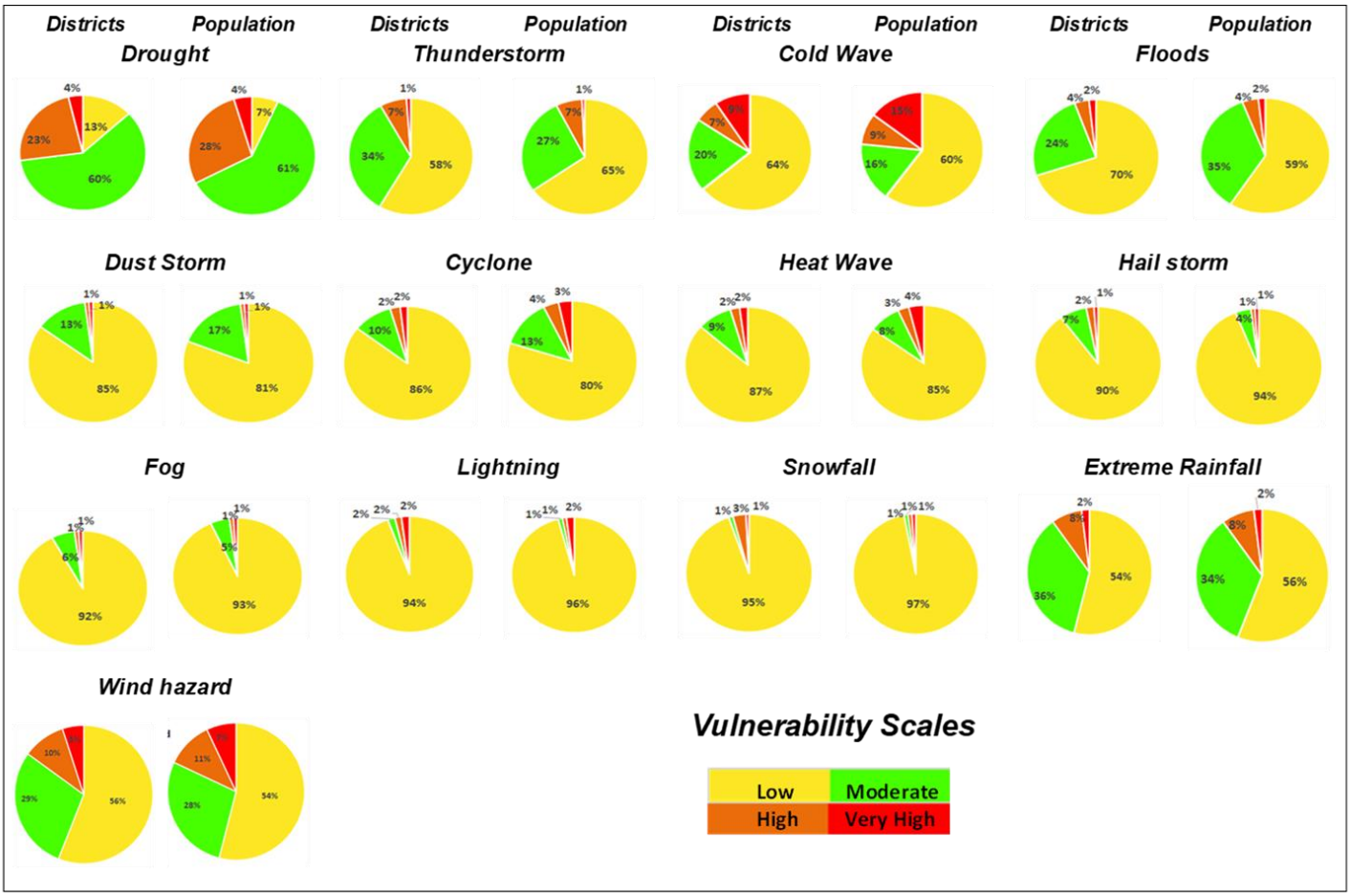
Summary of

Climate Hazards and Vulnerability Atlas of India

India Meteorological Department (IMD) monitors and provides impact-based early warning services for various meteorological disaster events at different temporal and spatial scales to support disaster risk reduction management. As a part of these services, IMD has now prepared a Web version of Climate Hazards and Vulnerability Atlas of India for the thirteen most hazardous meteorological events, viz. Cold wave, Heat Wave, Flood, Lightning, Snowfall, Dust Storm, Hail Storm, Thunderstorm, Fog, Strong winds, Extreme rainfall, Drought and Cyclone that cause loss of life, injury or other health **impacts,** property damage, loss of livelihoods and services, social and economic disruption or environmental damage. The web Atlas is depicted using Geographic Information System (GIS) tools and is made available in IMD, Pune website (https://www.imdpune.gov.in/hazardatlas/index.html). The Atlas provides districts maps on Hazard events and vulnerability for all the calendar months and at annual scale. The Hazard maps are prepared based on the climatological data, census data on population and housing density and using different statistical and mathematical methods. Climate vulnerability maps are prepared based on the disaster data from the annual publication of India Meteorological Department "Annual Disastrous Weather Reports" for the climate hazardous events that cause casualties in terms of death and other losses. Percentage of districts and population affected by disastrous weather events in different categories of vulnerability scales based on the Normalized vulnerability index for eleven out of these thirteen climate hazards are given below using pie charts and brief description of thirteen hazardous events are below:

Percentage of districts and population affected by disastrous weather events in different vulnerability scales based on normalized vulnerability index



HIGHLIGHTS

Drought: 87% of the districts and 93% of the population are moderate to very highly vulnerable (27% of the districts and 32% of the population are highly vulnerable). Madhya Pradesh is the most vulnerable state (19 districts are high to very high) followed by Uttar Pradesh (15 districts), Gujarat (14 districts), Karnataka (14 districts),

Thunderstorms: 42% of the districts and 35% of the population are moderate to very highly vulnerable (8% of the districts and population are highly vulnerable) for Thunderstorms. Assam and UT of Jammu & Kashmir (12 districts each are high to very high), Tripura (8 districts) are most vulnerable.

Cold wave: 36% of the districts and 40% of the population are moderate to very highly vulnerable (16% of the districts and 24% of the population are highly vulnerable) for cold wave. Uttar Pradesh (75 districts) is the most vulnerable state for cold waves.

Floods: 30% of the districts and 41% of the population are moderate to very highly vulnerable, annually 6% of the districts and population are highly vulnerable. In the case of states, Assam (23 districts are high to very high) is the most vulnerable state for floods.

Dust storm: 15% of the districts and 19% of the population are moderate to very highly vulnerable (2% of the districts and population are highly vulnerable) for Dust storm. States of Uttar Pradesh (3 districts are high to very high) and Assam (2 districts are high to very high) are the most vulnerable states for Dust storm events.

Cyclones: 14% of the districts and 20% of the population are moderate to very highly vulnerable (4% of the districts and 7% of the population are highly vulnerable) for cyclones. Most of the coastal districts of east coast (Tamil Nadu:11, Andhra Pradesh: 9, Odisha: 6 and West Bengal: 3) are high to very highly vulnerable for Cyclone.

Heat wave: 13% of the districts and 15% of the population are moderate to very highly vulnerable (4% of the districts and 7% of the population are highly vulnerable) for heat waves and the states of Rajasthan (15 districts) and Andhra Pradesh (13 districts) are the most vulnerable states for Heat Waves.

Hail Storm: 10% of the districts and 6% of the population are moderate to very highly vulnerable (3% of the districts and 2% of the population are highly vulnerable) for Hail storm. State of Uttarakhand (7 districts) followed by Union territory of Jammu & Kashmir (5 districts) are most vulnerable for Hail storm.

Fog: 8% of the districts and 7% of the population are moderate to very highly vulnerable (2% of the districts and population are highly vulnerable) for the fog annually. In the month of December most of the districts of Delhi and a few districts of Uttar Pradesh; in January, most of the districts of Delhi, many districts in Uttar Pradesh and Tripura and few districts in Haryana, West Bengal and Manipur are most vulnerable for fog.

Lightning: 6% of the districts and 4% of the population are moderate to very highly vulnerable in the case of lightning, annually 4 % of the districts and 3% of the population are highly vulnerable. State of Odisha (20 districts) ranked top in the most vulnerable states for lightning.

Snowfall: 5% of the districts and 3% of the population are moderate to very highly vulnerable (4% of the districts and 2% of the population are highly vulnerable) for the snow fall events. Union Territory of J&K and Ladakh (19 districts) and state of Himachal Pradesh (8 districts) are most vulnerable for snow fall.

Wind Hazards: 44% of the districts and 46% of the population are moderate to very highly vulnerable. Most of the Coastal districts of Odisha, southern coastal districts of Andhra Pradesh and northern coastal districts of Tamil Nadu, few districts of Bihar, Jharkhand, Rajasthan, Gujarat and NE states experience high extreme wind speed of greater than 55m/s (50 years return period extreme value).

Extreme Rainfall: 46% of the districts and 44% of the population are moderate to very highly vulnerable. All the districts of entire western coast, most of the districts of Assam & Meghalaya, Tripura, Kerala and few districts of Bihar, Jharkhand, West Bengal, Karnataka, Odisha, Maharashtra and Uttarakhand have maximum probable frequency of heavy rainfall events of more than 20 days during the southwest monsoon season.

Hazard	% of High To very high vulnerable districts	% of High to very high vulnerable population	High to very high vulnerable state/UT in decreasing order of no. of districts (in bracket)
Drought	27	32	Madhya Pradesh(19), Uttar Pradesh(15), Gujarat(14), Karnataka(14), Maharashtra(12), Rajasthan(12), Bihar(11), Telangana(10), Delhi(9), Odisha(8), Jharkhand(7), Andhra Pradesh(6), Assam(6), Kerala(6), Tamil Nadu(6), Haryana(5), Tripura(5), Arunachal Pradesh(4), Himachal Pradesh(4), Punjab(4), West Bengal(4), Andaman & Nicobar Islands(2), Chhattisgarh(2), Jammu & Kashmir(2), Uttarakhand(2), Goa(1) and Manipur(1)
Thunderstorms	8	8	Assam(12), Jammu and Kashmir(12), Tripura(8), West Bengal(6), Manipur(6), Uttarakhand(4), Arunachal Pradesh(4), Kerala(2), Karnataka(1), Uttar Pradesh(1), Himachal Pradesh(1) and Nagaland(1)
Cold wave	16	24	Uttar Pradesh(75), Rajasthan(17), Bihar(14), Jharkhand(1) and Punjab(1)
Floods	6	6	Assam(23), Kerala(5), Karnataka(2), Maharashtra(2), Andhra Pradesh(1) and Telangana(1)
Dust storm	2	2	Uttar Pradesh(3), Assam(2), Delhi(1) and Uttarakhand(1)
Cyclones	4	7	Tamil Nadu(10), Andhra Pradesh(9), Odisha(6), Puducherry(3), West Bengal(3) and Andaman & Nicobar Islands(1)
Heat wave	4	7	Rajasthan(15) and Andhra Pradesh(13)

Hazard	% of High To very high vulnerable districts	% of High to very high vulnerable population	High to very high vulnerable state/UT in decreasing order of no. of districts (in bracket)
Heat wave	4	7	Rajasthan(15) and Andhra Pradesh(13)
Hail Storm	3	2	Uttarakhand(7), Jammu & Kashmir(5) and Himachal Pradesh(3)
Fog	2	2	Delhi, Uttar Pradesh, Tripura, Haryana, West Bengal and Manipur
Lightning	4	3	Odisha(20)
Snowfall	4	2	Jammu and Kashmir(19) and Himachal Pradesh(8)
Wind Hazards	15	18	Odisha(19), Andhra Pradesh(11), Tamil Nadu(10), Assam(9), Manipur(5),, Delhi(5), Punjab(5), Rajasthan(5), Gujarat(4), Telangana(4), Uttar Pradesh(4), Jammu & Kashmir(3), Maharashtra(3), Uttarakhand(3), Andaman & Nicobar Islands(2), Bihar(2), Jharkhand(2), Madhya Pradesh(2), Meghalaya(2), Mizoram(2), Nagaland(2), Tripura(2), Arunachal Pradesh(1), Chhattisgarh(1), Goa(1), Himachal Pradesh(1), Karnataka(1) and West Bengal(1)
Extreme Rainfall(Annual)	10	10	Assam(12), Kerala(9), Maharashtra(8), Karnataka(7),Meghalaya(5), West Bengal(4),Himachal Pradesh(3), Tamilnadu(3), Arunachal Pradesh(2), Manipur(2), Goa(2), Tirpura(1), Mizoram(1), Odisha(1), Sikkim(1), Uttrakhand(1), Bihar(1), Jammu& Kashmir(1) and Andaman and Nicobar Island(1).