. This brief period of significant climate change triggered extreme weather, harvest failures and food shortages in many areas around the world. Several climate forcings coincided and interacted in a manner not reported earlier after any other large recorded volcanic eruption. Once of the dangers, is that such events could cut food supplies drastically and countries must be prepared for feeding the survivors. While there are some discussions on the global catastrophic risks, there is not much clarity on preparing for such situations. India too needs to closely follow the global initiatives.

Boat safety guidelines 2017

Background of Boat Accidents
In many of the navigable waterways in India, boats usually run without life jackets or inflated tubes and engines - mostly local made or impoverished versions, are not checked for fitness. It is observed that the safety of the boatman, operating conditions of boats and boat making docks, inconsistent or nonexistent ferry ghat infrastructures have not been outlined much in the rules and ferry acts available.
There is an overall paucity of control measures over the private boat operating services in major water channels. Such boats do have little safety measures, yet daily passengers have no other means than to travel in such dangerous conditions.
The following prime factors contribute to boat/ferry accidents in most of the inland waterways -
• Understaffing/Unqualified crew
• Severe overcrowding
• Ageing vessels
• Lack of regulatory standards
• Faulty boat design and stability

OPERATORS DISTRACTION
The person operating the boat or personal watercraft divert attention to other issues while driving boats may cause accidents
• RECKLESS OPERATION OF THE BOAT
Many a times, boats accidents occur due to over speeding of boats or watercrafts. In addition negligence in boat operations also cause accidents.
• UNRULY OR RAMPANT PASSENGERS
Sometimes unruly passengers in boats/ferries create ruckus or chaos on board, and may slips and hits their head, falls overboard, etc. This also cause accidents due to imbalance.
• RECKLESS SKIERS
Reckless skiers performing illegal or dangerous stunts around boats may cause imbalance of boats or distraction by boat operator that may cause accidents.
• DRIVING UNDER THE INFLUENCE OF ALCOHOL
When a person has been drinking they are far more likely to fall overboard and drown. Alcohol also leads to a lack of judgment which results in many of the other factors listed here as contributing to boat accidents. Person may be injured because of someone else's operating their boat or watercraft under the influence of alcohol.
• FAILURE TO POST A PROPER LOOKOUT
Many boating accidents, especially collisions occur because no one is watching for obstacles, other boats, etc.
• INEXPERIENCED OPERATOR
Just as car accidents are more common among new
EQUIPMENT FAILURE
Boat accident may also be caused due to the failure of equipments on board of boats or personal watercrafts
POOR WEATHER CONDITIONS
This is a major contributor to many serious boating accidents, especially accidents that involve the loss of the vessel. It is important to pay attention to weather advisories so that you are not caught in conditions