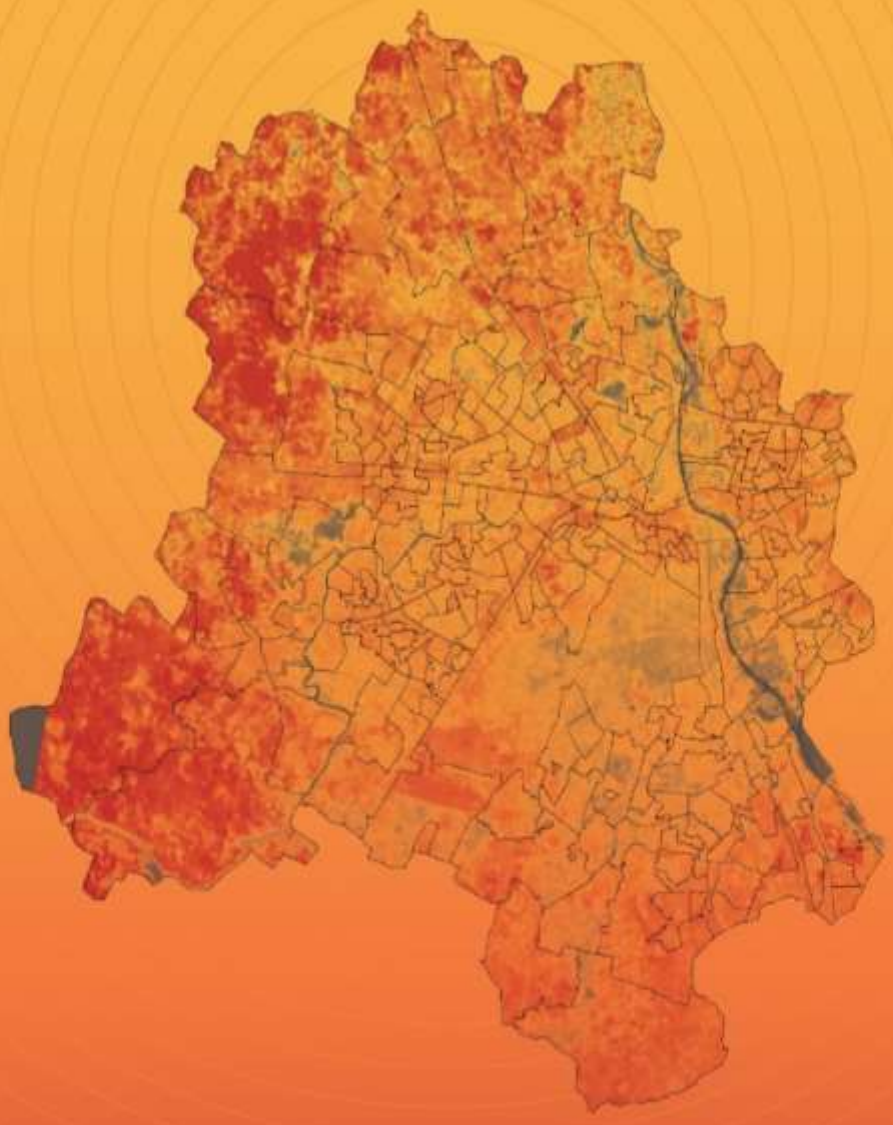
HEAT WAVE ACTION PLAN DELHI (DRAFT)



Heat Wave Action Plan- Delhi City

Prepared by:

Integrated Research and Action for Development

Supported by:

International Development Research Centre, Government of Canada (IDRC)

'Heat Wave Action Plan- Delhi City"

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1 City Profile

Delhi as the capital of India, is one of the fastest growing megacities in the world. The National Capital Territory of Delhi is the largest city in the country in terms of area, spread across approximately **1486.5 sq.km** (Gov. NTC, 2020)**. It comprises** of **11 districts, 33 tehsils/sub-divisions, 272 wards** and five local bodies. It has a population of **16.78 million** with a population density of**11320** persons per square kilometre**.** Delhi recorded decadal growth rates of **21.20%** from 2001-2011.

Characteristics of the City	
Location	85°44' E to 85°44' 'E longitude and 20° 12' to 20˚25’ N latitudes
Height above main sea Level	45 m above Mean Sea Level (MSL)
Total area (sq. km)	**1486.5 sq.km** (Census, 2011)
Total Population	**16.78 million** (Census, 2011)
Population Density	14698 per sq km
Slum Population	6343 slum

Table 1: Delhi City Characteristics

The UN report, The World Cities in 2018, reports the Delhi metropolitan area’s population for the year 2018, as 28.5 lakh, which is projected to increase to 38.9 lakhs by 2030, with a percentage change of 1.7 %.

1.1 Demography:

The decadal growth rate of the population during 2001-2011 was recorded at 21.2 per cent. This is a peculiar feature of Census 2011, as in all censuses since 1951, the decadal growth rate of the population was more than 50% and 47% in 2001.

The average size of a household in city was found to be **5.02**. About **one-third of Delhi lives in sub-standard housing**, it comprises of about **6343 slums with approximately 10.20 lakhs households** (DIRECTORATE OF ECONOMICS & STATISTICS, 2012).

Table 2: Delhi Population Growth Rate (1951-2011)

S.No.	Years	Delhi	
		Population (Lakh)	**Growth**
1	1951	17.44	NA
2	1961	26.59	52.44
3	1971	40.66	52.93
4	1981	62.20	53.00
5	1991	94.21	51.45
6	2001	138.51	47.02
7	2011	167.88	21.20
Source: Census of India (Primary Census Abstract 2011)			

1.2 Hazard Profile

The State of Delhi has been prone to various disasters both natural as well as manmade. Delhi is at risk to numerous hazards, such as earthquake, flood, fires, industrial and nuclear, biological & chemical hazards, flash floods, building collapses, road accidents, water logging etc. The state's major hazard include earthquake, floods and Heat wave.

1.2.1 Earthquake:

Delhi is located in zone IV which has fairly high seismicity where the general occurrence of earthquakes is of 5-6 magnitude, a few of magnitude 6-7 and occasionally of 7-8 magnitude. Delhi thus lies among the high-risk areas.

1.2.2 Flood Hazard

Floods in Delhi are majorly because of the anthropogenic reasons. This is very clear from the recurring phenomenon of floods in the river Yamuna and flash floods caused by rains due to choked drains of Delhi. The flood prone areas of Delhi have been classified into thirteen zones based on the flooding risk in relation to incremental rise in the water level of the Yamuna (DDA, 1993). High rates of development along with the resultant loss of soft landscape has led to high surface water sun-off rates. This results in flash floods in the low lying areas even after moderate precipitation.

1.2.3 Heat stress:

Delhi features a typical version of the tropical steppe type of climate. During summers, in the months of April, May and June, the city's temperature may rise to 40-45˚C (Authority D. D., 2014). In 2016, an orange alert was flagged in Delhi and parts of the national capital region (NCR) after temperatures touched 47oC. Most of northern and central India reeled under an intense heatwave that year. The minimum temperature in the morning was recorded in May 2016, at 27.6 degrees Celsius, three degrees above the season's average (India T. O., 2017).

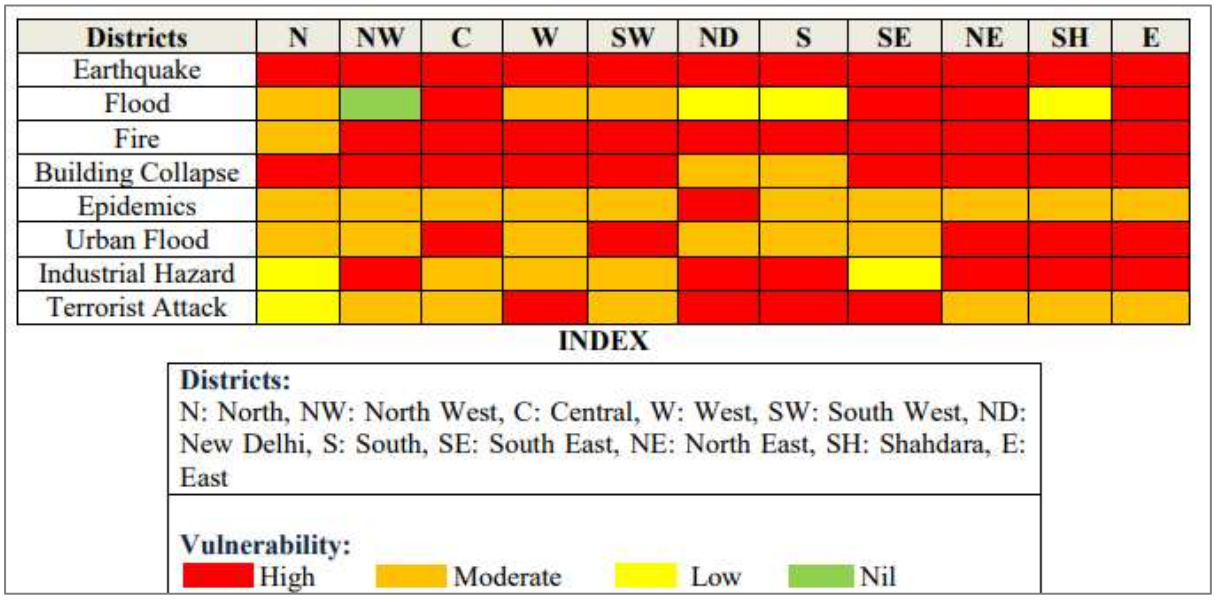


Figure 1 Delhi Vulnerability Profile (Source: Delhi Disaster Management Plan)

1.3 Urbanization:

The city of Delhi is overwhelmingly urban; with 75 % of its total area (1483 sq km) falling in urban jurisdiction and the population density in urban area is as high as 14698 persons per sq km as per 2011 Census. 16.37 million Population i.e. 98 % of total population (16.79 million) of Delhi is residing in urban areas.

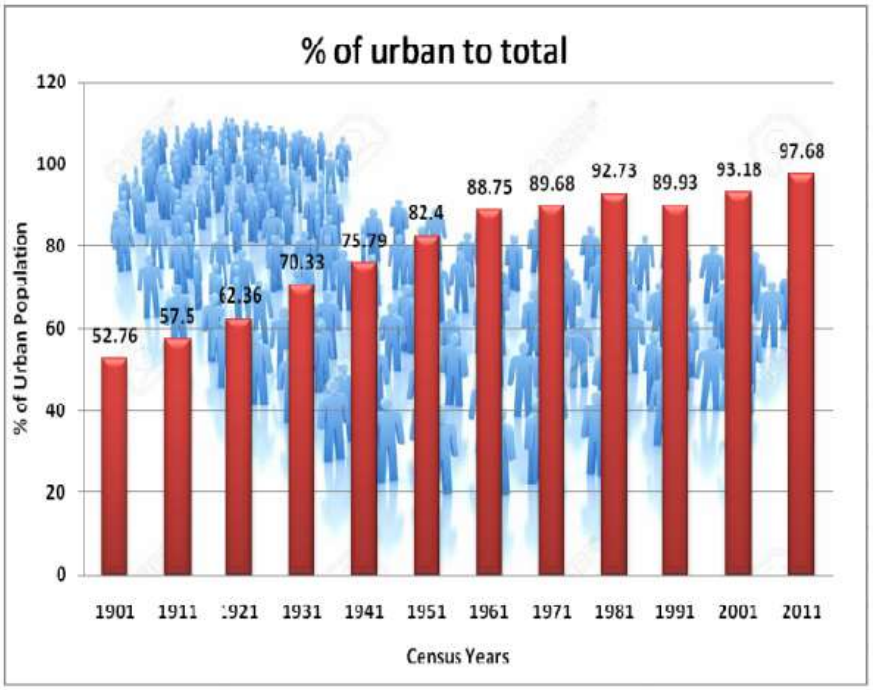


Figure 2:Delhi Urbanization Growth Rate (1901-2011)

2 Heat Waves and Need for Heat Action Plan

2.1 Heat Waves:

As per the National Disaster Management Authority, a Heat Wave is a period of abnormally high temperatures, more than the normal maximum temperature that occurs during the summer season. According to Indian Meteorological Department (IMD), a heatwave condition is when the maximum temperature of a station reaches at least 40°C or more for Plains, 37°C or more for coastal stations and at least 30°C or more for Hilly regions.

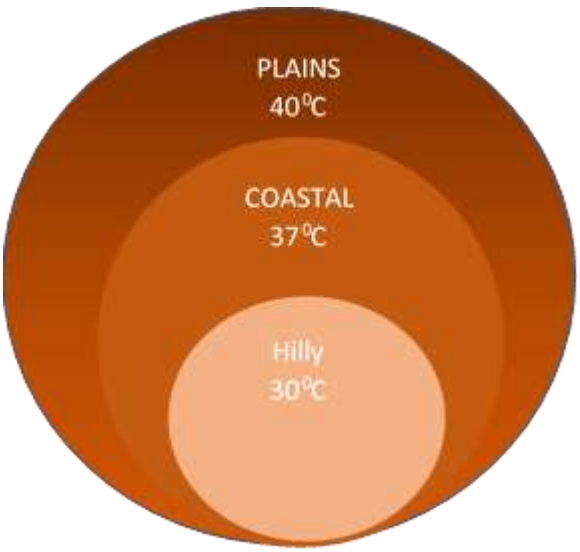


Figure 3: Criteria for Heatwave in Plains. Coastal and Hilly Regions

Green (No Action)	Normal Day	Maximum temperatures are near normal
Yellow(Be updated)	Hot day advisory	>= 40 °C
Orange Alert(Be prepared)	Heat alert day	>= 45°C
Red Alert (Take Action)	Extreme heat alert day	>= 45°C

Table 3: Heat Alert Thresholds for Delhi City (source: NDMA)

Last 50 years have witnessed a hike in the frequency of hot days, nights and heat waves in the world (IPCC, 2014). India has experienced a number of heat wave incidences, since 2006, and average temperature during 2018 was significantly above normal (+.41^{o}C above). The year 2019 was the seventh warmest year on record since nation-wide records commenced in 1901. June and July 2019 have been the hottest month record globally, with National Oceanic and Atmospheric Administration (NOAA) confirming June 2019 being hottest on records, 0.95^{o}C above normal average.

Under 2^{o}C warming scenario, the frequency of heat waves in India is projected to increase by 30 times the current frequency by the end of the century. The duration of heat waves is also expected to increase 92 to 200-fold under 1.5 and 2^{o}C scenarios. Coupled with poverty in South Asia, the impact can be severe. Future projections of temperature indicate a steady increase across the three periods (2030s, 2050s, 2080s), with anomalies reaching 4-5°C for high emission scenarios by 2080. Higher daily peak temperatures of longer duration and more intense heat waves are becoming increasingly frequent globally due to climate change. Extreme temperatures are among the most dangerous natural hazards but rarely received adequate attention.

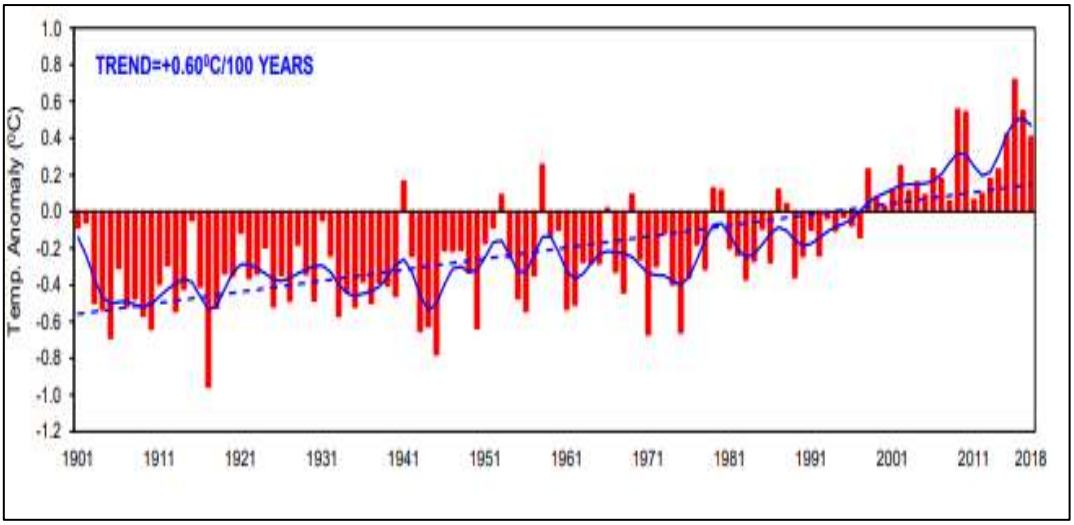


Figure 4: Annual mean land surface air temperatures anomalies 1901- 2018. IMD, 2019

The IPCC AR6 states climate change is already affecting nearly every part of the planet, and human activities are unequivocally the cause. The report indicates that the earth is now around 2.0°F (1.1°C) warmer than in 1850-1900, warming at a rate without precedent in at least 2000 years, possibly longer. This report confirmed that the climate-driven changes occurring around the world are widespread, rapid, and intensifying. The report makes clear that until we reach global net zero emissions of greenhouse gases, we cannot limit warming to any temperature threshold, be it 1.5°C, 2.0°C or 3.0°C.[1]

2.2 Heat Waves in Delhi:

Heatwaves have increased in intensity, frequency and duration, along with the increased temperature and Relative Humidity, the number of Heat Wave days have also increased. For instance, in case of Delhi the number of Heat wave days have increased by 35% from 49 days in 2028 to 66 days in 2019.

[1] https://www.climate.gov/news-features/understanding-climate/release-ipcc-6th-assessment-report-working-group-1

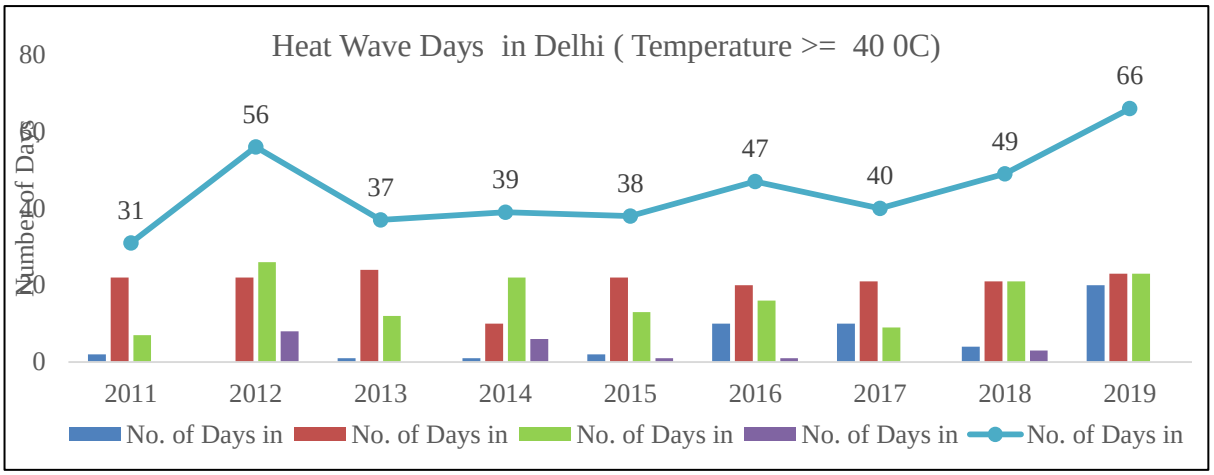


Figure 5:Trend in Heat Wave Days, Delhi (2011- 2019)

- **Highest heat wave days have been recorded in 2012 and 2019**
- **The number of heat wave days have increased from 49 days (2018) to 66 days (2019) in 3 months (April, May, June) – increased by 35%**

2.3 Impacts of Heat Wave:

Heat wave is a "silent disaster" and adversely affects the livelihood and productivity of people. Heat Wave has emerged as a major Health Hazard. WMO predicts Heat Wave related fatalities to double in less than 20 years. Health impacts of heat are more severe in urban areas, where residents are exposed to higher and nocturnally sustained temperatures, due to the Urban Heat Island (UHI) effect (Climate Council of Australia, 2016). Recent Study by Tata Centre of Development, University of Chicago warns that 1.5 million people may die by 2100 due to Extreme Heat due to Climate Change. The baseline death rate due to heat induced climate change in the early 2000s in India was 550 per 100,000 of the population. There has been a 10% increase upon current death rate (Climate Impact Lab, 2019). In 2010 May, the city of Ahmedabad had a major heat wave, registering 1,344 additional deaths in the city with an excess of 800 deaths recorded in the week of 20-27th May.

India has experienced a lot of heat wave incidences, since 2006. 2017 witnessed the 4th consecutive heat wave in India out of which the year 2016 had the deadliest heatwave. Heatwaves in India took a large number of deaths in 4 years (2014-2017). India experienced a loss of 4,500 lives in 4 years' period alone.

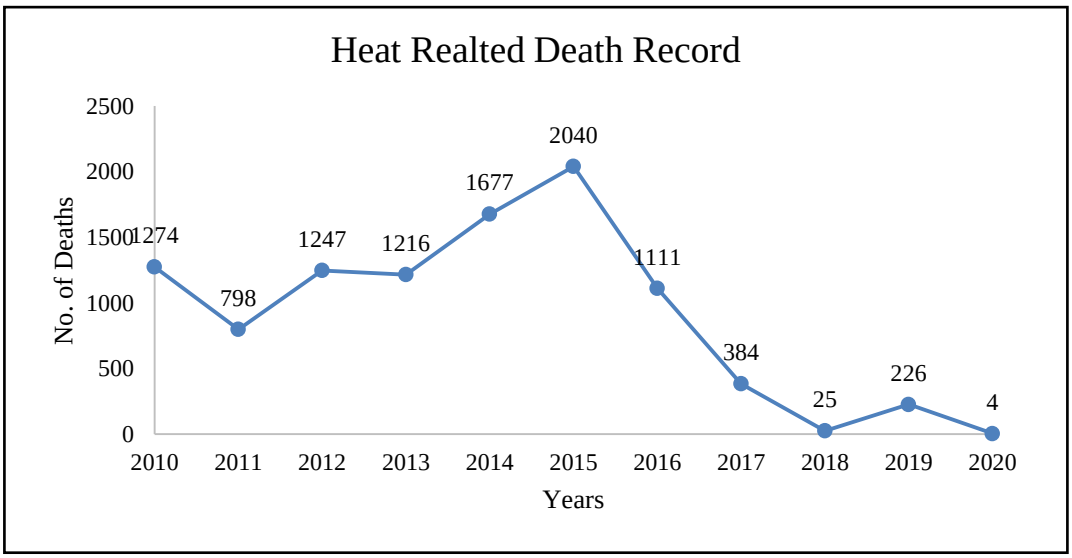


Figure 6: Heat Wave Mortality Records, India (2010- 2020)

The Integrated Disease Surveillance Programme (IDSP) under the National Centre for Disease Control (NCDC) of the Ministry of Health and Family Welfare (MoH&FW) is responsible to collect and record data regarding the heat waves and related mortality and morbidity.

3 Climate Adaptive Heat Action Plan for Delhi:

3.1 Introduction

Integrated Research & Action for Development (IRADe) is preparing a Climate Adaptive Heat Stress Action Plan for the city of Delhi in collaboration with Delhi Municipal Council, Government of NCT and Indian Institute of Public Health (IIPH)-Gandhinagar. The project is supported by International Development Research Centre (IDRC), Govt. of Canada. The Heat Stress Action Plan developed through this initiative will support the city in prioritizing and integrating adaptive resilience within the agenda of climate resilient smart cities.

Climate Adaptive Heat Action Plans

- Provide a framework for implementation, coordination and evaluation of extreme heat response activities in cities.
- Alert those populations at risk of heat-related illness in places where extreme heat conditions prevail.
- Include concerned departments to reduce the impact of heat waves on health as part of preventive management.

3.2 Climate change in Delhi

The study is based on the analysis of daily data of two important climate parameters viz. Temperature and Humidity of Delhi city for the summer season. The summer season covered months of March, April, May and June. Daily maximum temperature (T max) and daily minimum temperature (T min) from year 2001 to year 2017 was collected. The data was further analysed to determine monthly mean values of T Max and T Min. Mean values of T max and mean T Min for the summer season were also determined. The established mean values were further compared with long term climatological mean of T Max and T Min. Observed Climatological mean values established by IMD for the period 1905-2000 were used to compare monthly and seasonal variability of T Max and T Min for the study period of 17 years.

Similarly, daily maximum humidity (RH max) and daily minimum humidity (RH min) for the years 2004-2017 were analysed to assess mean monthly RH Max, RH Min trends for months of April, May, June and July as well as for summer season. These values were further compared against long term climatological mean for corresponding months and the summer season.

Below gives the mean climatological values (based on IMD data from 1905 to 2000) for temperature and relative humidity for the summer months.

Table 4: Climatological Values, Delhi

Month	Tmax (° C)	Tmin (° C)	RH (830) (%)	RH (1730) (%)
March	29.6	15	65	35
April	36	21.5	45.33	23.17
May	39.8	26.2	44.67	26
June	39.4	28.3	55.55	38.67

3.2.1 Variation of Mean Monthly Maximum Temperature (Tmax) for the individual

1. On an average, **maximum departure from climatological mean has been observed for the month of March (1.2 °C) in Delhi**, followed by April (0.5°C), May (0.5°C) and June (0.1°C) during the study period. **This means for Delhi, March is getting heated at relatively faster rate than rest of the summer months.**

2. For March, maximum positive deviation in Tmax from climatological mean was observed in 2010

3. Looking at the trend,it seems the average monthly Tmax value in Delhi has increased for all the summer months, though the increase is relatively more in March.

summer months in Delhi during 2010-18

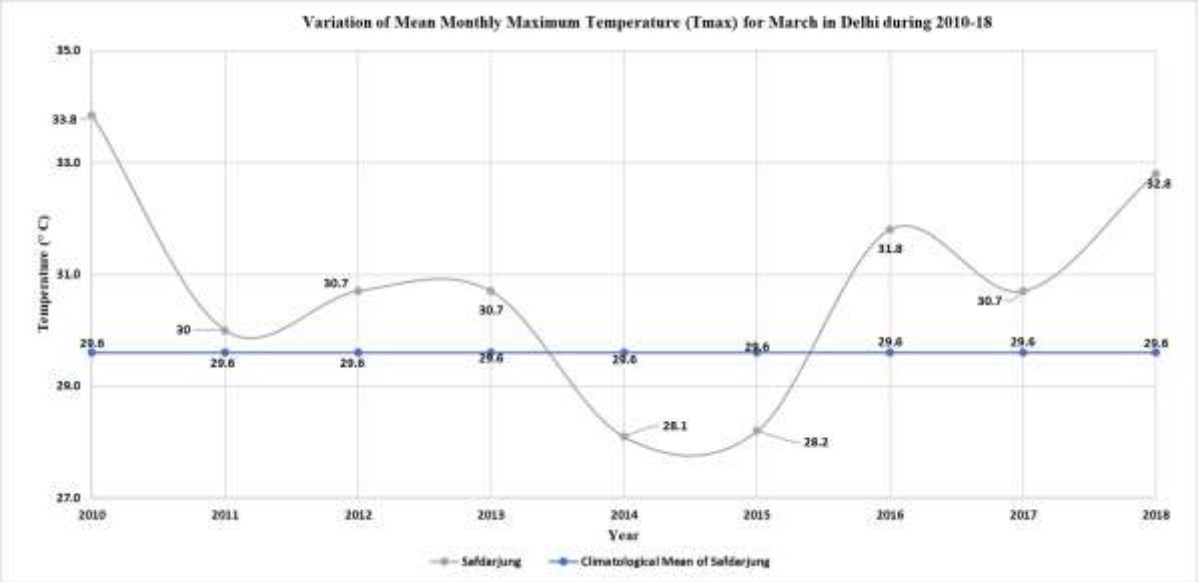


Figure 7: Variation of Tmax for March in Delhi during 2010-18

3.2.2 Variation of Mean Monthly Minimum Temperature (Tmin) for the individual summer months in Delhi during 2010-18

1. As observed for Tmax, **here also the maximum deviation in Tmin value has been observed in the month of March (0.9°C) followed by April (0.43°C)**. Thus, March and April are relatively getting more hotthan other summer months in Delhi.

2. Surprisingly, there was no deviation observed for May, whereas negative deviation observed in case of June (- 0.1 °C).

3. **Maximum deviation was noticed in March, thus March is getting relatively hotter**

4. Maximum positive deviation was noticed in 2010 for March, April and May months and for 2012 for June

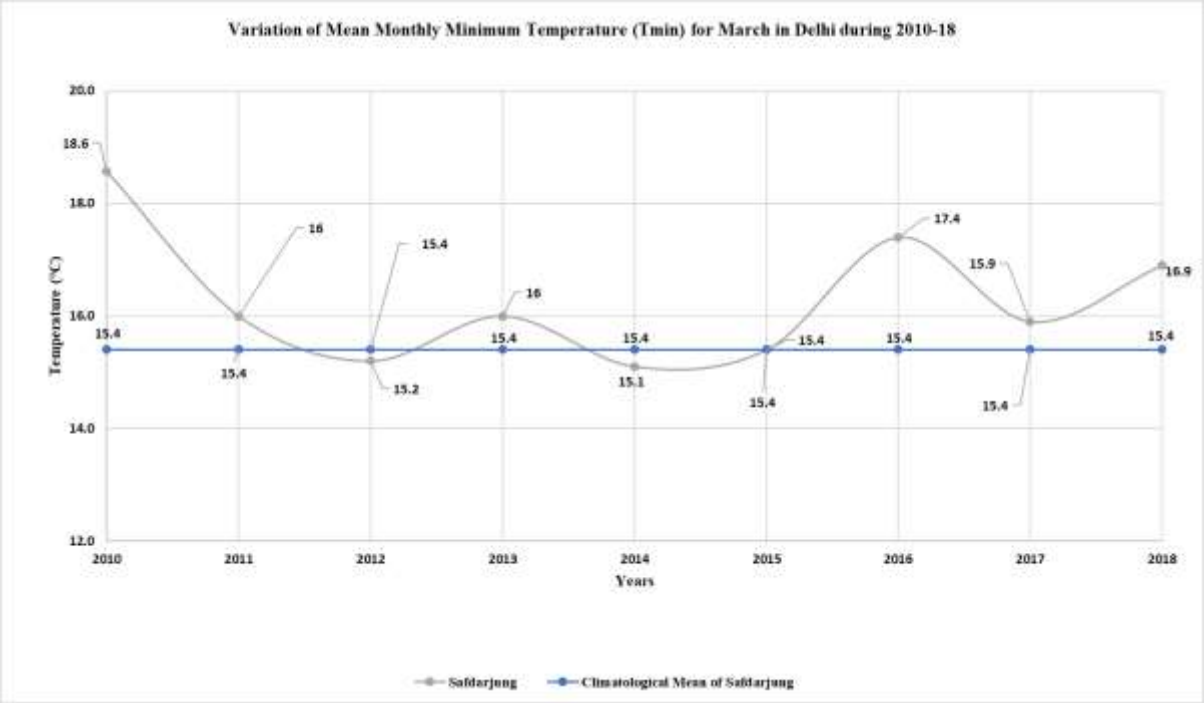


Figure 8: Variation of Tmin for March in Delhi during 2010-18

3.2.3 Variation of Mean Monthly Maximum Temperature (Tmax) for the entire summer period in Delhi during 2010-18

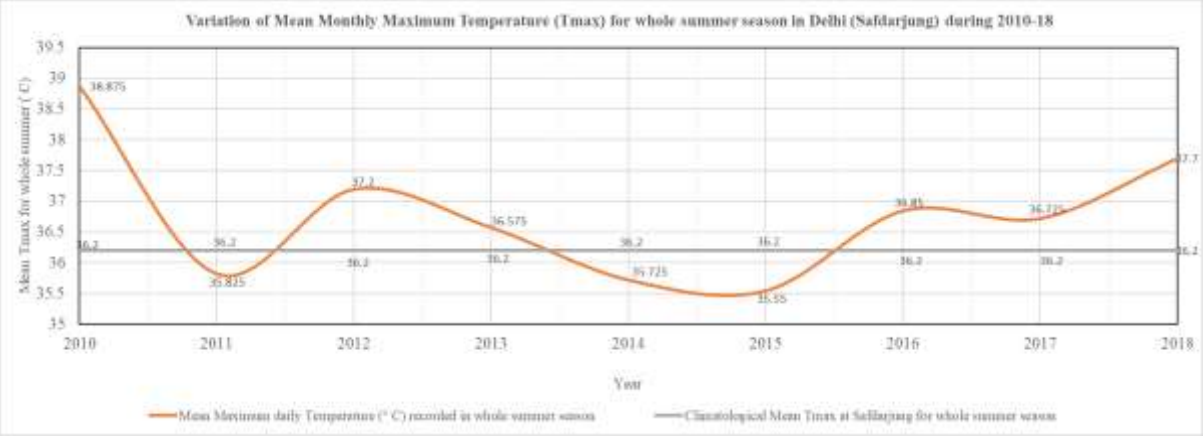


Figure 9: Variation of Tmax for whole summer season in Delhi during 2010-18

1. The mean monthly maximum temperature was observed to be higher than the climatological mean in 2010, 2012, 2013, 2016, 2017 and 2018.
2. **Maximum deviation from climatological mean was observed in 2010, suggesting 2010 to be an unusually warm summer for Delhi.**
3. There was a sharp dip in 2011 followed by rise in 2012. 2013 showed the temperature values approaching closer to the climatological mean.
4. 2014 and 2015 saw the average Tmax for the season declining below the climatological mean values and then an increase was observed during 2016-2018.

3.2.4 Variation of Mean Monthly Minimum Temperature (Tmin) for the entire summer period in Delhi during 2010-18

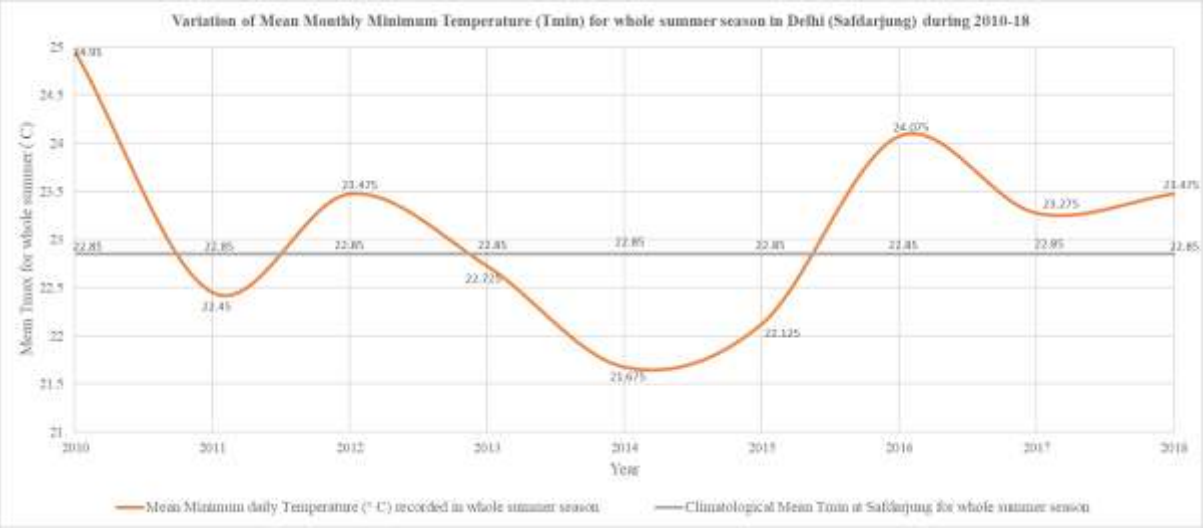


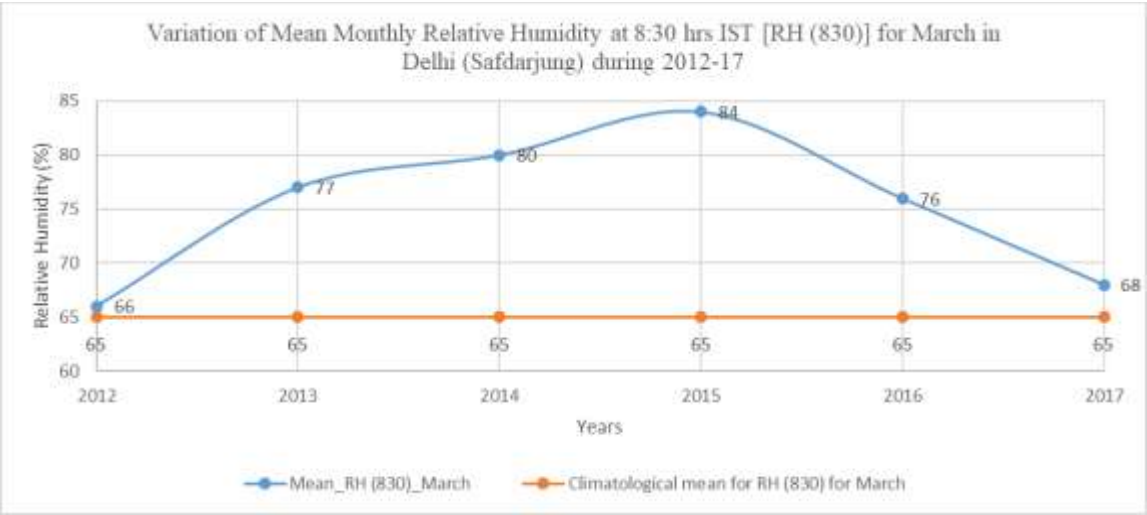
Figure 10: Variation of Tmin for whole summer season in Delhi during 2010-18

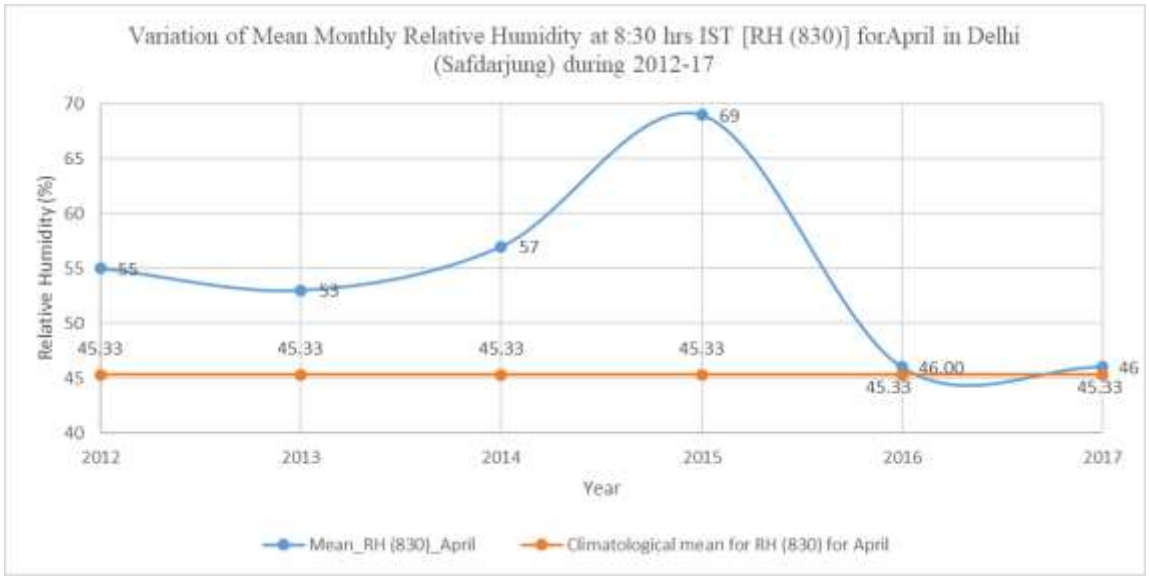
1. The mean monthly minimum temperature also showed undulating behaviour during 2010-18. It was observed to be higher than the climatological mean in 2010, 2012, 2016, 2017 and 2018.
2. **Similar to what was observed for Tmax, maximum deviation from climatological mean was observed in 2010, suggesting 2010 to be an unusually warm summer for Delhi.**
3. There was a sharp dip in 2011 followed by rise in 2012. 2013, 2014 and 2015 showed the temperature values lower than the climatological meanand then an increase was observed during 2016-2018. However, the increase in 2016 was relatively higher than that observed in 2017 and 2018.

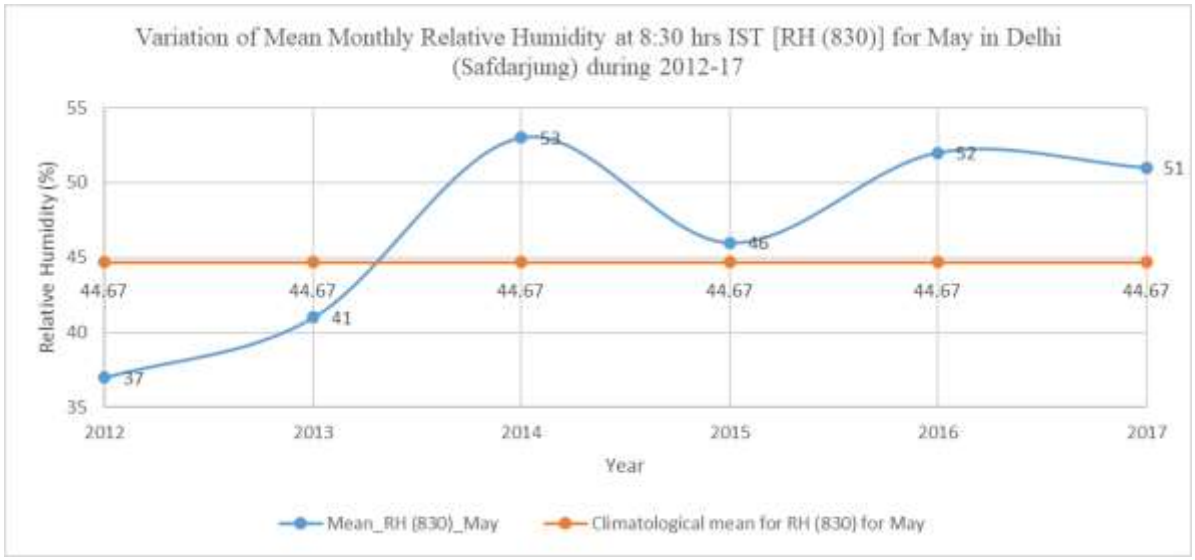
Table 5: Mean monthly Temperature value and Deviation, Delhi, 2010-18

Month (2010-2018)	Climatological Mean value of Tmax (° C)	Average Mean Tmax over a period of 9 years (° C)	Average Deviation (from Climatological Mean value of Tmax (° C)) over a period of 9 years	Climatological Mean value of Tmin (° C)	Average Mean Tmin over a period of 9 years (° C)	Average Deviation (from Climatological Mean Value of Tmin (° C) over a period of 9years
March	29.6	30.8	+1.2	15.4	16.3	+0.9
April	36	36.5	+0.5	21.5	21.93	+0.43
May	39.8	40.3	+0.5	26.2	26.2	0
June	39.4	39.5	0.01	28.3	28.2	-00.1
Tmax- Maximum Temperature, Tmin – Minimum Temperature, Source: IMD						

3.2.5 Variation of Mean Relative Humidity measured in the morning at 8:30 AM [RH (830)] for the individual summer months in Delhi during 2012-17







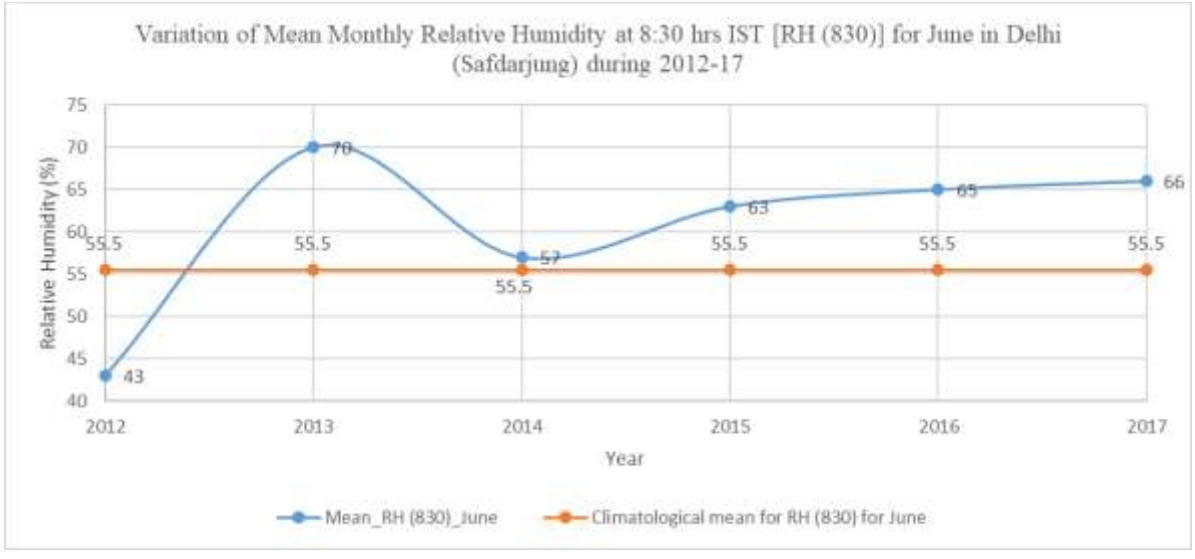
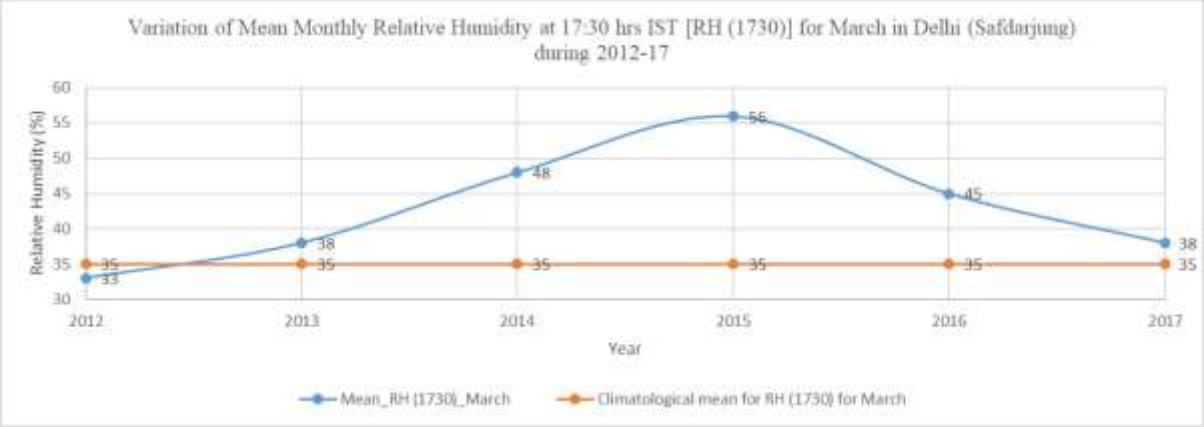
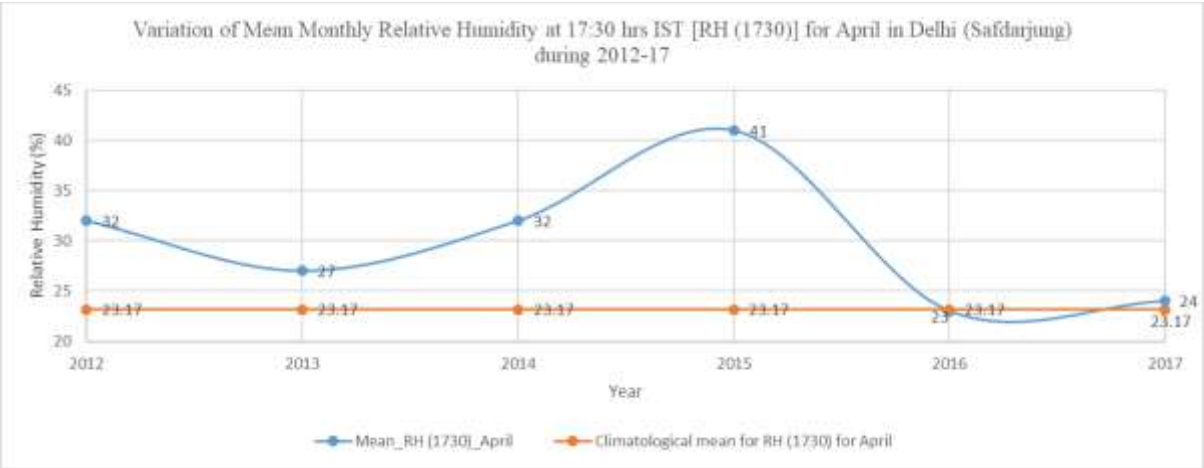


Figure 11: Variation of RH (830) for entire summer season for Delhi during 2012-17

1. Mean monthly relative humidity measured in the morning at 8:30 AM [RH(830)] was found to be higher than the climatological mean for all the years for March. A bell-shaped curve was observed for March with 2015 showing maximum deviation for the month. The deviation increased gradually till 2015 and then tapered down in 2016 and 2017, however still showing values above the climatological mean.
2. For April also, 2015 clocked highest deviation. The deviation after 2015 was found close to climatological mean value.
3. For May, [RH(830)] was higher than climatological mean values for 2014-17, with 2014 showing maximum deviation.
4. For June, except 2012, all the study years showed morning humidity values in excess of climatological mean value.

3.2.6 Variation of Mean Relative Humidity measured in the evening at 17:30 PM [RH (1730)] for the individual summer months in Delhi during 2012-17





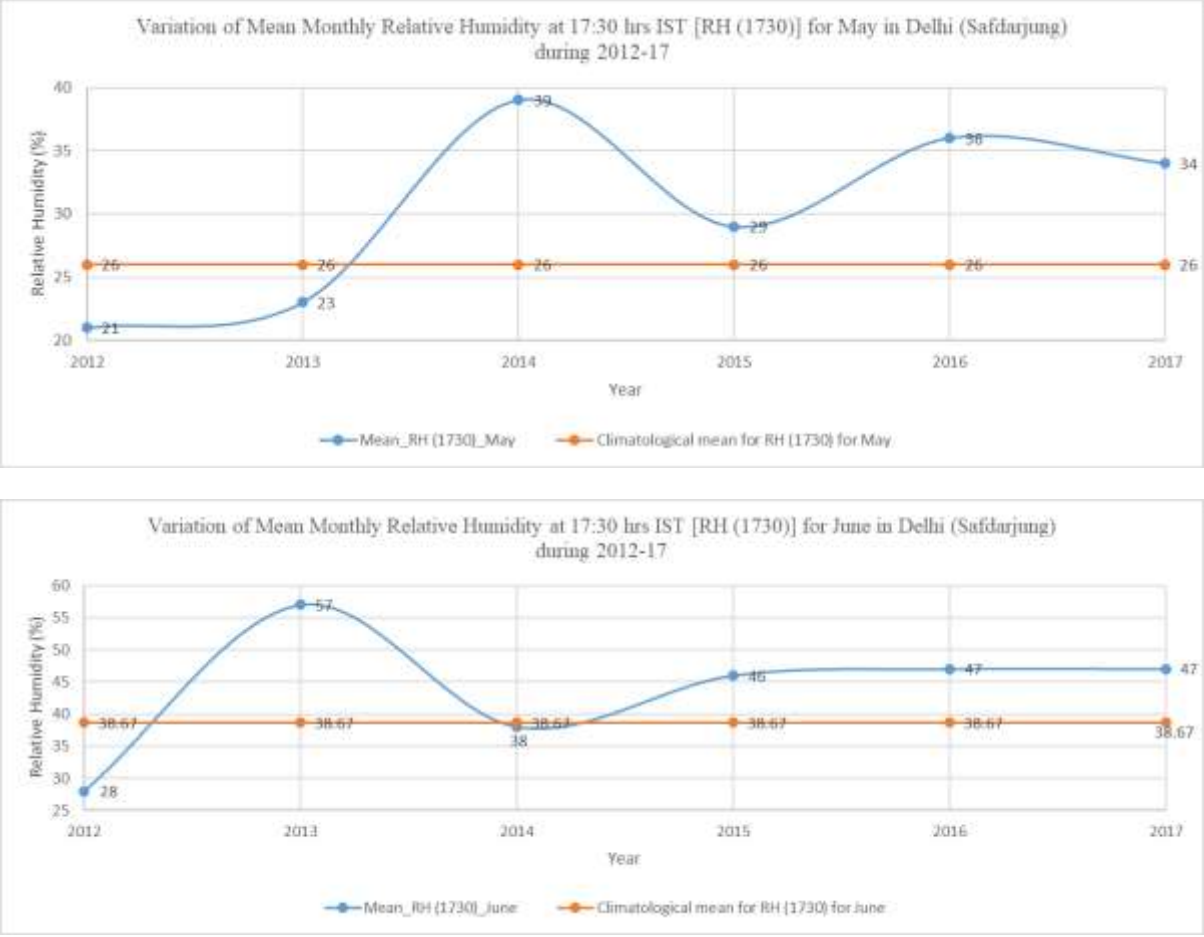


Figure 12: Variation of RH (1730) at Delhi (Safdarjung) in March, April, May and June months during 2012-17

1. Mean monthly relative humidity measured in the evening at 17:30 PM [RH(1730)] was found to be higher than the climatological mean for all the years for March except 2012. A bell-shaped curve was observed for March with 2015 showing maximum deviation for the month. The deviation increased gradually till 2015 and then tapered down in 2016 and 2017, however still showing values above the climatological mean. This behaviour is pretty similar to that observed for RH (830).
2. For April also, 2015 clocked highest deviation. The deviation after 2015 was found close to climatological mean value.
3. For May, [RH(1730)] was higher than climatological mean values for 2014-17, with 2014 showing maximum deviation.
4. For June, except 2012, all the study years showed evening humidity values in excess of climatological mean value.

3.2.7 Variation of Mean Relative Humidity measured in the morning at 8:30 HRS [RH (830)] for the entire summer season in Delhi during 2012-17

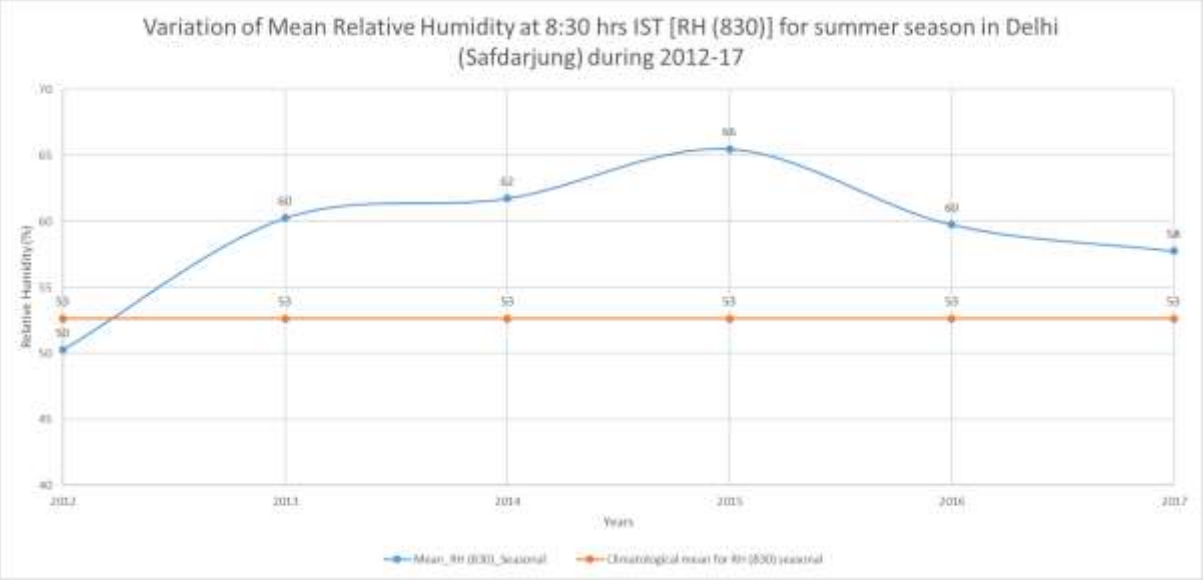


Figure 13: Variation of RH (830) for entire summer season for Delhi during 2012-17

1. As can be observed from the above graph, except 2012, RH measured at 8:30 HRS in the morning [RH(830)] has recorded higher values compared to the climatological mean value, consistently during 2013-2017.
2. It showed a consistent increase during 2013-2015 and then consistent decrease in 2016 and 2017.
3. Maximum deviation from the climatological mean was noticed in 2015.

3.2.8 Variation of Mean Relative Humidity measured in the evening at 17:30 HRS (RH-II) for entire summer season in Delhi during 2012-17

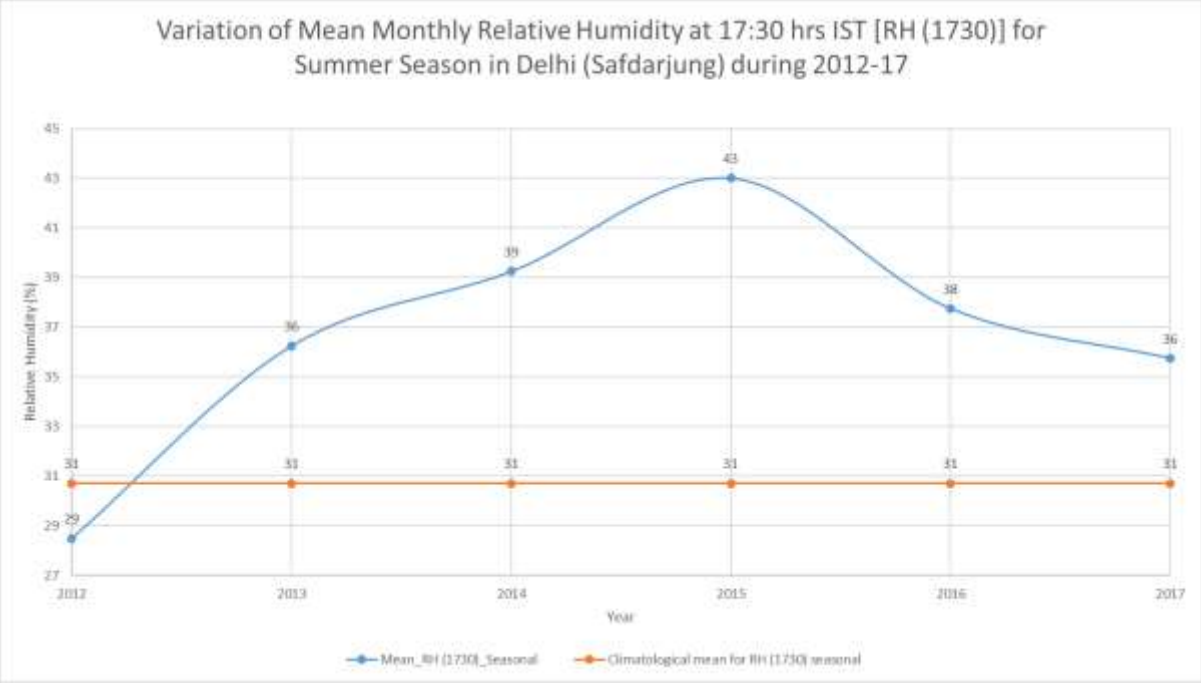


Figure 14: Variation of RH (1730) for entire summer season for Delhi during 2012-17

1. The trend for evening humidity in Delhi during 2012-2017 is fairly similar to what has been observed for the morning humidity. RH (1730) values were recorded higher than the seasonal climatological mean during 2013-2017.
2. 2015 showed maximum deviation from the seasonal climatological mean.
3. There is an increase consistently observed in RH (1730) values during 2013-15 and then a decrease consistently observed in 2016 and 2017.

Table 6: Mean monthly Relative Humidity value and Deviation, Delhi, 2012-17

Month (2012-2017)	Climatological Mean Value of RH (830) (%)	Average Mean RH (830) (%) over a period of 6 years	Average Deviation (from Climatological Mean RH (830) (%)) over a period of 6 years	Climatological Mean Value of RH (1730) (%)	Average Mean RH (1730) (%) over a period of 6 years	Average Deviation (from Climatological Mean RH (1730) (%)) over a period of 6 years
March	65	75.17	+10.17	35	43	+8
April	45.33	54.33	+9.00	23.17	29.83	+6.66
May	44.67	46.67	+2.00	26	30.33	+4.33
June	55.5	60.67	+5.17	38.67	43.83	+5.16
RH – Relative Humidity **Source: IMD**						

There is clear evidence of the month of March getting hotter than rest of summer months for maximum temperature as well as minimum temperature which indicates that summer season is arriving early and would lead to higher number of heat stress days in Delhi. Also, there has been increase in RH for the summer season which is likely to increase the wet bulb temperatures which can lead to high heat stress in Delhi.

3.3 Thermal Hotspot Maps for Delhi

The surface temperature maps of the city are developed using LANDSAT 8 satellite data and superimposed on the ward-boundaries map of the city to develop the city hot spot area. Wards with temperature above 42 degrees Celsius were delineated across the city.

Land Surface Temperature (LST) maps were prepared for 30 May 2019 (the day when Delhi recorded a maximum air temperature of 48 °C), and spatial variability of LST in different municipal zones of Delhi was analyzed. The zones Narela and Najafgarh recorded a maximum LST of 60.48 °C and 59.06 °C.

The LST Maps indicate higher temperatures recording across the wards Harkesh Nagar 092s, Harkesh Nagar 092s, Khyala 008s, Wazir Pur 072n, Bijwasan 048s, Vishwas Nagar 017e, Hari Nagar A 010s, Jahangir Puri 021n, Delhi Gate 088n, Shastri Park 025e

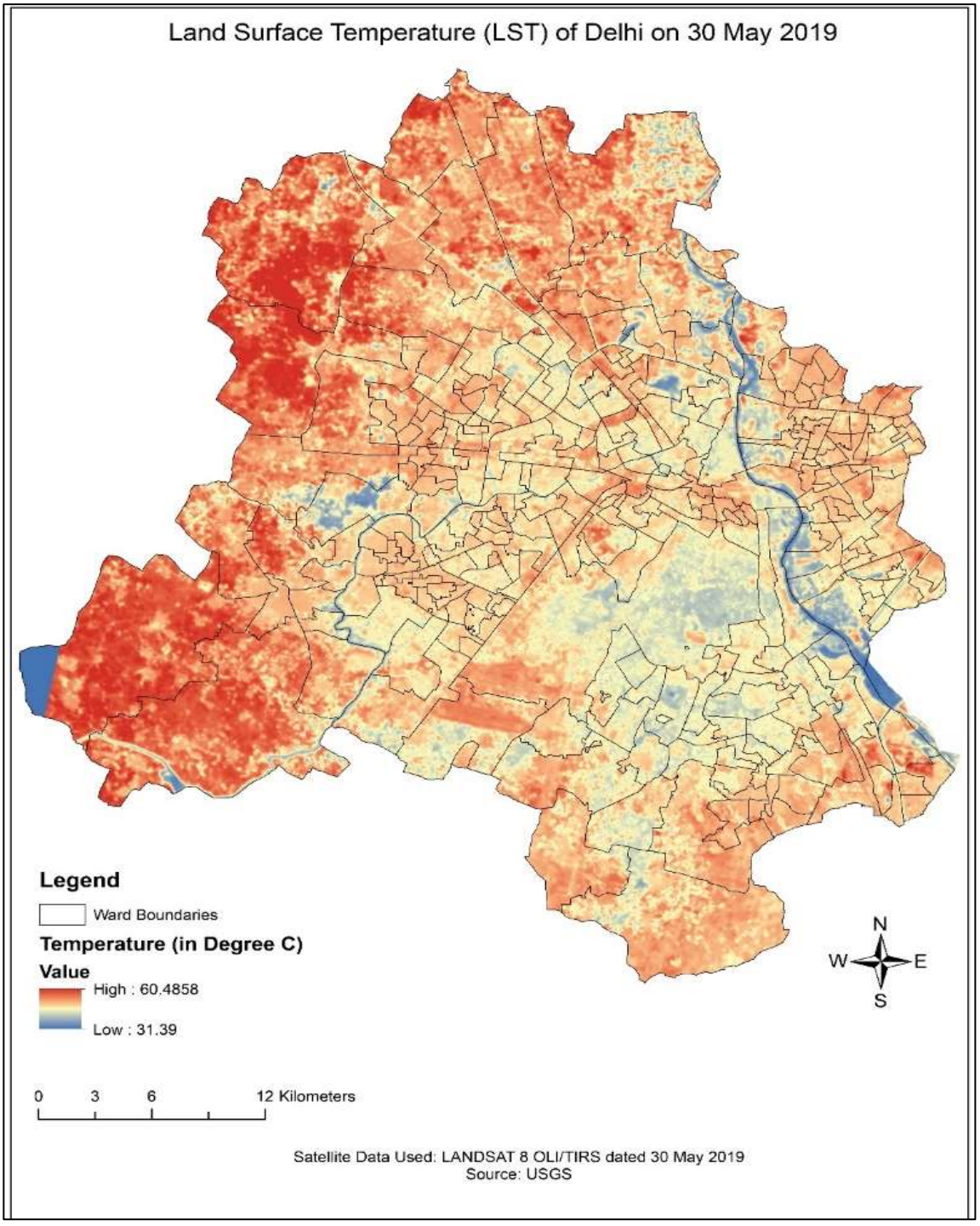


Figure 15: Thermal Hot Spot Map, Delhi, 2019

3.4 Identification of Ward- level vulnerability- Delhi

Heat stress vulnerability across the above identified wards in hot spot areas of Delhi were analysed using the comprehensive index, comprising of nine sectors - ***Sanitation, Water, Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms*** and their respective sub sectors. The total 10 hotspots are identified in Delhi which includes overlap of vulnerable areas with vulnerable section. The cumulative ward wise heat stress vulnerability analysis indicated that nearly 6 wards in Delhi are highly vulnerable and minimum basic amenities available to the vulnerable group to cope with heat stress.

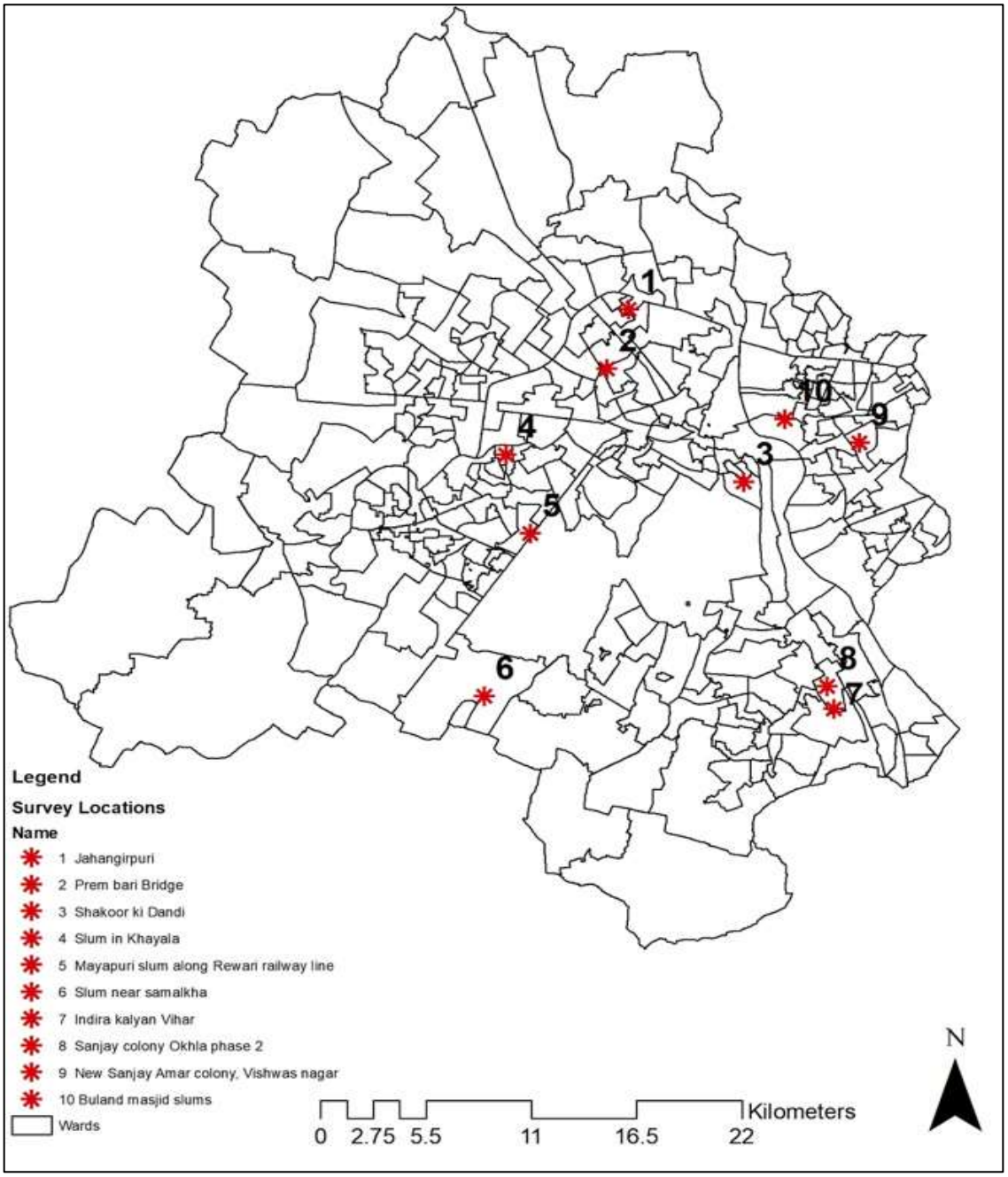


Figure 16: Survey Hotspots, Delhi

Table 7: Survey Hotspots, Delhi

Delhi	
New Ward No	**Ward Name**
Harkesh Nagar 092S	Indira kalyan Vihar
Harkesh Nagar 092S	Sanjay colony Okhla phase 2
Khyala 008S	Slum in Khayala
Wazir Pur 072N	Prem bari Bridge
Bijwasan 048S	Slum near Samalkha
Vishwas Nagar 017E	New Sanjay Amar colony, Vishwas nagar
Harinagar A 010S	Mayapuri slum along Rewari railway line
Jahangirpuri 021N	Jahangirpuri
Delhi Gate 088N	Shakoor ki Dandi
Shastri Park 025E	Buland masjid slums

3.5 Ward- level vulnerability:

Heat stress vulnerability across the above identified wards in hot spot areas of Delhi were analysed using the comprehensive index, comprising of nine sectors - **Sanitation, Water, Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms** and their respective sub sectors.

Table 8: Survey Sectors

S.No.	SECTORS	SUB—SECTORS
1	**Sanitation**	Type of Toilet
		Individual Toilets
2	**Water**	Water Source
		Water Source Location
		Water Collection Time
		Frequency Water Supply
3	**Electricity**	Electricity Cut-off
4	**Health**	Access to Health Infra- Public/ Private/ Both
		Distance to Hospital
		Health Insurance
5	**Transportation**	Mode of Transport
6	**Housing**	Years of Occupancy
		Number of Rooms
		Type of House
		Floor Type
		Roof Type
		Wall Type
		Number of Windows
		Wall Colour
7	**Cooking**	Cooking Place
		Cooking Fuel
8	**Awareness**	Heat Stress Awareness
		Awareness about use of Medical facilities for heat
		Awareness about availability of Medical measures in ULB
9	**Heat Stress Symptoms**	Heat Exhaustion

		Heat Stroke

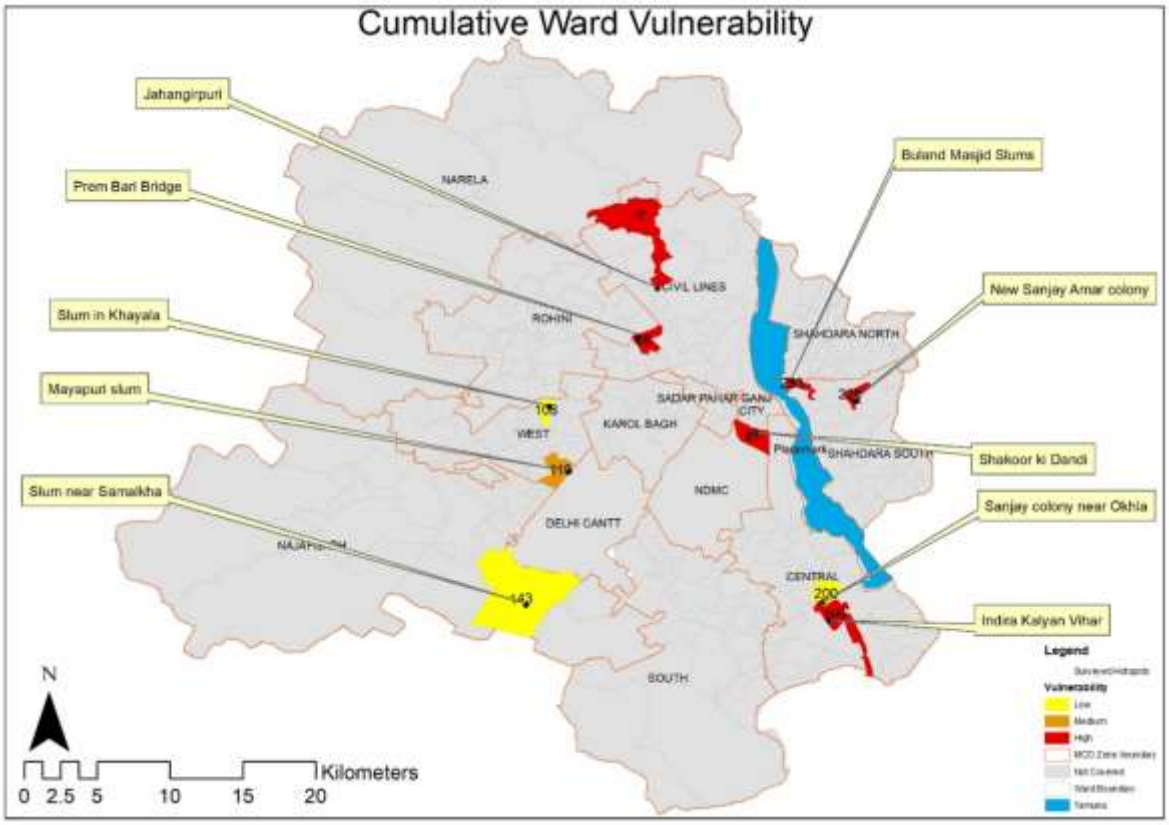


Figure 17:Cumulative Ward-level Vulnerability to Heat Stress, Delhi

Table 9: Ward-level Vulnerability to Heat Stress, Delhi

Vulnerable wards	Wards Number (Out of 10 Thermal Hotspots)	Total
Medium	(110)	**1**
High	(5, 81, 88, 199, 226, 233)	**6**

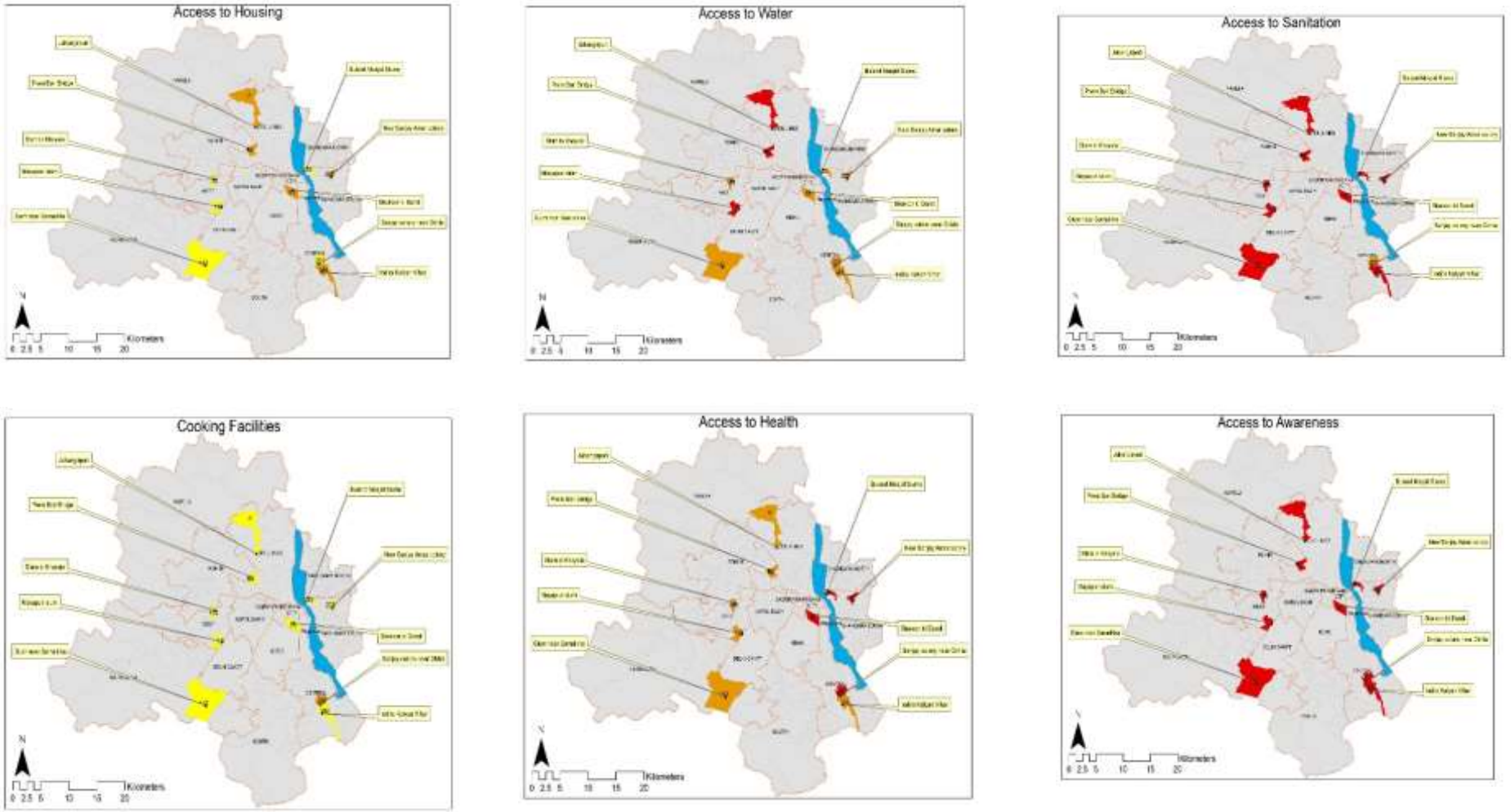


Figure 18: Sector wise ward level Vulnerability to Heat Stress, Delhi

3.6 Wage and Productivity Loss due to Heat Stress

Due to the rise of heat stress, its impact reflected on the wage and productivity loss amongst the working population, especially in vulnerable sections of the society.

3.6.1 Wage Loss:

3.6.1.1 Average Wage Loss:

The average wage loss in the city falls under the category INR 1 to 999. The survey shows that the majority of casual workers fall in class 1 to 999.

3.6.1.2 Gender Wise Wage Loss:

The survey shows that the majority of males (90% out of the total) experienced wage loss due to heat as compared to the women involved in work. Both males and females experience wage loss in the category INR 1 to 999. The average monthly wage loss in females in INR 20 while in males is INR 120.

3.6.1.3 Occupation wise Wage Loss:

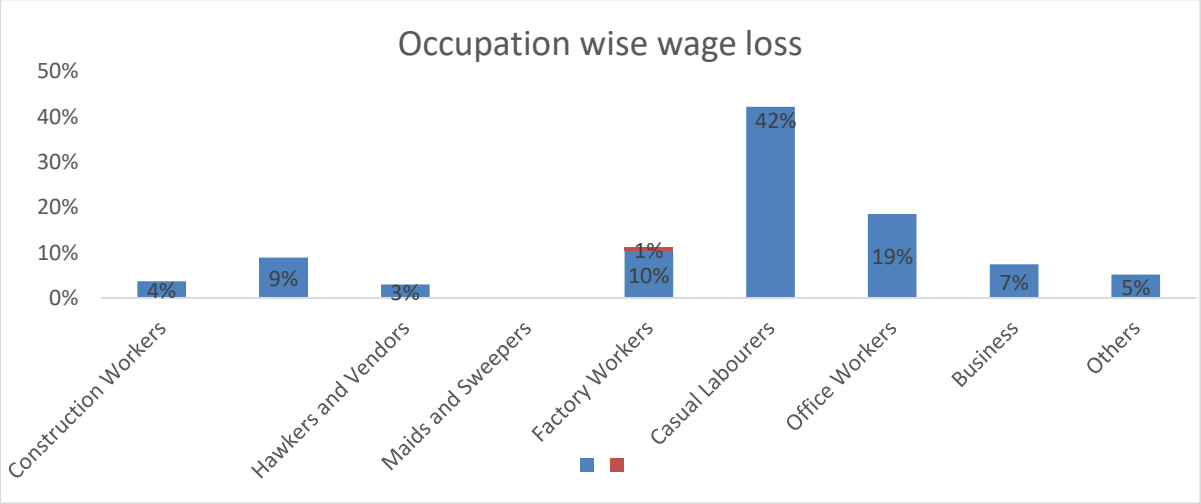


Figure 19: Occupation-wise Wage Loss

The casual labourers are most affected by the high heat days, as the maximum wage loss is reported in the daily causal labourers (42%). It is due to the high share of involvement and a low percentage of income, which is followed by the office workers experiencing heat exhaustion during high temperatures. Hawkers and Maids are least affected amongst the identified occupations

3.6.2 Productivity Loss:

3.6.2.1 Average Productivity Loss

Figure 20: Average Productivity Loss

With the loss in wages, the productivity of the individuals is also positively affected. The majority (91%) of the working population had reported the failure in the working days by 1 to 5 days during the heat stress period, followed by 10 to 15 days (21%) in a month.

3.6.2.2 Gender Productivity Wage Loss

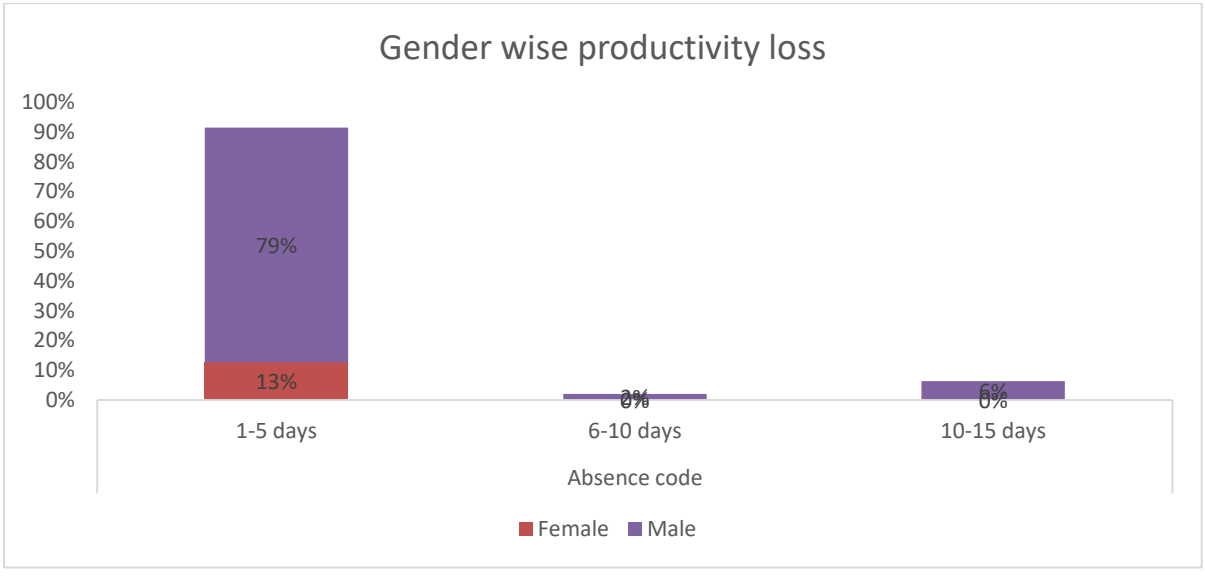


Figure 21: Gender-wise productivity Loss

Similar to wage loss, the males (64%) are at a more significant loss as compared to females. The majority of males and females experience productivity loss in 1 to 5 days. The average days lost due to high temperature is ½ a day for males, while for women, it is 04 hours in a month.

3.6.2.3 Occupation Productivity Wage Loss

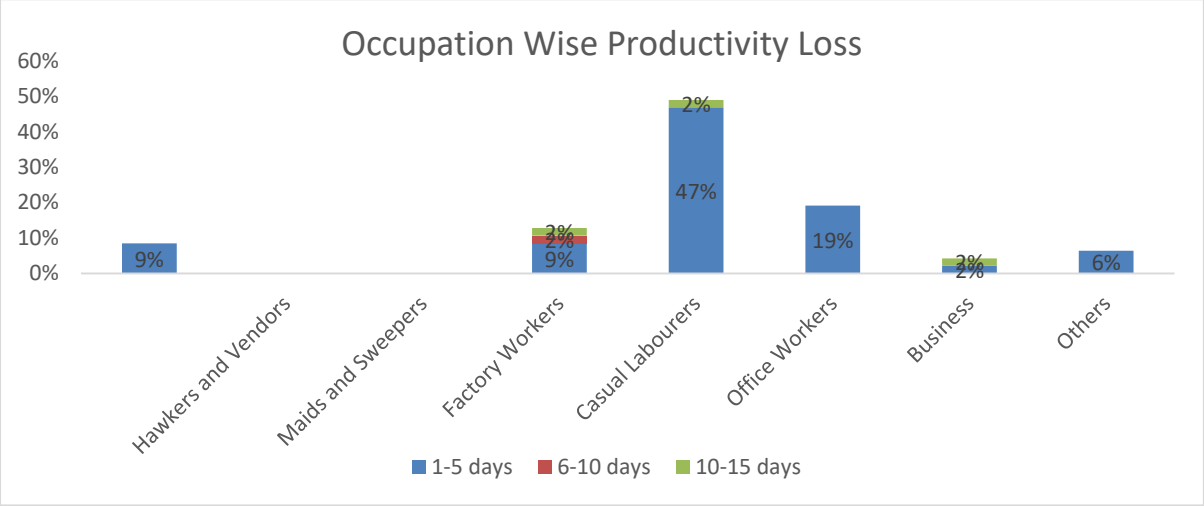


Figure 22: Occupation-wise Wage Lass

Casual labourers are most affected at the time of high-temperature days, as the maximum productivity loss is reported in the casual labourers (49%), followed by the office workers (19%). Prolonged working hours, not suitable working conditions, and lack of sensitization are some reasons behind the loss. The survey shows that hawkers and maids are least affected amongst the identified occupations.

3.7 Gender-sensitive impact of heat stress

Women and men experience thermal stress differently and gender inequalities affect women's ability to adapt. Studies on gender inequality indicate that women are more likely to suffer the various effects of climate change. Their lack of awareness of adaptation and mitigation measures and exclusion in adaptation decision-making behaviour are mutually reinforcing that increases their exposure and vulnerability.

Given lower thresholds of physical endurance and generally poor nutritional status apart from the biological factors, it is critical to know the health effects of heat stress or thermal stress among women, especially socially and economically marginalised, to draw any adaptive intervention or policy formulation to ensure their well-being and economic productivity

The study showed broad-based heat distress among the poor working women at a subsistence level of employment. Most of them reported suffering from heat exhaustion, heat rash, dehydration, fatigue and not being able to seek medical advice to avoid spending on medical consultation and medicines. Dehydration was reported by women with poor access to drinking water at the workplace.

The study done by IRADe suggests a higher vulnerability to heat stress for urban poor women with inadequate access to resources and information and control over the available resources. Heat stress vulnerability of pregnant women can even be higher.


TAILORS
Mc DOWELL'S

4 Mapping of Heat Hotspots

The thermal hot-spot maps give insight into the differences in hot spot distribution within cities. Identifying hot spots within a city can help focus interventions where they are most needed during heat waves.

We consider 'hot-spots' as the areas within the city which experience ambient temperature in excess of the average monthly maximum temperature.

Such thermal maps provide information about the areas which have the accumulation of hotspots, and therefore population living there is under high physiological and socio-economic risks due to thermal stress. Thus, specific measures to curb the problem of heat stress for the resident population can be taken using these maps.

The hotspot maps so generated are useful for policymakers and city administrators in analysing the local factors contributing to heat-stress in different wards and devising mitigation options to reduce heat stress in these areas.

4.1 Ward level Thermal Heat Spots

To assess spatial distribution of heat stress at ward level in Delhi, we followed an approach when we first mapped thermal heat spots through remote sensing using LST images. Thermal hotspots maps were developed using Landsat 8 data.

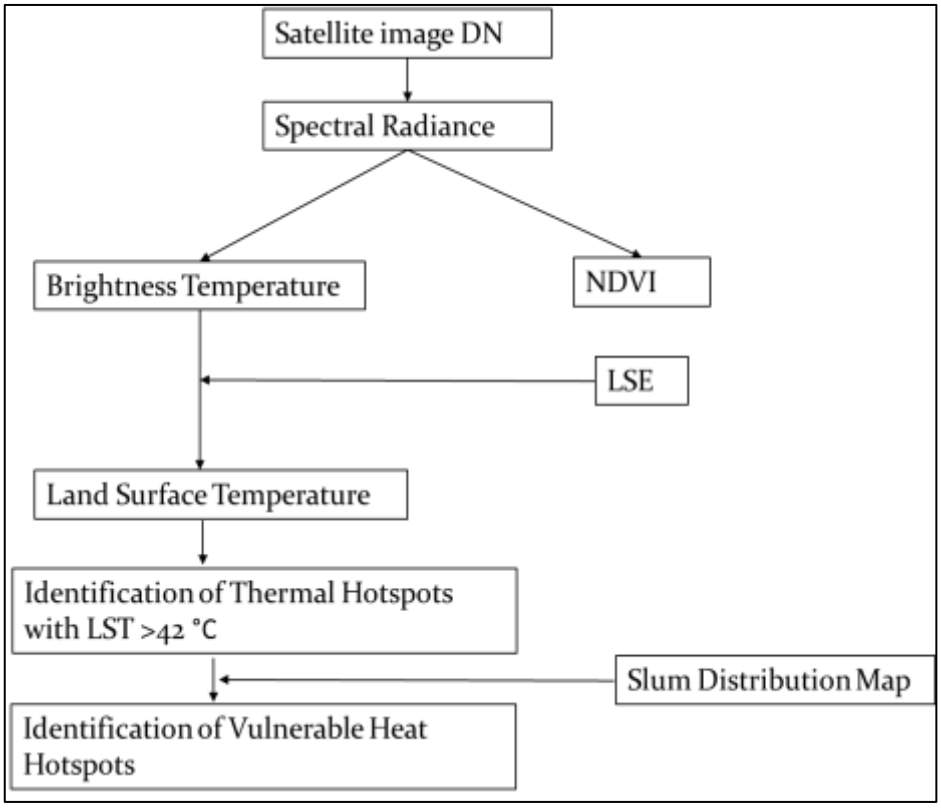


Figure 23: Thermal Hotspot Mapping Methodology

The LST derived from satellite data (NDVI – Normalised Difference Vegetation Index and LSE – Land Surface Emissivity) was validated with ambient air temperature recorded by IMD station within the city. Landsat 8 provided a range of open-source data at a spatial resolution of 30 m. Landsat 8 data was used for retrieval of LST. Data of April and May months of the years 2017, 2018 and 2019 were employed to map LST. For 2017, data of 06 April , for 2018 27th May and for 2019 30th may imageries were used, as these dates provided images without any cloud cover. Hence clear images were derived on the particular dates. Shapefile of Delhi municipal wards and slum distribution data was also obtained. LANDSAT data captures the Land surface at 10:30 AM (IST) in the morning. The methodology flow chart is shown in figure below.

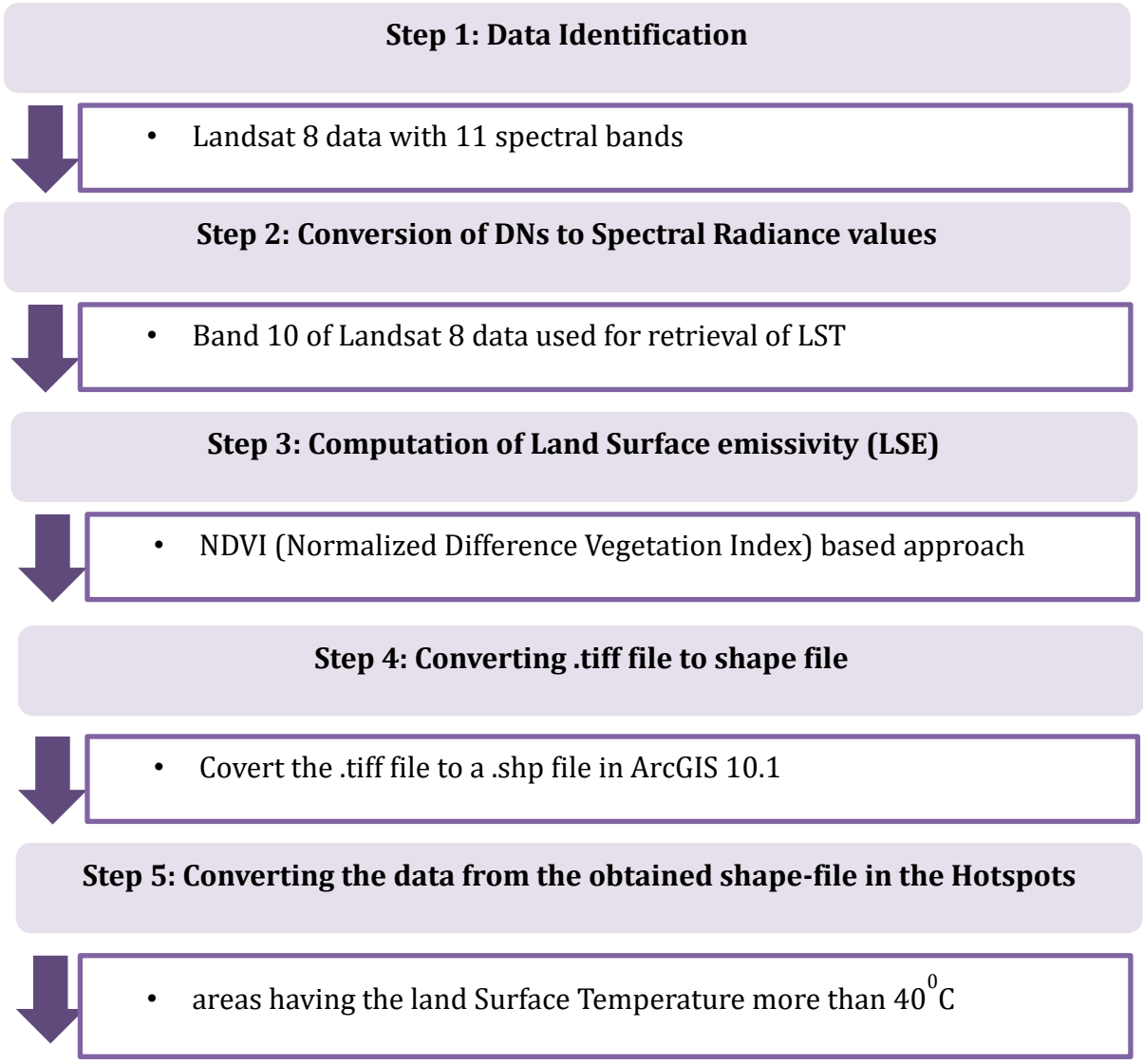


Figure 24: GIS Methodology for identification of vulnerable heat hotspots

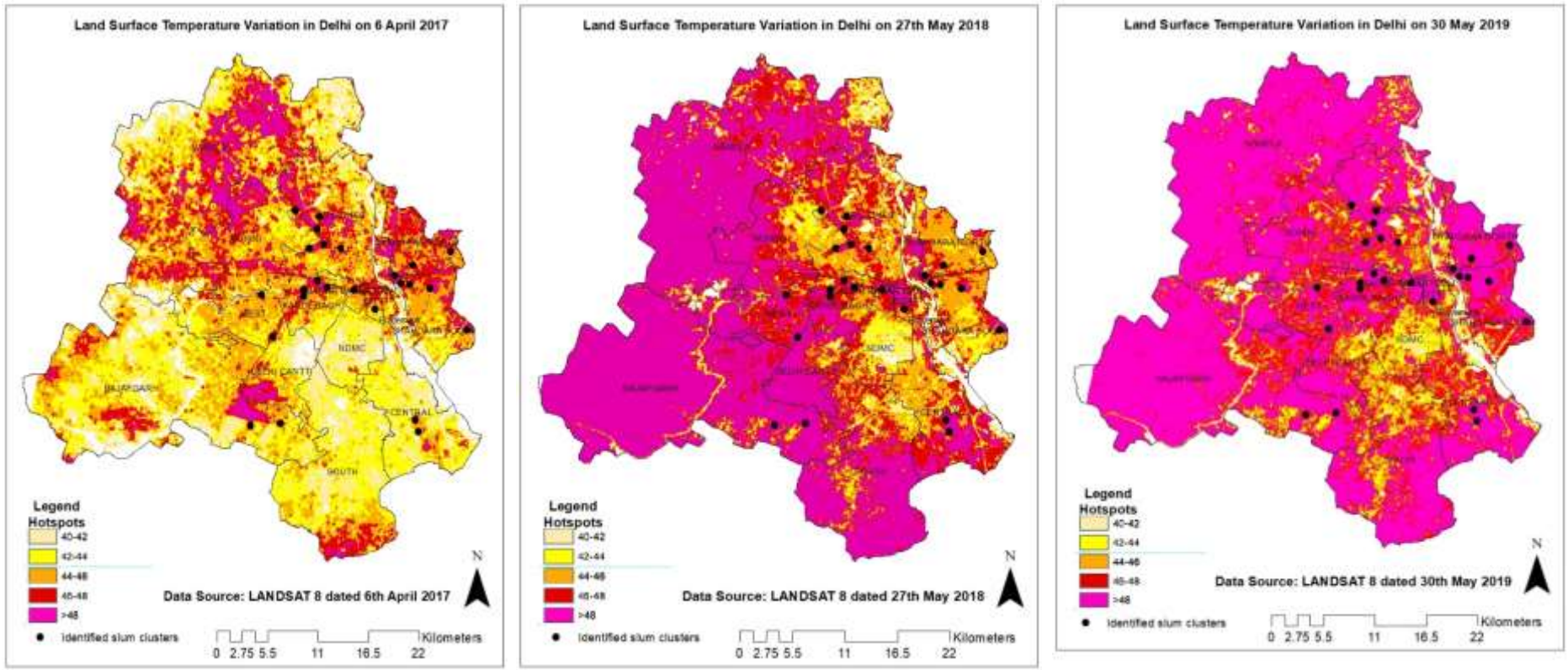


Figure 25: Thermal Hotspots, Delhi (2017, 2018, 2019)

4.1.1 Delineation of Hotspots

To delineate the hotspots, the percentile method was adopted. In this approach, first the areas experiencing temperature above 95% of highest LST observed on a particular date were extracted. These areas represent the thermal hotspots at temperatures in excess of 95% of highest LST measured on the particular date.

Extraction of hotspots based on percentile of highest temperature observed in the LST map. For each LST map, areas experiencing LST more than 95%, 90%, 85% of the highest LST range were extracted.

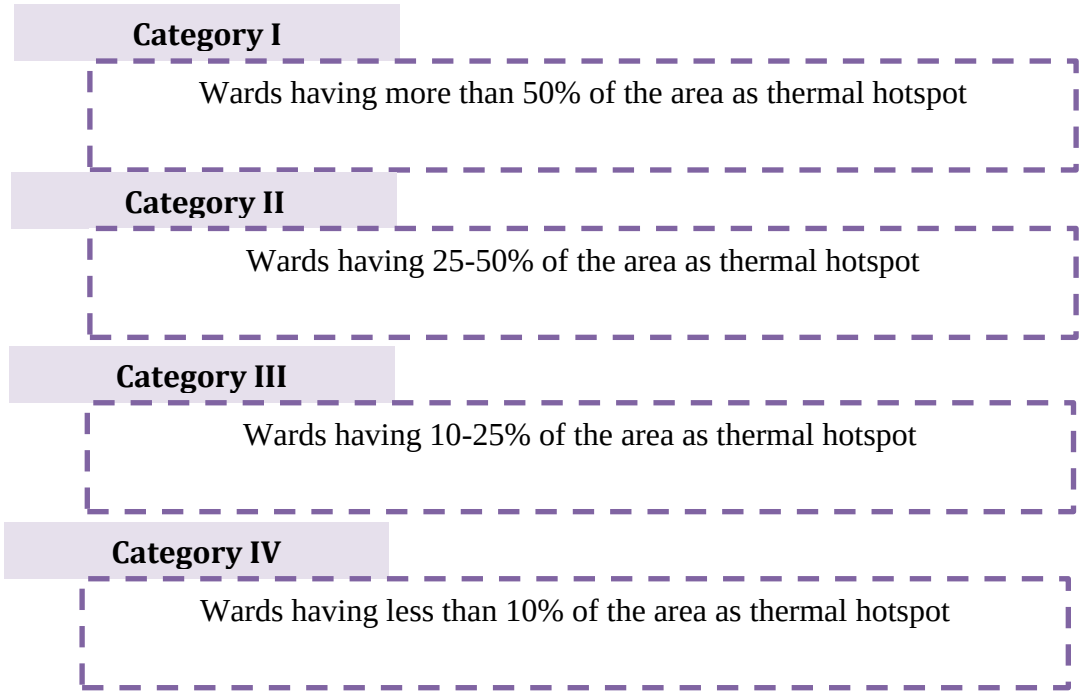
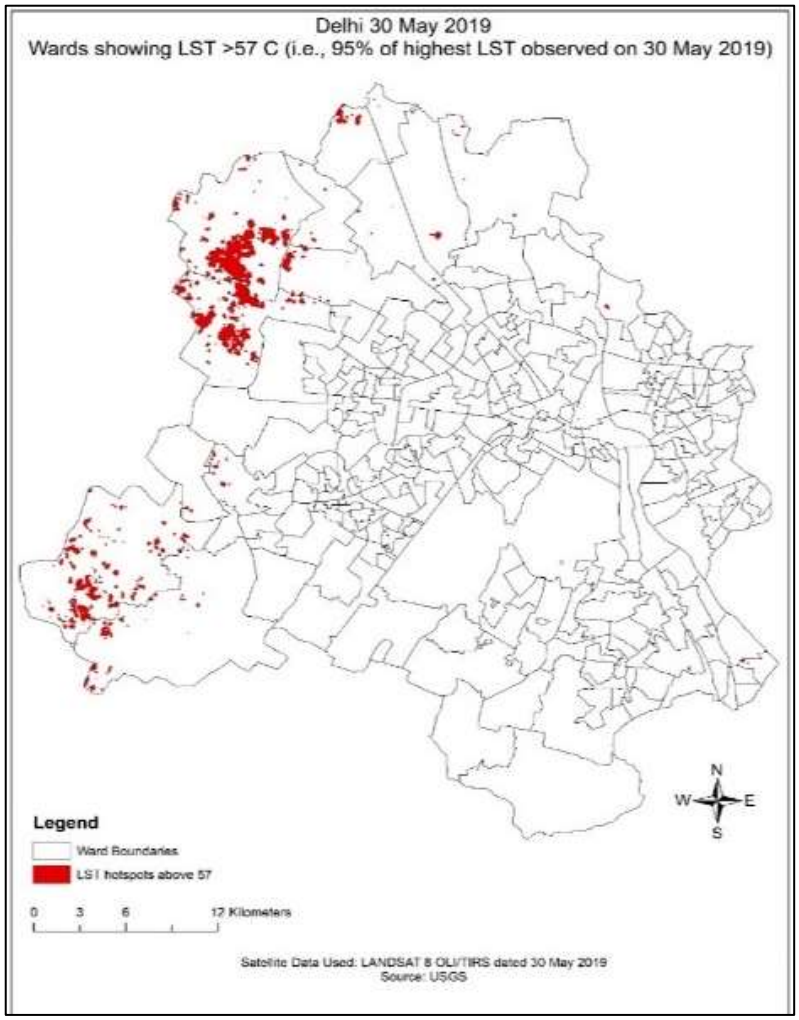
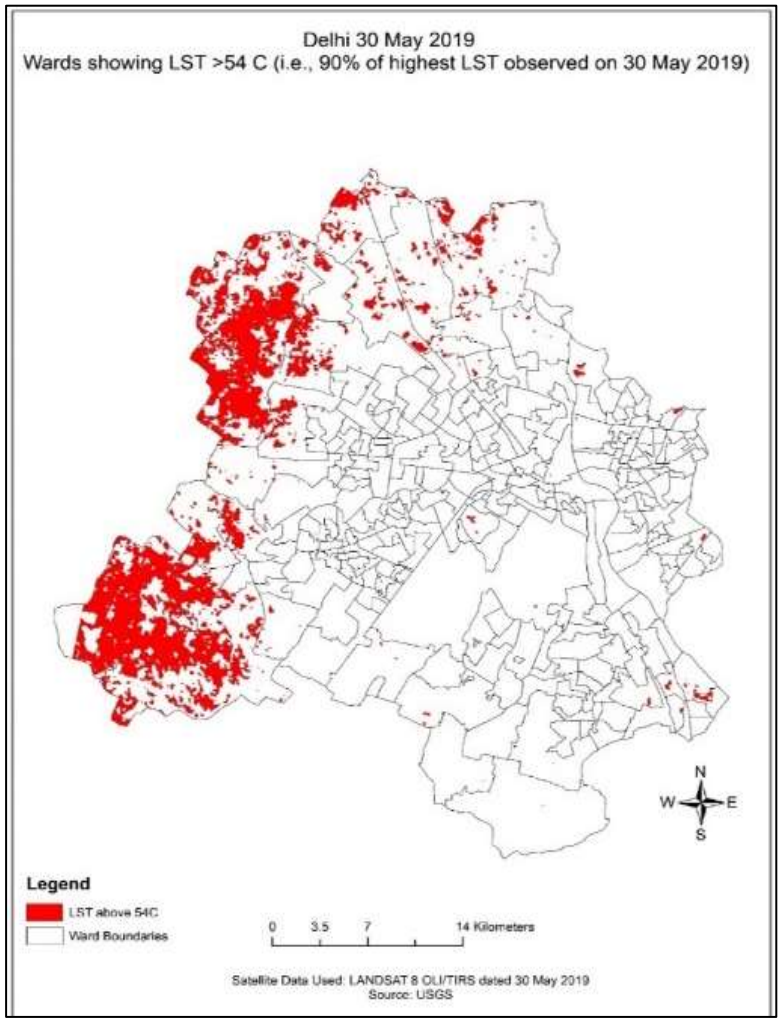


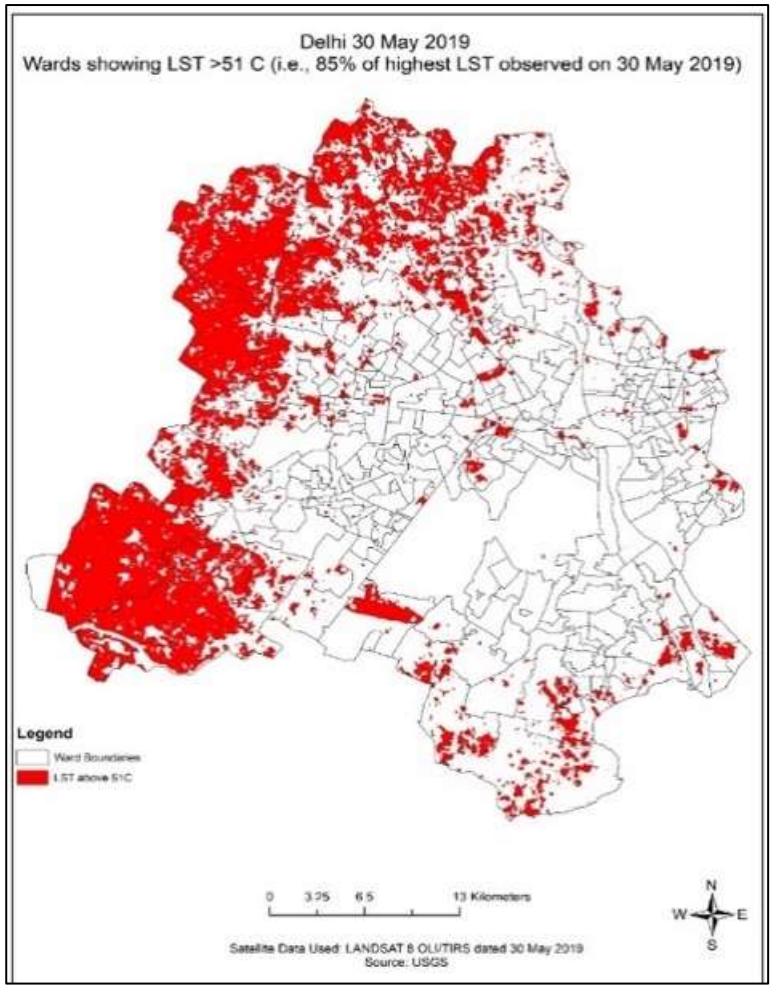
Figure 26: Hotspot Delineation methodology





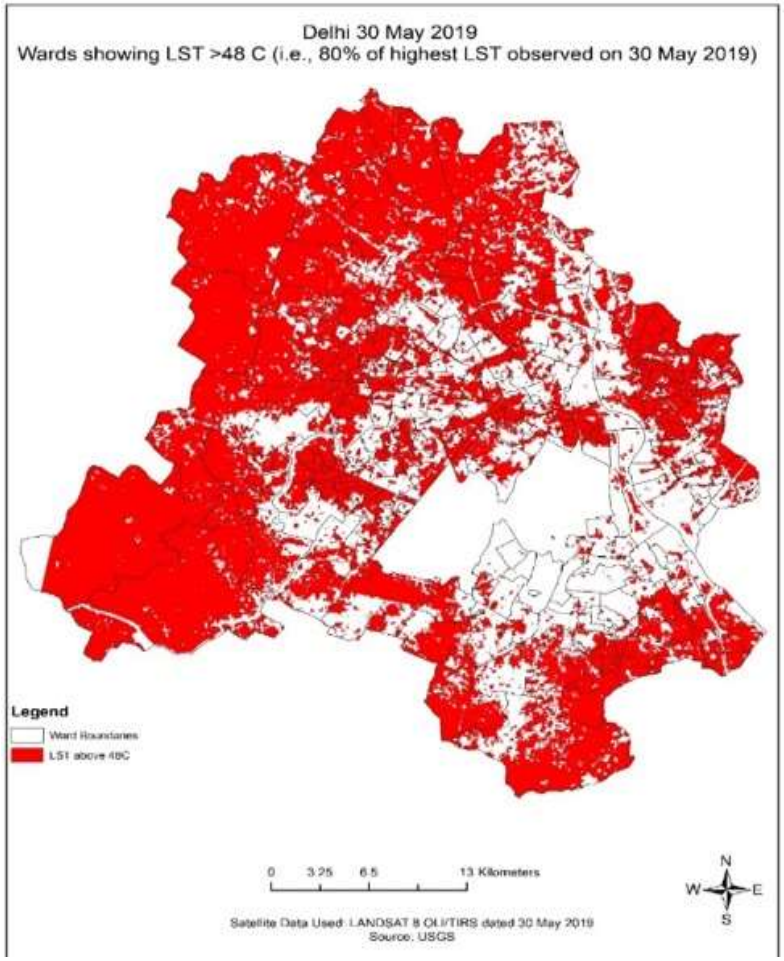
Th **Thermal hotspot map of Delhi showing wards with LST >54 ^{o}C**

Wards, Isapur and Kanjhawala, Dichaon Kalan, Ghuman Hera and Nangal Thakaran have above 25% area as thermal hotspot



Thermal hotspot map of Delhi showing wards with LST >48 ^{O}C

At 80% of the highest LST, all the wards of Delhi showed UHI, with 167 wards felling in Category I.



Thermal hotspot map of Delhi showing wards with LST >51 ^{O}C

171 wards showed UHI with LST more than 51 ^{O}C, with 8 wards belonging to Category I and 21 wards belonging to Category II

4.2 Identification of Urban Heat Islands

Urban areas typically experience higher—and nocturnally sustained—temperatures because of the "heat island" effect (Oke, 1987; Quattrochi et al., 2000).

Similar trend of urban heat islands is observed in delhi city due to urbanization and land use patterns. Within the city it was observed there was maximum temperature deviation up to + 1.2-degree C and similar trends were observed for the Average Minimum Temperature for which the deviation was up to +0.43 degree C.

While yellow alert is being issued in the city based on the weather observatory of IMD, early warning alerts can be provided to the heat hot spots. This will also help in prioritised actions for the heat hotpot locations within the city.

5 Vulnerability Mapping

A heat wave may lead to both direct or indirect impacts on human health. These impacts are influenced by interactions between medical, environmental, demographic and geographical factors, which may further compound health related effects.

While it is clear that all people are at risk of illness and deaths due to exposure to hot temperatures, there are certain sub-groups that are highly vulnerable in comparison. Similarly, some areas of a city bear the brunt of heat waves more than remaining parts.. Vulnerability assessment for heat waves have to take into account both geographical area and vulnerable populations.

A heat wave health vulnerability assessment allows health department/ medical stakeholders to better understand and identify people and places that are more likely to face adverse health impacts. It further helps in implementing targeted public health interventions and minimize health-heat risks.

The table below illustrates vulnerability mapping and its essential components.

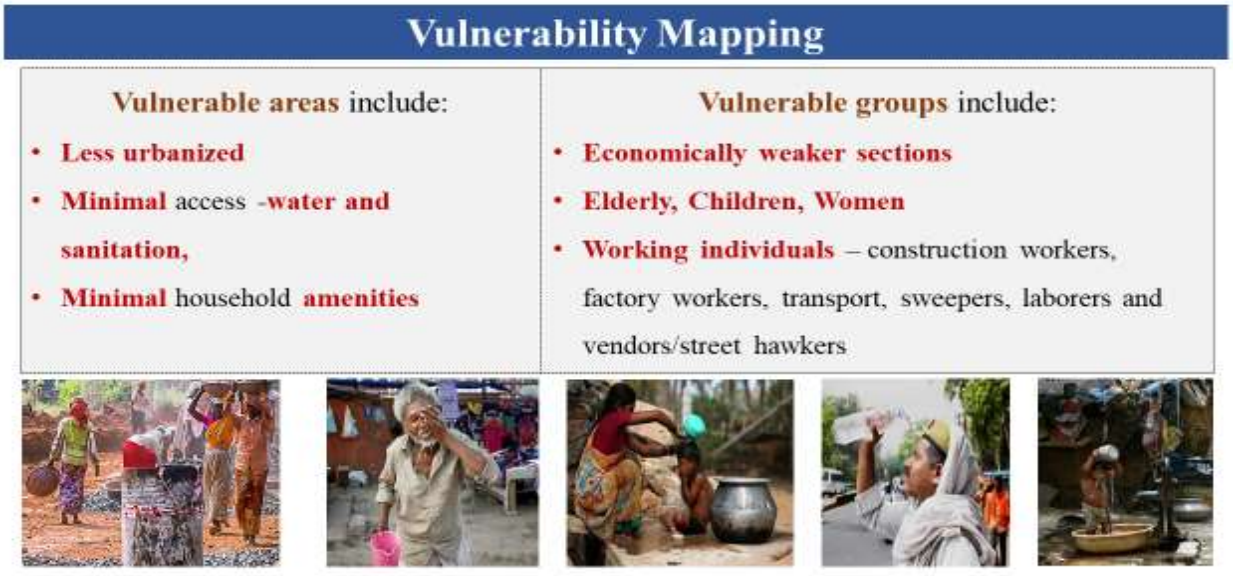


Figure 27: Vulnerability Mapping for Heat Wave

5.1 Vulnerable Areas:

Hot temperatures during a heat wave often result in some parts getting much hotter than rest the city. The air, surface and soil temperatures influence the overall temperature Hence, it is important to identify beforehand such areas to minimize any potential health impact.

The spatial documentation of heat related health risks in addition to the biophysical vulnerabilities will help policy, planners, medical stakeholder etc. in developing heat preparedness plans at local scale /ward level.

Vulnerable areas within the city are classified as under:

Slums Pockets & Squatter Settlements

The economically weaker section of people in these areas are affected much more due to their poor coping mechanisms and limited ability of the inhabitants especially women to respond to health challenges during hot temperatures. The night time outdoor microclimatic conditions along with poor housing structure and no access to services make it extremely difficult for people to cope with heat stress. Consequently. acutely affecting the health of people living it these areas. The women of these areas faces its brunt the most as they not only have to deal with heat wave but also have to make arrangement for services such as water etc.

Low-income group Areas

People living in these areas constantly suffer from heat stress due to poor built up environment, limited access to basic services and housing material ***that*** are good at ***absorbing*** and storing the sun's ***heat***.. It has been observed that people living in higher floors with poor ventilation and bad housing material are more vulnerable to heat related impacts. People with disabilities and chronic diseases are worst sufferers. Women cannot even leave their front door open for safety and security reasons.

Heat Wave Vulnerable Hotspots

The hotspots identified during the vulnerability assessment of heatwaves undergo significant rise in temperatures as compared to rest of the city. These areas are most likely to have higher number of inhabitants being affected during heat waves and experiencing huge heat-health implications.

5.2 Vulnerable Groups During Heat Wave

A heat wave has varied health outcomes, with specific group of people being more vulnerable to heat related mortality and morbidity. Among these are, infants, children, woman, elderly, construction workers and people from economically weaker sections. .

Identifying such groups is important as it allows medical professionals to prioritize actions to treat heat related illnesses effectively in order to minimize potential threats.

The vulnerable groups are as follows:

Figure 28: Vulnerable groups during heat wave

Infants (0-1 years)

They are particularly sensitive to heat due to different metabolism and poor ability to adjust to changes in temperatures. The infants sweat less which considerably decreases their ability to cool their body. Infants are more susceptible to heat related deaths due to their high metabolism rate and inability to remove sheets or clothing.

Children (1-14 Years)

They are physiologically more vulnerable to heat stress unlike adults. Heat related illnesses are associated with their physical activity, production of more metabolic heat/ kilogram, in comparison to their body weight, dehydration and lower cardiac output. Henceforth, strict vigilance is required during a heat wave to avoid any heat related sickness and overheating among them.

Woman

They are more at risk for heat related mortality. They are vulnerable to heat stress as their ability to thermoregulate is compromised. There are increasing evidences of still birth among pregnant women due to Heat Stress. Their heat related illnesses are further intensified due to social norms and gender discrimination.

The Elderly

They are at a great risk to morbidity and mortality during heat wave. With growing age there is considerable reduction in the cardiac output and capacity to circulate blood to skin, intestinal and renal circulatory beds. Aging compounds these problems which reduces the efficiency of heat dissipation in them.

Working Individuals

They perform activities both indoors and outdoors in farms, manufacturing and construction and hence are at greater risk to dehydration and heat stress. Their capacity to thermoregulate exceeds on a regular basis and exposure to heat for long duration leads to dehydration, compromises abilities to carry out normal activities, chronic kidney disease, cardiovascular and pulmonary illnesses. The cultural aspects such and clothing and use of Personal Protective Equipment (PPE) may also hinder a worker's ability to cool through sweat.

Economically Weaker Sections of Society

They often lack awareness and the means to undertake any measures for protecting themselves against heat related illnesses. Most suffer from chronic diseases which often get aggravated during heat wave.

Poor quality housing, lack of access to basic services such as water, health services and sanitation, compounds their vulnerability during..

People with Disabilities

They are highly vulnerable to heat waves as their ability to receive or respond to heat alerts is substantially reduced. In certain cases, such as spinal cord injury, the body does not sweat, inhibiting the body's ability to cool from overheating. Besides, any form of physical or mental disability adds to their vulnerability. In addition, high social risk factors, such as household pattern, poor health conditions, food insecurity and housing instability, likewise further adds to these challenges. It has been observed that heat wave messages are not always designed in a way that makes it easy for people with disabilities to comprehend. For example, people with hearing impairment, visually challenged or reduced mental health have to depend on their caregivers.

Chronic Disease Patients

They are most likely to face the heat stress. Their medication not only impacts their ability to gauge changes in temperatures but also can make effect of hot temperatures even worse. Patients with conditions of heart diseases, mental illnesses, poor blood circulation and obesity are more at the risk of heat related illnesses. Overweight people often tend to retain body heat which makes them vulnerable to heat stress and its associated impacts.

6 Heat Action Plan — Strategy, Roles and Responsibilities

Benefits of Heat Stress Action Plan

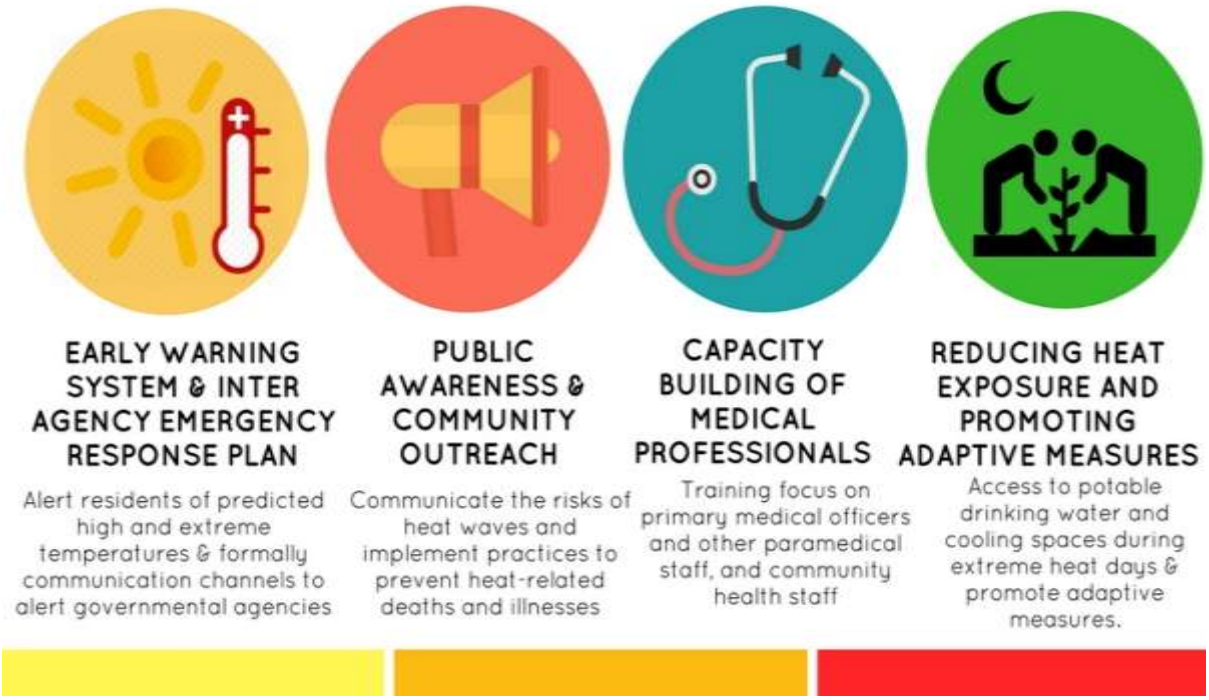
1. Prevents deaths associated with heat strokes.
2. Government commitment to protect the poor and vulnerable citizens.
3. Reduces chances of illness due to heat waves.
4. Making Indian cities future ready, Climate resilient cities.
5. Better preparedness of hospitals/health centres.
6. Economic losses- labour productivity, loss of job days, reduced labour and opportunity loss.

A Climate Adaptive Heat Stress Action Plan has been developed by IRADe to improve the management of heat-related risk in Delhi city. The plan intends upon being more spatially oriented and gender-sensitive while supporting the city's planning especially in prioritizing and integrating adaptive resilience within the agenda towards climate resilient smart city.

The Heat Action Plan provides a framework for implementation, coordination and evaluation of extreme heat response in Delhi and guides on mitigation and adaptive measures to avert loss of life and productivity. The Plan's primary objective is to alert populations at risk of heat-related illness, such as in places where extreme heat conditions either exist or are imminent, and to take appropriate precautions. The Heat Action Plan brings together all stakeholders for a citywide strategy in enforcing preventive, mitigation and adaptive measures to check heat-related debility among people.

This Heat Action Plan identifies:

1. Vulnerable populations and the health risks specific to each group (see section: Impact of Heat Stress on Health, Livelihood and Productivity)
2. General heat-health risks (see section: Impact of Heat Stress on Health, Livelihood and Productivity)
3. Effective strategies, agency coordination, and response planning
4. Process of activating heat alerts and the plan implementation
5. Evaluate and update the Heat Action Plan based on new learning



6.1 Strategy and Components of Heat Action Plan

Given that heatwaves can disrupt social and economic services, the local government has a critical role in designing and administering pre-emptive measures in responding to heatwaves working in tandem with all stakeholders, including health department, various institutions and community. This Heat Action Plan details coordinating role and responsibilities of the Urban Local Bodies and the roles and responsibilities of other stakeholders, including non-government institutions and the community. It lays out the essential components of preparedness of mitigative and adaptive measures to ensure stable health and productivity in the event of heatwaves.

- Build Public Awareness and Community Outreach on mitigative and adaptive measures through media engagement — television and radio broadcasts, SMS, WhatsApp, social media — to prevent heat-related deaths and illnesses. Inter-personal communication may be required to reach out to very vulnerable populations.
- Use Early Warning Weather Forecasts for Inter-Agency Coordination. Everyday Indian Meteorological Department shares five-day weather forecast with the Heat Action Plan Nodal Officer during the heat season. The Urban Local Bodies, in turn, must alert the government agencies, health officials and hospitals, emergency responders, local community groups, and media outlets about high temperature or heat waves.
- Develop Capacity Among Healthcare Professionals to recognize and respond to heat-related illnesses, particularly during extreme heat events. Such capacity building must include primary medical officers, paramedical staff, and community health staff so that they effectively manage heat-related cases to check mortality and morbidity.
- Reduce Heat Exposure and Promote Adaptive Measures. Identify high-risk areas of the city. Launch advocacy on preventive, adaptive and mitigative methods to deal with heat stress; ensure access to adequate potable water and cooling spaces during extreme heat days.

Collaborate with non-governmental organizations to expand outreach and communication with the city's most at-risk communities.

Other Components

- Develop heat emergency response plan
- Collaborate with non-governmental organizations and civil societies for developing 'cool public places' and improvising bus stands, building temporary shelters, providing access to cold drinking water in public areas and other similar measures to mitigate the risks of exposure to heatwaves.

6.2 Medical emergency preparedness

Heat waves creates an emergency situation in people that makes their medical attention urgent for treatment and also avoid any fatality. Such situations inevitably lead to a rapid increase in demand for hospital services which ultimately has a crippling effect on its operational capacity. This urgently calls for deployment of a quick response plan that works towards such emergency preparedness and effectively responds to health emergency along with maintaining its regular health facility.

Understanding emergency preparedness

The emergency preparedness for heat waves in hospital refers to the steps taken by it to be ready with response during emergency situation by giving adequate and emergency medical care. This would require continuous planning, coordination, capacity building, monitoring, appraising, and acting in accordance with the laid down procedures along with collaborative efforts from all the stakeholders. The hospital's emergency preparedness plan should generally take into account all aspects of heat waves including the pre, during and post heat waves.

Pre- Heat Season

1. Create and implement gender based heat health guidelines on the diagnosis and treatment of heat stress, heat exhaustion, and heat stroke to reduce and prevent mortality and morbidity. Use materials extensively for training and communication, including posters and pamphlets that inform patients about upcoming heat warnings and offer tips to prevent heat stress
2. Identify and relocate the most vulnerable hospital wards (e.g., the maternity or neonatal ward) from the top floor of hospitals, where the temperatures are highest. Move patients to cooler parts of the building
3. Measure wards' morbidity and mortality rates before and after location change to evaluate the effectiveness of intervention
4. Set up steering committee to supervise, monitor the emergency preparedness, dealing with inflow of patients during heat wave and post heat wave evaluation
5. Establish Cool Wards within the hospitals
6. Ensure bed availability especially in emergency departments and special wards for heat related illness especially among women
7. Ensure adequate storage of IVs, ORS and other medicines for heat stress treatment
8. Increase medical doctors, nursing staff to ensure full coverage in case of an increase in admissions
9. Development of training modules or multiday training for health care providers, ward leaders, and paramedics on extreme heat and health, as well as specific heat case management and diagnosis, especially during heat waves

10. Organizing a training of trainers workshops for primary medical officers so they can offer heat-specific advice (symptoms, diagnosis, and treatment including self-monitoring hydration) to their medical staff
11. Conduct workshops for link workers/front line health workers (ASHA;Anganwadi worker; community health workers) to increase gender sensitive outreach and community-based surveillance for heat illness in slum communities. Link workers should receive informational materials that cover how to counsel patients especially women, what threshold temperatures apply for different levels of treatment, and surveillance protocols
12. Collaborations with the medical service provider/ research institutes to train emergency service professionals on responding to extreme heat emergency cases
13. Increase heat stress outreach and education for women in maternity wards before they leave the hospital, since newborns are particularly vulnerable to heat stress
14. Update heat wave monitoring and management protocols and programs, including tracking of daily gender associated heat-related data as per the monitoring sheet template shared below

During Heat Season

1. Adopt gender specific heat-focused examination procedures at local hospitals and Urban Health Centers (ASHA; Anganwadi worker; community health workers). Examination of admitted patients for signs and symptoms of heat related illnesses could become routine, adding a brief procedure during the peak-heat summer months at a minimum. The basic statistics of such patients should also be recorded to identify the locations, occupations, gender and socioeconomic status of city's residents who are most vulnerable to heat stress and illness.

2. Adapt pharmacological treatments according to Standard Treatment Guidelines (STGs). Gender aspects should be given due consideration

3. If possible, postpone non-emergency hospitalizations and surgeries.

4. Ensure high risk patients are placed in rooms with air conditioning; less critical patients should at least have access to an area with air conditioning during the hottest hours of the day.

5. Increase liquid oral and intravenous intake of patients.

6. Modify diet accordingly with increased fruit and vegetables.

7. Adjust patient bed and personal clothing according to need.

8. Start and special and adequate health and social assistance for hospital discharge of high risk patients especially new mothers with babies or postpone discharge till post- heat wave.

9. Ensure availability of adequate number of Medical Mobile Van in high risk areas of heat waves

10. Maintain record of heat wave patients and report to Urban Local Body (ULB) daily according to monitoring sheet

11. Expedite recording of cause of death certificates

Post-Heat Season

1. Share final data of gender based hospital admissions as per indicators set for reporting during heat wave with the Urban Local Body (ULB)
2. Give feedbacks in annual evaluation of heat action plan
3. To prepare a set of key learnings during heat wave to build on institutional memory and share it with other stakeholders

7 Adaptation and Mitigation Measures

The measures which have been taken by Delhi Municipal Corporation as part of Delhi Heat Stress Action Plan can be classified into short term, medium term and long term measures.

7.1 Short and Medium Term Measures

Awareness Campaigns

- Hoardings, posters, to be displayed by smart city LED TVs at various locations, distribution of pamphlets.
- Awareness workshops for occupationally exposed - traffic police, hawkers, street vendors, construction workers and school children.

Mitigation measures

- Keeping gardens, cooling shelters and other possible cooling centres open with water availability.
- Availability of water and sheds at open construction sites.
- Pilot project on roof painting with white colour - cool roof and or distribution of gunny bags for putting on the tin roofs/asbestos in slums.
- Provision of water points and ORS at Construction sites, Bus stands and other Public places during processions and political and other rallies and processions during summer.
- Distribution of cool roof jackets to on-duty traffic police personnel.
- Water tanker campaign- Tankers to be made available on call in slums during orange/red alert days.

Early warning communication

- SMS and WhatsApp messages for early warning to citizens, NGOs, Citizen welfare groups, construction contractors.
- Public announcement through mikes across the city through car during orange and red alert days a day before and early on the forecasted day.
- Press Releases and campaigns on radio, TV and websites.

Medical Preparedness

- Stocking ORS and cool packs at the health centres & readiness with cooling and rehydration as well as shock management treatments.
- Medical camps on day of red alerts at hotspots.

Monitoring and Analysis

- Recording ward wise heatstroke cases, proper cause of death and monitoring daily mortality as well as daily hospital admission due to all causes and due to heat-related causes.
- Monitoring and analysis of the morning temperatures recorded from AWS sites and issue early warnings.

7.2 Long term Measures

- Heat alerts and emergency response plan needs to target vulnerable groups, high-risk areas and incorporation of the same in the City Development Plan. Planned development of urban areas ensuring appropriate amenities are available to all the residents in every location is required.
- Insulation and building standards need to be increased, with improving building bye-laws along with increasing heat tolerance for new infrastructure, retrofitting. Building bye-laws can have components of passive ventilation and cool roof technologies to increase thermal comfort and made mandatory in more vulnerable cities.
- Identifying locations for building shelters and shades in urban areas. Shelter locations for the urban poor and slum dwellers must be identified and constructed.
- Incorporation and documentation of indigenous knowledge to develop protective measures at regional and community level for sensitization and awareness generation. Local culture and physical exposure of population needs to be improvised to reduce the impact of heat stress on health and physical wellbeing.
- Capacity building at the community level, through awareness campaigns and outreach programmes. Communicating risks associated with heat stress and its impact on health, livelihood and productivity and ways to mitigate the same.
- Initiating research on micro-climate and corroborating the need to monitor temperatures in urban areas. Policy level intervention to retrieve natural eco-systems and natural shelters.
- Improvising the urban landscapes through vertical greenery, roof gardens can prove to be good alternate methods to bring down the temperature of built environment. Greening infrastructure can be an effective method to cope with heat stress. Urban forests have found to be effective for city heat mitigation. A combination of shading, reduced heat build-up in materials, humidity and wind management can provide heat refuge at street levels.
- Initiating Early warning systems, advisories and alerts against extreme heat for the communities and Urban Local Bodies. Building communication networks through Local bodies, Health officers, Health care centres, hospitals, communities and media.
- Encourage investing in water bodies, fountains in areas of mass presence and promote greeneries in urban areas along with improving green transport and energy systems.

7.3 Capacity Building:

Medical Stakeholders Training cum orientation workshop was organized for health care professionals towards managing Heat-Related Illnesses in Delhi. The training aimed towards orienting healthcare professionals of Delhi city on Heat Stress Action Plan, enhancing their capacities for proper and inclusive management of heat related illnesses and health impacts. More than 50 doctors and public health professionals from Delhi city had been a part of the training, which not only heat stress and protocols for heat-related diagnosis and treatment but towards overall preparedness for prevention and management of heat stress.

7.4 Heat Wave Advisory

DOS AND DON'TS FOR DURING HEAT WAVES

Heat wave conditions can result in fatal physiological strain. To minimize the health impacts of heat wave, the following measures are useful:

DOs

- ✓ Follow weather forecast and advisory on radio, TV, newspapers for appropriate caution.
- ✓ Drink water often, even if not thirsty.
- ✓ Wear lightweight, light-coloured, loose, and porous cotton clothes. Use protective goggles, umbrella/hat, shoes or chappals while going out in the sun.
- ✓ While travelling, carry water with you.
- ✓ If you work outdoors, use a hat or an umbrella and also use a damp cloth on your head, neck, face and limbs.
- ✓ Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. which re-hydrate the body and replace mineral loss.
- ✓ Recognize the signs of heat stroke, heat rash or heat cramps such as weakness, dizziness, headache, nausea, sweating and seizures. If you feel faint or ill, see a doctor immediately.
- ✓ Keep animals in shade and give them plenty of water to drink.
- ✓ Keep your home cool, use curtains, shutters or sunshade and open windows at night.
- ✓ Use fans, damp clothing and take bath in cold water frequently.
- ✓ Provide cool drinking water at workplace.
- ✓ Caution workers to avoid direct sunlight.
- ✓ Schedule strenuous jobs to cooler times of the day.
- ✓ Increase the frequency and length of rest breaks for outdoor activities.
- ✓ Pregnant women and workers with a medical condition should be given additional attention.

DON'Ts

- × Do not leave children or pets in parked vehicles.
- × Avoid going out in the sun, especially between 12.00 noon and 3.00 p.m.
- × Avoid wearing dark, heavy or tight clothing.
- × When the outside temperature is high, avoid strenuous activities especially 12 noon and 3 p.m.
- × Avoid cooking during peak hours. Open doors and windows to ventilate cooking area.
- × Don't consume alcohol, tea, coffee and carbonated soft drinks as these drinks dehydrate the body.
- × Avoid high-protein food and do not eat stale food.

7.4.1 Heat Advisory:

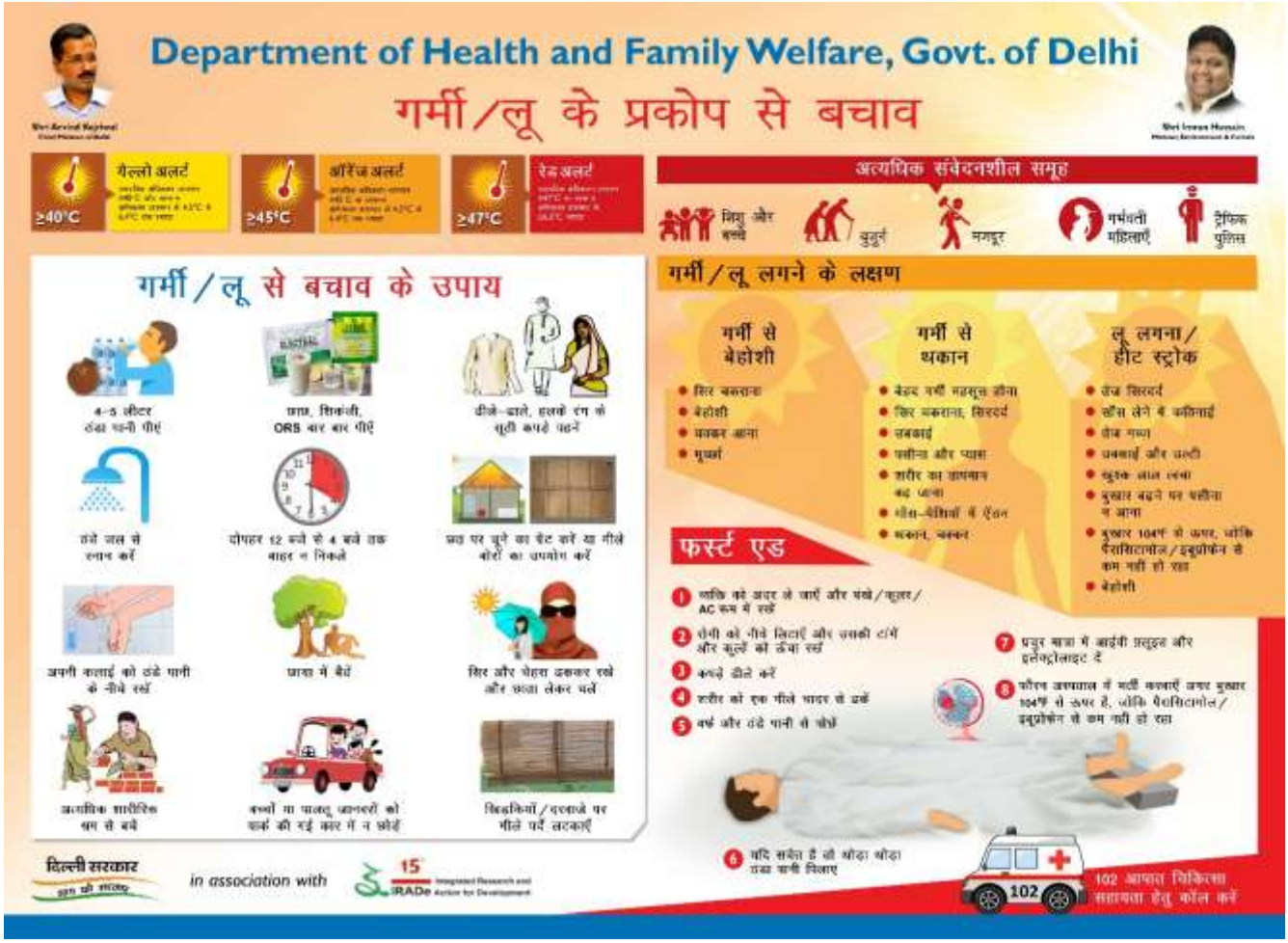
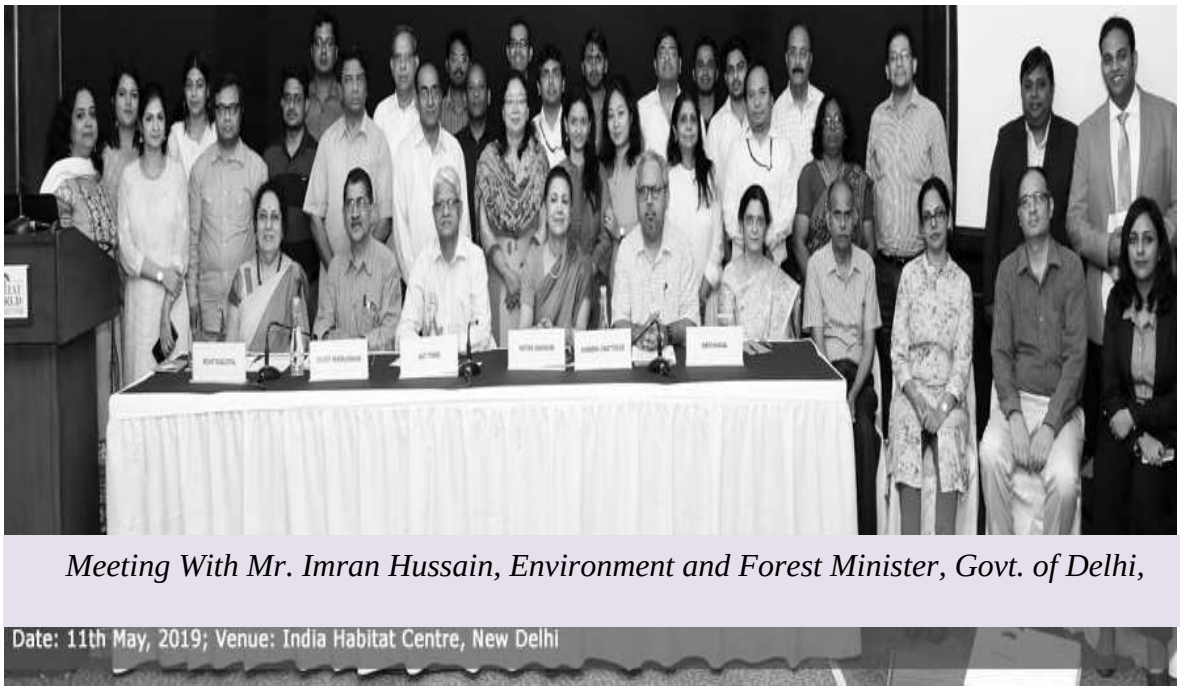


Figure 29: Heat Advisory, Hindi

7.4.2 Advocacy and Dissemination:



Meeting With Mr. Imran Hussain, Environment and Forest Minister, Govt. of Delhi,

8 Implementation of HAP

The Action Plan divides responsibilities into pre-, during- and post-event categories, detailing preparation for a heat wave (pre-event responsibilities), steps to be taken to reduce heat stress during a heat wave (during-event responsibilities) and measures to incorporate lessons learned and fill gaps found in the management of heat stress (post-event responsibilities).

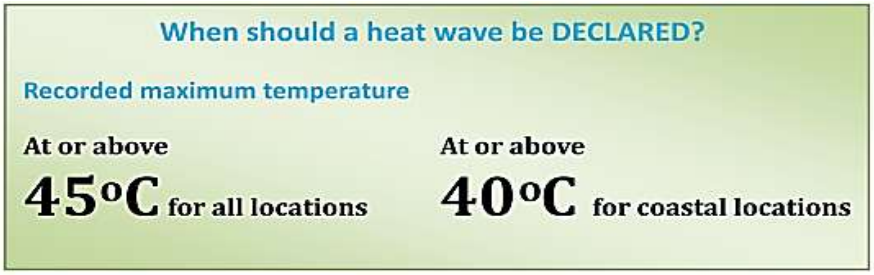
Phase-I: – Pre -Heat Season (February to March) Pre-Heat Season is devoted to developing early warning systems, communication plan of alerts to the general public, health care professionals and voluntary groups (caregivers) with emphasis on training and capacity building of these groups.

Phase-II: - During the Heat Season (April to June) High alert, continuous monitoring of the situation, coordination with all the department's agencies concerned on one hand and general public & media on the other hand is the focus of this phase.

Phase-III: – Post -Heat Season (July to October) In Phase – III concentration is on evaluation and updating of the plan. It is important at the end of the summer to evaluate whether the heat health action plan has worked. Continuous updation of plan is a necessity. Global climate change is projected to further increase the frequency, intensity and duration of heat-waves and attributable deaths. Public health preventive measures need to take into consideration the additional threat from climate change and be adjusted over time.

Heat Alert Severity

Based on the Meteorology Department's weather forecast, Nodal Officer of Delhi Govt., who heads Heat Action Plan, must issue heat alert based on the undermentioned thresholds of the alert severity. The Nodal Officer is also responsible for coordinating and communicating ahead of, and during, extreme heat events, and provides support staff through the Nodal Office as necessary. Approved by the Nodal Officer, the following are the roles and responsibilities of various stakeholders under the Heat Action Plan, 2020.



8.1 Roles and Responsibilities in Phase 1 (Pre-Heat Season January through March)

Nodal Officer

- Convenes a meeting of key stakeholders (Delhi State Disaster Management Authority, Delhi State Surveillance Unit, local non-government organizations, community health groups,

media, health department and hospitals, departments of labour, water and sanitation, transportation, power supply and distribution, private institutions, religious places, etc.) to respond to extreme heat events (See figure titled Communication Plan When the Nodal Officer Activates a Heat Alert).

- Engages state and local agencies to facilitate internal communications.
- Organizes training for health workers, link workers, health departments, school children and the local communities.
- Organizes outreach of health services to vulnerable communities.
- Undertakes publicity and awareness campaigns on health risks of heat stress through multilingual pamphlets, posters at vantage locations in hospitals, schools, and public and private institutions.
- Creates a list of high-risk areas in the city where people are more vulnerable to heatwaves for focused heat prevention measures.

Media and Press Officer

- Execute campaign and awareness outreach through multilingual pamphlet and advertisements on risks of exposure to high temperature, heat stress prevention, and tips for health protection during extreme heat events with greater focus on high-risk areas.
- Ensure wide visibility of information and heat communication materials to the public.
- Increase the number of installed LED screens to display daily temperature forecasts for public view.

Health Department and Medical Professionals

- Enhance targeted training programmes, capacity building efforts and communication on heat illness for medical staff at local hospitals and Urban Health Centres (UHCs) based on the framework for Medical Professionals and Health Workers. These efforts should include nursing staff, paramedics, field staff and link workers.
- Ensure hospitals update their admissions and emergency case records to track heat-related morbidity and train them in recording heat stroke/ heat stress as the cause of death in certificates, if death is triggered by an illness from the exposure. This will give reliable dataset to analyse epidemiology of illnesses associated with heat stress. The training components can include information, education and communication (IEC).
- Adopt heat-focused examination procedures at local hospitals and urban health centres, more so during the summer months.
- Equip Urban Health Centres, 108 emergency centres, ambulances and hospitals with wherewithal for the treatment of illnesses associated with exposure and heat stress.
- Explore creation of ice pack dispensaries for easy access by vulnerable communities.

Labour and Employment Department

- Organize training for employers, outdoor labourers and workers on the health impacts of extreme heat as well as on the mitigative and adaptive measures to prevent exposure, heat stress and associated debility.

- Identify high-risk outdoor workers and give them focussed attention in outreach and advocacy. Use irradiance map from IMD or heat island map to identify vulnerable areas/pockets. During the high-risk days, conduct publicity campaigns to these specific areas.

108 Emergency Service

- Create displays on ambulances to build public awareness.
- Identify vulnerable populations in at-risk areas and be in the state of preparedness to provide immediate relief in case of an illness reporting.

Civil Society and Individuals

- Conduct training workshops and outreach sessions with community groups and mobilizers such as Mahila Arogya Samiti, Self-Employed Women's Association (SEWA), ASHA workers, aanganwadis, municipal councils, etc., to help them organise community action. In such activities, Delhi Govt. must take lead and involve higher education, non-profits, and community leaders.
- Provide child-relevant educative and preventative training at schools so that children avoid exposure and keep themselves adequately hydrated.
- Equip schools with materials for heat protection. Through "Teach the Teachers" workshop, give school administration training and material for insulation from heat.
- Encourage individuals to take heat stress preventive measures and seek medical care at hospital or Urban Health Centre at first experience of heat exhaustion.
- Inform fellow community members about how to keep cool and protect oneself from heat.

8.2 Roles and Responsibilities in Phase 2 (During the Heat Season March through July)

Nodal Officer

- Activates the citywide **heat alert** and response mechanism based, on the Department of Meteorology's weather forecast, by notifying the key stakeholders, Deputy Municipal Commissioners and the Delhi state agencies in accordance with the Communication Plan (See figure titled Communication Plan When the Nodal Officer Activates a Heat Alert).
- Monitors the **heat alert** level based on the weather temperature severity forecast (see section Heat Alert Severity). Increase in severity level necessitates the Municipal Commissioner to convene a special meeting of key agency leaders.
- Activates "cooling centres," such as temples, public buildings, malls, temporary night shelters, etc., during a **heat alert.**
- Expands access to shaded areas for outdoor workers, slum communities, and other vulnerable populations. During heat alerts, orders night shelters be kept open through the day.
- Holds frequent, possibly daily, meetings to assess developments during a **heat alert**, and ensures that communication channels stay alert.
- Identifies key spots to set up large LED display boards to share temperature forecasts with general public.
- Ensures continuous surveillance of temperature data and forecasts for appropriate action.
- Communicates suspension of all non-essential uses of water (other than drinking, keeping cool) via the Water Project's protocol procedures in cases of water shortage.

- Increases efforts to ensure adequate drinking water supply to the public. Besides, expands potable water access during a **heat alert** at religious places, BRTS transit stations, organizes water pouch handouts to the poor and high-risk areas (identified by irradiance maps).
- Communicates local utility protocol to prioritize uninterrupted power to critical facilities (such as hospitals and UHCs).
- Notifies the Steering Committee and relevant agencies when the **heat alert** is over.

Press Officer

- Issues heat alerts through WhatsApp and SMS platforms utilizing the centralized mobile databases of private sector telecom companies.
- Issues heat alerts to the public via centralized email databases.
- Sends direct heat alert messages to private medical practitioners, public hospitals and UHCs.
- Utilizes local radio FM broadcasts to disseminate heat protection tips and high temperature warnings to the city's at-risk populations.
- Explores other means of communications for outreach to vulnerable population.

Health Department and Medical Professionals:

- Give tips for the treatment of heat related illness and prevention of further exposure.
- Ensure adequate medical supplies are available at all hospitals and UHCs.
- During a heat alert, produce weekly report of public health impact of heatwave for the Nodal Officer.
- If required, increase the number of healthcare staff and doctors at hospitals and UHCs to attend to the influx of patients during a heat alert.
- Increase link worker and community health worker outreach to at-risk neighbourhoods during a heat alert.
- Frequent invigilation of UHCs by zonal health officer to ensure their preparedness to deal with the outbreak of heat-related illness and conduct case audits during heat season.

108 Emergency Service:

- Ensure adequate supply of ice packs and IV fluids.
- During a heat alert, disseminate SMS text messages to warn residents in the vulnerable areas.

Labour and Employment Department:

- Encourages employers to shift outdoor workers' schedules away from the peak afternoon hours (1pm – 5pm) during a heat alert.
- Provides emergency ice packs and heat-illness prevention materials to traffic police, BRTS transit staff and construction workers.

Community Groups and Individuals:

- Keep cool and hydrated during the heat season by drinking water, staying out of the sun, and wearing light clothing.
- Check on vulnerable neighbours, particularly during a heat alert.
- Limit heavy physical work under the sun and even indoors if poorly ventilated, especially during a heat alert.

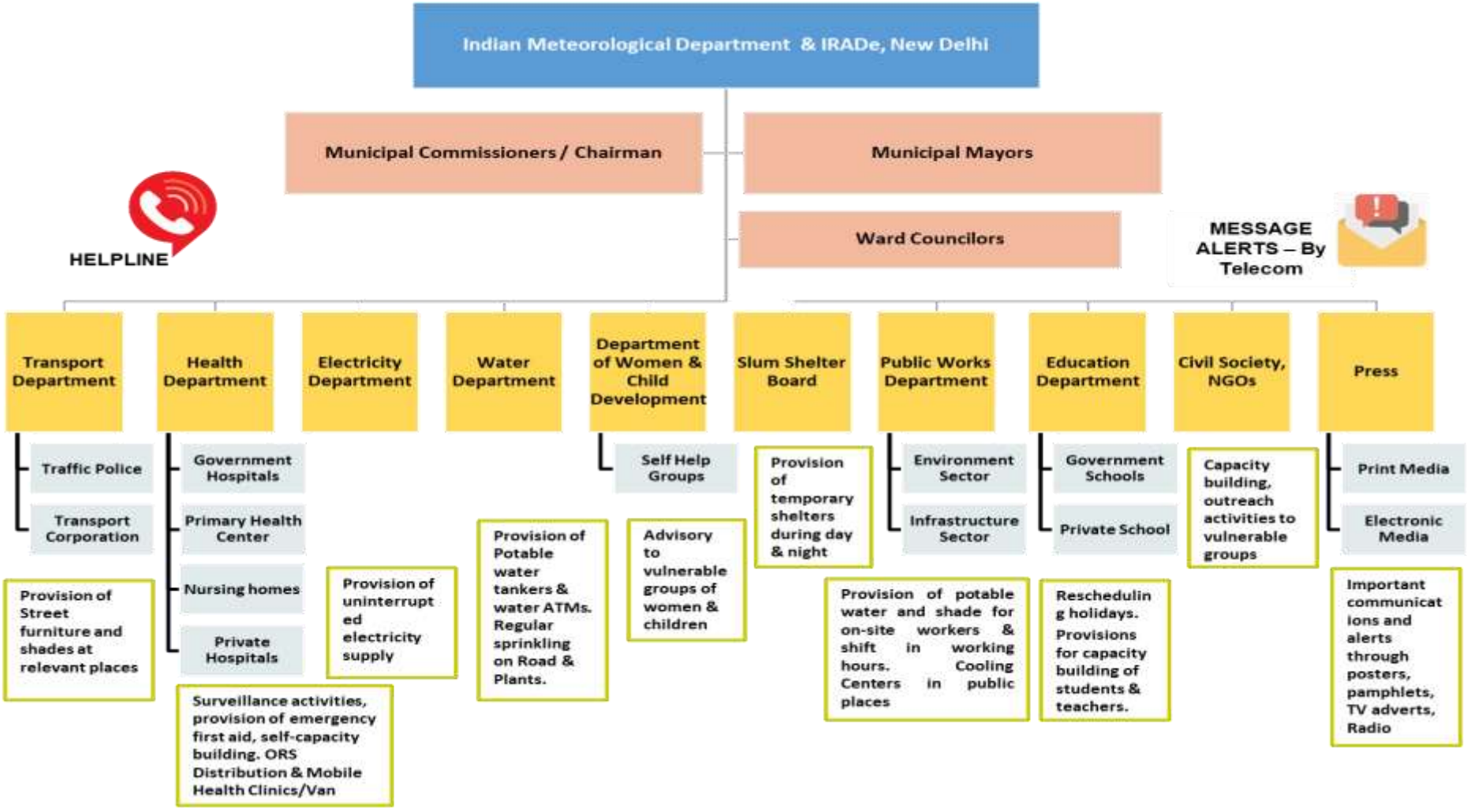


Figure 30: Heat Stress Action Plan Communication Flowchart

8.3 Roles and Responsibilities During Phase 3 (Post-Heat Season July through September)

Nodal Officer:

- Organizes annual Heat Action Plan evaluation meetings with key agency leaders and relevant stakeholders.
- Evaluates the Plan process based on performance and revise accordingly.
- Evaluates the reach and impact of the Plan and revise accordingly.
- Posts the revised Plan on the govt. website ahead of the next heat season for stakeholders' feedback and opinion.
- Undertakes tree-plantation in heat hotspot areas. Encourages or incentivizes builders to plant trees.
- Establishes cool resting centres in high-risk areas around the city.

Health Department and Medical Professionals

- Perform an epidemiological case review of heat-related mortalities during the summer.
- Based on average daily temperatures, gather epidemiological data on heat risk factors, illness and death.
- Incorporate data and findings into future versions of the Heat Action Plan.
- Measure mortality and morbidity rates based on data before and after the Plan's interventions.

Nodal Officer

Pre-Summer

- Designates point of contact for each department
- Identifies facilitator to coordinate communications and schedule monthly meetings
- Establishes heat mortality tracking system and updates datasets
- Establishes Heat Action webpage on website
- Facilitates training of schoolchildren and school staff
- Launches heat stress awareness campaigns before onset of summer
- Creates list of high-risk areas of city heat-wise

During Heat Event

- Appoints point person in each department for coordination with the Nodal Office
- Coordinates Heat Action Plan activities through points person in each department
- Ensures adequate staff and supplies in each department
- Communicates locations of emergency facilities and cooling centres/shaded areas to all stakeholders
- Monitors severity of heat alert based on forecast

Post-Summer Evaluation

- Review quantitative and qualitative data for process evaluation and improvements
- Call meeting for annual evaluation of heat plan with key agency leaders and community partners
- Post revised heat action plan online for stakeholders

Medical Colleges and Hospitals

Pre-summer

- Adopt heat-focused examination materials
- Get additional hospitals beds and ambulances ready
- Update surveillance protocols and programs including tracking of daily temperature and heat-related data
- Train clinicians, medical officers and paramedics in diagnosis and treatment of health complications from heat stress

During Heat Event

- Establish treatment and prevention protocols for health issues arising from heat stress
- Equip hospitals with required medicines and equipment
- Ensure adequate medical staff to meet emergency
- Keep emergency ward in the state of readiness
- Monitor incidence of water borne diseases, malaria and dengue
- Keep stock of small reusable ice packs to apply to PULSE areas
- Report heat stroke patients to daily
- In case of death from heat stroke/ exposure, mention it as the cause of mortality in death certificates

Post-summer Evaluation

- Participate in annual evaluation of Heat Action Plan
- Review revised Heat Action Plan and recommend amendments

ROLES AND RESPONSIBILITIES - HEAT ACTION PLAN

Public Health Managers

Pre-summer

- ✓ Identify vulnerable areas
- ✓ Ensure adequate inventories of medical supplies in health centres
- ✓ Ensure appropriate to health workers, para medics, clinicians, etc.
- ✓ Identify cooling centres and barriers to access cooling centres

During Heat Event

- ✓ Prepare rapid response team
- ✓ Distribute pamphlets with "Dos and Don'ts" instructions among vulnerable community
- ✓ Effectively send a "Take Care but Don't Panic!" message to community
- ✓ Ensure access to Medical Mobile Van in the Red Zone
- ✓ Ensure additional medical vans are available during red alerts

Post-summer Evaluation

- ✓ Participate in annual evaluation of Heat Action Plan
- ✓ Review revised Heat Action Plan and suggest needed amends

Urban Health Centres and Link Workers

Pre-summer

- ✓ Advice community on treatment and prevention of heat related illness
- ✓ Sensitize and train link workers
- ✓ Develop and execute school health programs with support from Department of Education
- ✓ Create awareness campaigns in slum communities
- ✓ Coordinate community outreach efforts with non-profits

During Heat Event

- ✓ Recheck management stock
- ✓ Ensure UHCs preparedness to respond to emergency
- ✓ Visit at-risk populations for monitoring and prevention
- ✓ Communicate information on tertiary care and 108 service

Post-summer Evaluation

- ✓ Participate in annual evaluation of Heat Action Plan
- ✓ Review revised Heat Action Plan and recommend needed amends

Press Officer

Pre-Summer

- ✓ Secures commercial airtime slots for health advisories and public service announcements
- ✓ Identifies public areas to display health alerts during heat season
- ✓ Organizes training for health workers and medical professionals
- ✓ Activates heat telephone-hotlines
- ✓ Places temperature forecasts in newspapers
- ✓ Installs LED screens with scrolling temperature data

During Heat Event

- ✓ Issues heat-related health warnings in the media
- ✓ Contacts local FM radio and TV stations for health and weather advisories
- ✓ Releases advisories through SMS and WhatsApp platforms using centralized mobile databases
- ✓ Contacts BRTS and transport department to place warnings on buses

Post-Summer Evaluation

- ✓ Evaluates efficacy of advocacy and campaign outreach and other communications
- ✓ Participates in annual evaluation of Heat Action Plan
- ✓ Review revised Heat Action Plan and suggests amends

Labour Department

Pre-Summer

- ✓ Organize orientation for factory medical officers and general practitioners on health effects of heat stress or exposure
- ✓ Compile list of factory medical officers and contractors for heat action communications from Nodal Officer
- ✓ Prepare outreach and advocacy strategy for unorganized labour
- ✓ Use maps of construction sites to identify high-risk outdoor workers
- ✓ Conduct advocacy campaigns in high-risk areas

During the Heat Season

- ✓ Ensure water supply at work sites
- ✓ Request use of A/C at factory facilities
- ✓ Extend work hours of Occupational Health Centres
- ✓ Consider long afternoon break or change the working hours to avoid heat exposure
- ✓ Provide emergency ice packs and heat-illness prevention kit to traffic police, BRTS transit staff and construction workers

Post-Summer Evaluation

- ✓ Participate in annual evaluation of Heat Action Plan
- ✓ Review Heat Action Plan and recommend amends

108 Emergency Service

Pre-Summer

- ✓ Prepares handouts for paramedics on heat illness
- ✓ Uses informative visuals on ambulances to build public awareness
- ✓ Establishes Dynamic Strategic Deployment Plan for ambulances
- ✓ Ensures adequate supply of IV fluids
- ✓ Identifies at-risk areas
- ✓ Prepares SMS messages to disseminate during emergencies
- ✓ Identifies media point of contact

During the Heat Season

- ✓ Ensures adequate staff and stock of required medicine and equipment
- ✓ Keeps accurate record of pre-hospital care
- ✓ Sends messages to 108 Emergency Service employees on Heat Action Plan and heat alerts
- ✓ Activates Dynamic Strategic Deployment Plan for the ambulance service

Post-Summer Evaluation

- ✓ Provides data to key agency leaders
- ✓ Participates in annual evaluation of Heat Action Plan
- ✓ Review revised Heat Action Plan and recommend amends

8.4 Conclusion:

Heat stress action plans are key to city adaptation strategies. With the forecast of increased frequency and intensity of heat waves in the future, a climate adaptive heat stress action plan will enable Delhi to efficiently prepare, mitigate and adapt to the heat stress induced by climate change.

The action plan short, medium and long term strategies to counter the impact of heat stress. The spatially differentiated Heat Stress Action Plans (HSAPs) will serve to support Delhi's medium-term development planning especially in prioritizing and integrating adaptive resilience within the agenda of climate-resilient smart cities.

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