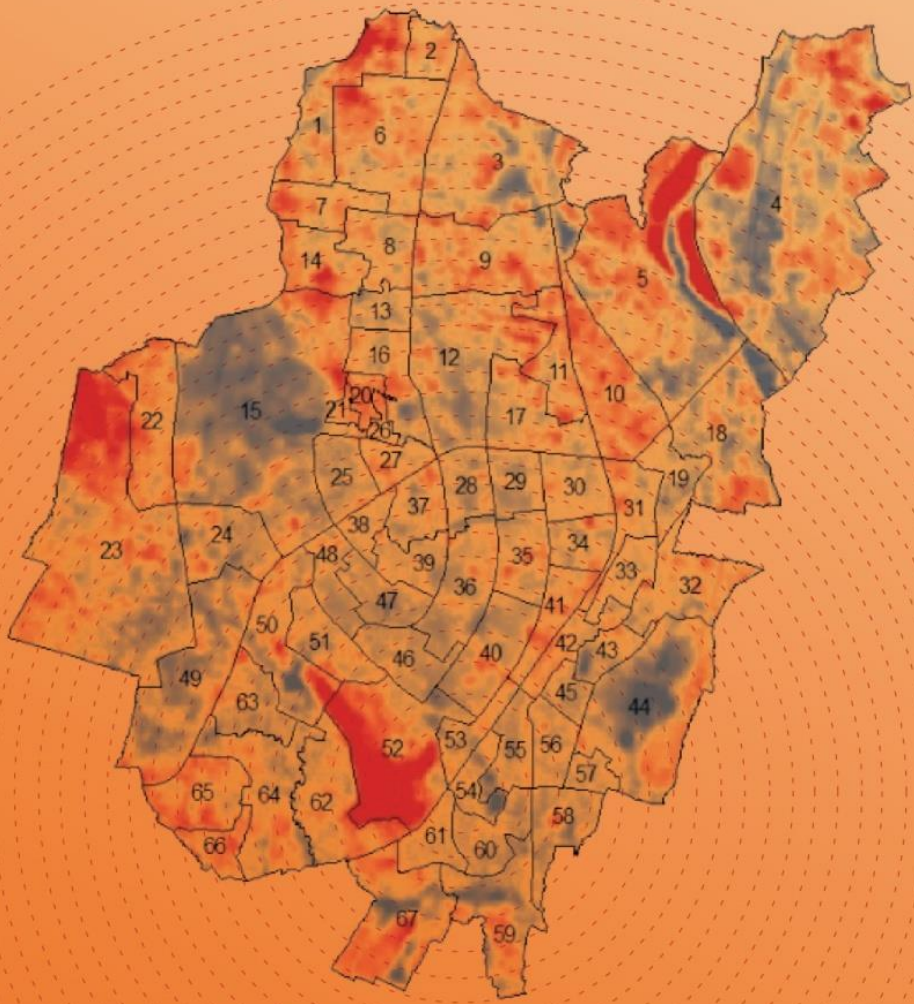
HEAT WAVE ACTION PLAN BHUBANESWAR CITY



BMC

OSDMA

Heat Wave Action Plan- Bhubaneswar City

Prepared by:

Integrated Research and Action for Development

Supported by:

International Development Research Centre, Government of Canada (IDRC)

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Contents

List of Figures

List of Tables

1. City Profile - Bhubaneswar

Bhubaneswar city is the largest city and capital of Odisha and located on the east coast of the Indian peninsula. Bhubaneswar is categorized as a Tier-2 city. An emerging information technology (IT) and education hub, Bhubaneswar is one of the country's fastest-developing cities.

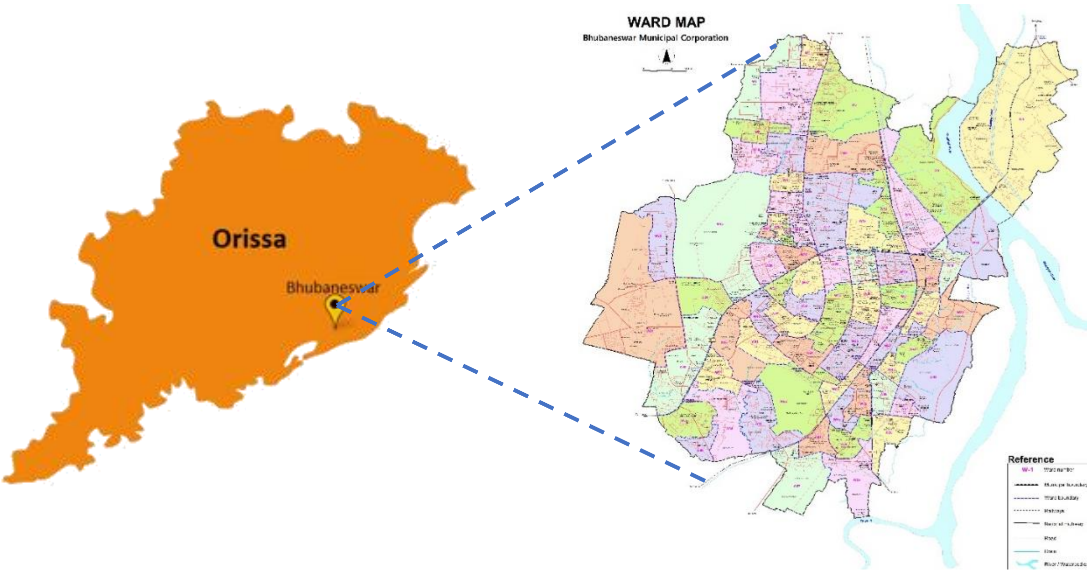


Figure 1: Bhubaneshwar City location Map

Classification 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)	135 sq.Km (Census, 2011)

1.1 Demography

Bhubaneswar, has a population of about 8,40,834 with a population density of 6,228 per sq km (Census, 2011). Due to increase in employment opportunities and migration, population growth has increased.

Table 1: Demography Trend (1981-2011)

Years	Bhubaneshwar City Population	Growth Rate	Density (Persons per Sq. Km.)	Area (Sq. Km.)
1981	2,19,211	107.80	2,357	92.91
1991	4,11,542	87.74	3,299	124.74
2001	6,48,032	57.46	4,800	135
2011	8,40,834	29.6	6,228	135
Source : Census of India				

The **UN report**, The World Cities in 2016, reports city agglomeration population for 2016, as 10.26 lakh, which was projected to increase to 14.39 lakhs by 2030, with an annual percentage of change being 2.4%. The **2018 report** again predicts the population to increase to 14.80 lakh, with the average annual rate of change being 2.5 when compared to the 2018 population of Bhubaneshwar Urban Agglomeration.

Table 2- Bhubaneshwar Urban Agglomeration

Population Projection	Average annual rate of Change (%)	
2030	**2000-2016**	**2016-2030**
1,439,000 (Urban Agglomeration)	**3.0**	**2.4**
2030	2000-2018	2018-2030
1,480,000 (Urban Agglomeration)	**3.0**	**2.5**
Source : UN World Cities Report , 2016 & 2018		

1.2 Urbanization

In 1956, the built- up area increased to 1654.9 ha because it became the capital city of the Odisha after 1948, as most of the people migrated from rural area to urban area because of the employment opportunity, economic development, and good transportation, etc. **During 1930-2010, urban area expansion continuously increased from 104.9 ha to 14008 ha due to the population increased**. The residential land use cover has increased from 9% (2000) to 15% (2000), with agricultural land though occupying the largest land-cover has decreased from 31.6% (2000) to 24.59% (2010). The residential built-up area has however increased by 2011, with shrinking agricultural plots.

The city is **spread across 67 Census** wards and has been experiencing very high growth both in terms of urban built as well as population, with almost **116 authorized and 320 un-authorized slum**, with **3.01 lakh population** and 80,630 households (2014), with the majority of slums lying along railway line, national highway and natural streams. Most of the water logging problems are also reported in these areas especially where the natural drainage system has been disturbed by human activities.

1.3 Hazard Vulnerability

The unique geo climatic conditions in the eastern coastal plains of the state, makes Bhubaneswar the capital city more vulnerable to multiple natural hazards like earthquake, heavy winds, cyclones, floods etc. The hazard and vulnerability assessment indicates the city to be prone to hazards like **cyclone winds, floods, water logging, epidemics, and heat waves**.

For the past three decades, the state of Odisha and in particular, Bhubaneswar city has been experiencing unprecedented contrasting extreme weather conditions; from heat waves to cyclones; from droughts to floods. The city recorded 44.1 ^{0}C in April, 2016, highest recorded in last 3 decades, with the highest recorded in 1985 at 45^{0}C. The number of Heat wave and severe heat wave days have increased over decades, recording almost 25 days in 2014, 19 days in 2015 and 10 days in 2018 (IMD).

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.

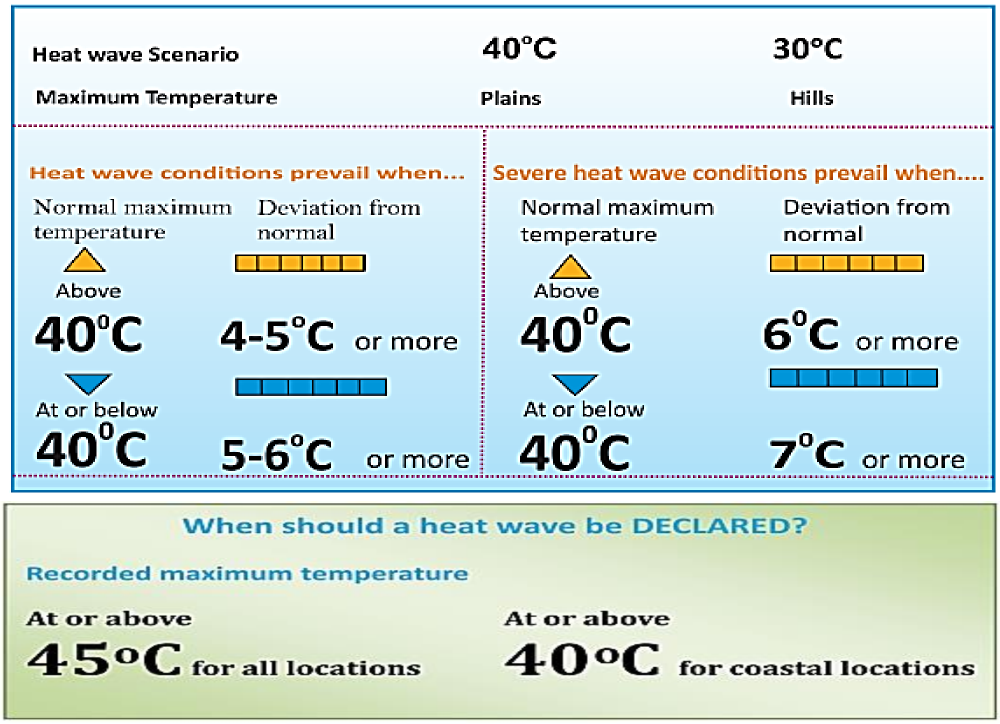


Figure 2 - Criteria for Heatwave in Plains. Coastal and Hilly Regions

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°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°C above normal average.

Under 2°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°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.

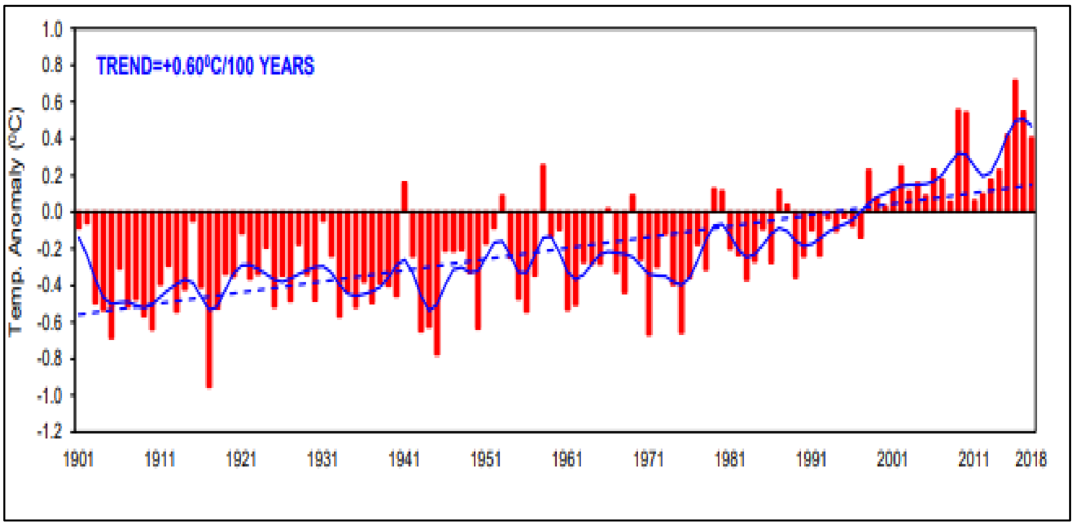


Figure 3-Annual mean land surface air temperatures anomalies 1901- 2018. IMD, 2019

2.2 Odisha State and Bhubaneswar City Scenario

In Odisha, heat wave has become a menace during hard summer and prolonged causing insurmountable human suffering. The poor people, farmers and workers are the most vulnerable groups. In the year 1998, the State of Odisha faced an unprecedented Heat Wave situation, as a result of which 2042 persons lost their lives. Though extensive awareness campaigns have largely reduced the number of casualties during post 1998 period, still a good number of casualties are being reported each year. Bhubaneswar experiences high daily temperatures in the summer season, with extreme temperatures being above 40°C for several days. In the year 1998, Bhubaneswar experienced one of its worst heat waves with a death toll of 123 persons. It is observed in the study that the total heat wave events have increased over the past two decades. The city has witnessed steep increase in the past decade post 2010 and major measure heat wave events are observed in 2014, followed by 2016 and 2012.

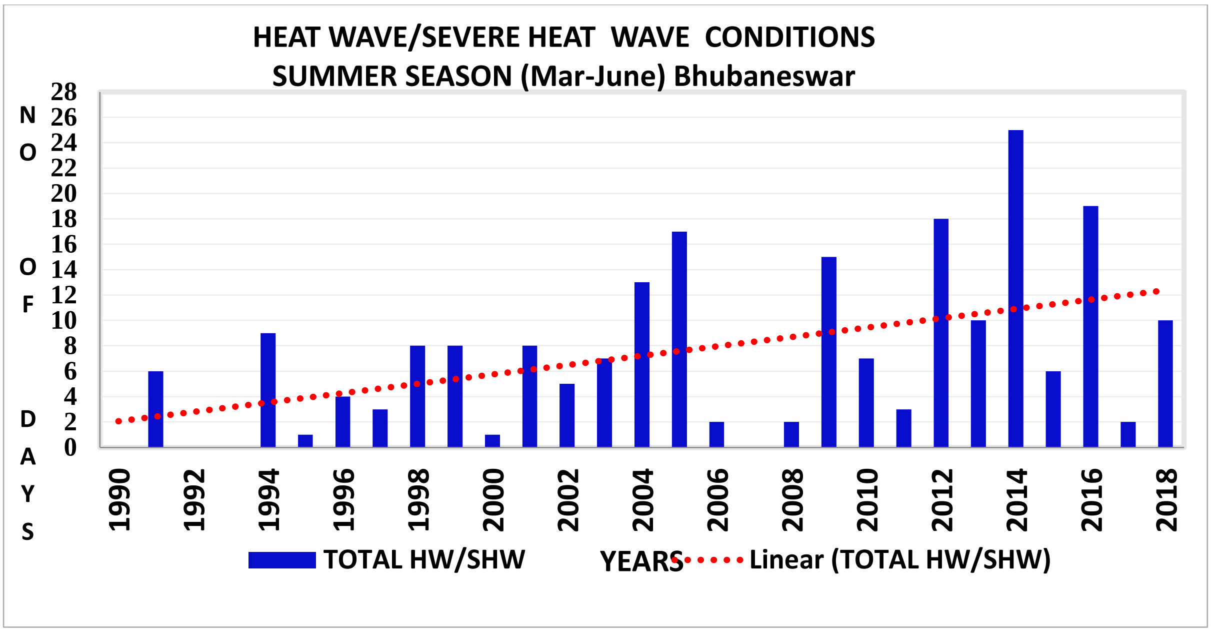


Figure 4-Heat Wave Conditions in Summer season (1990-2018), Bhubaneswar. Source: IMD

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. Refer to Table 3 for the heat related Mortality Records. 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*).

Year	No. of Death Record due to Heat Wave
2010	1274
2011	798
2012	1247

2013	1216
2014	1677
2015	2422
2016	1111
2017	220
2018	25
Source: NDMA, Ministry of Home Affairs, GoI, 2019	

Table 3-Heat Wave Mortality Records

A growing incidence of heatwaves has a significant impact on people's productivity, health and even triggers health complications that may lead to mortality. Thus Heat wave can be viewed as a major climatic hazard in the city, especially affecting the vulnerable population.

2.4 Need for Climate Adaptive action plan in Bhubaneswar

The impact of climate change on mortality from thermal stress in Bhubaneswar may be significant. Owing to its geo-climatic, geological and physical features, Bhubaneswar is vulnerable to all major natural hazards namely, drought, flood, cyclone, tsunami etc.

Existing Plans (pre-2020) are generic and do not address action required at regions, wards, vulnerable groups, climatological and spatial variation of the cityscapes in planning appropriate adaption and mitigation actions.

Vulnerable population and city authorities lack the resources to adapt to heat waves. Hence, a comprehensive Heat Stress Action Plan (HSAP) is needed to combat the dangers of Heat Stress. As per the guidelines, the heat action plans underline measures like capacity building of healthcare professionals, updating records to track emergency cases, running specialized dispensaries during peak summer, collecting real-time information and regulating the timing of construction and outdoor workers concerned.

Though the impact of heat wave has been known over the decades, it was not until 2016 that NDMA formulated the 'Guidelines for Preparation of Action Plan – Prevention and Management of Heat-Wave' to help the states take a pro-active approach to mitigate the heat stress.

ALERT CATEGORY	ALERT NAME	TEMPERATURE THRESHOLD (CELSIUS)
RED ALERT	Extreme heat alert day	Greater than or equal to 45
ORANGE ALERT	Heat alert day	43.1 – 44.9
YELLOW ALERT	Hot day advisory	41.1 – 43
WHITE ALERT	No alert	40
Source: NDMA guidelines[1]		

Heat alerts thresholds vary from city to city, based on their geography and climatology. For example, in the state of Odisha, the following thresholds are set for different cities during the summer months.

City	Month	Yellow	Orange Alert (Heat Alert Day)	Red Alert (Extreme Heat Alert Day)
Bhabanipatna	April	42.5	43.0	44.5
	May	43.5	44.5	45.5
	June	39.5	40.6	42.7
Jharsuguda	April	44.0	44.5	45.2
	May	44.3	45.0	45.5
	June	44.5	45.0	45.5
Keonjhargarh	April	40.0	41.0	42.1
	May	40.0	40.8	42.5
	June	36.3	37.8	40.4
Koraput	April	37.0	37.4	38.2
	May	37.0	37.6	39.1
	June	33.5	35.0	37.3
Sambalpur	April	42.2	43.2	44.6
	May	43.4	44.5	45.7
	June	41.1	42.6	44.8

Table 5-thresholds are set for different cities during the summer months

Bhubaneswar rapidly growing urban centre with a population of 837,737 (Census 2011). The city experiences hot and humid summers, starting in March and continuing up to July, when the advent of monsoon rains ushers in relatively cooler weather. The thresholds for Bhubaneswar city have been

Heat- Health Temperature Warning for Bhubaneswar

Hot day advisory	36.2^{0} C
Heat alert day	39.1^{0} C
Extreme heat alert day	Above 41.4^{0} C

Table 6-Advisory Threshold for Bhubaneswar by NDMA

3. Climate Adaptive Heat Action Plan for Bhubaneswar

3.1 Introduction

Integrated Research & Action for Development (IRADe) is preparing a Climate Adaptive Heat Stress Action Plan for the city of Bhubaneswar in collaboration with Bhubaneswar Municipal Corporation, Indian Institute of Public Health (IIPH)-Bhubaneswar and Odisha State Disaster Management Authority (OSDMA). 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 Bhubaneshwar

The climatological parameters that influence heat wave are high temperatures and relative humidity of a region. The climatological parameters analyzed were: Maximum Temperature

(Tmax), Minimum Temperature (Tmin), Relative Humidity were measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)]. The mean monthly values of these parameters for the summer months of March, April, May and June were plotted against the long-term climatological mean for these parameters for the respective months, to see the deviation in these parameters for the mentioned months over 2008-2018.

<table>
<tr><th>Month
(2001-2017)</th><th>Tmax
(° C)</th><th>Average Mean Tmax
(° C)</th><th>Deviation from Mean Tmax
(° C)</th><th>Tmin
(° C)</th><th>Average Mean Tmin
(° C)</th><th>Deviation from Mean Tmin
(° C)</th></tr>
<tr><td>March</td><td>+35.1</td><td rowspan="4">+36.25</td><td>+1.15</td><td>+22.3</td><td rowspan="4">+25.0</td><td>+2.7</td></tr>
<tr><td>April</td><td>+37.2</td><td>-0.95</td><td>+25.1</td><td>-0.1</td></tr>
<tr><td>May</td><td>+ 37.5</td><td>-1.25</td><td>+26.5</td><td>-1.5</td></tr>
<tr><td>June</td><td>+ 35.2</td><td>+1.05</td><td>+26.1</td><td>-1.1</td></tr>
<tr><td colspan="7">Tmax- Maximum Temperature, Tmin – Minimum Temperature,
Source: National Data Centre, IMD</td></tr>
</table>

Table 7- Maximum and Minimum Temperatures, Average Mean, and Deviation from Mean for the City of Bhubaneswar between 2001-2017

The average deviation in Tmax value for entire summer period over the study duration of 11 years is 0.89 °C, in Bhubaneshwar. All of these seven summers have shown, the mean Tmax value above 37 °C. The average deviation in Tmin value for the entire summer season over the 11-year period comes out to be 0.37 °C, with maximum deviation in seasonal Tmin value was observed in 2010 (1.425 °C).

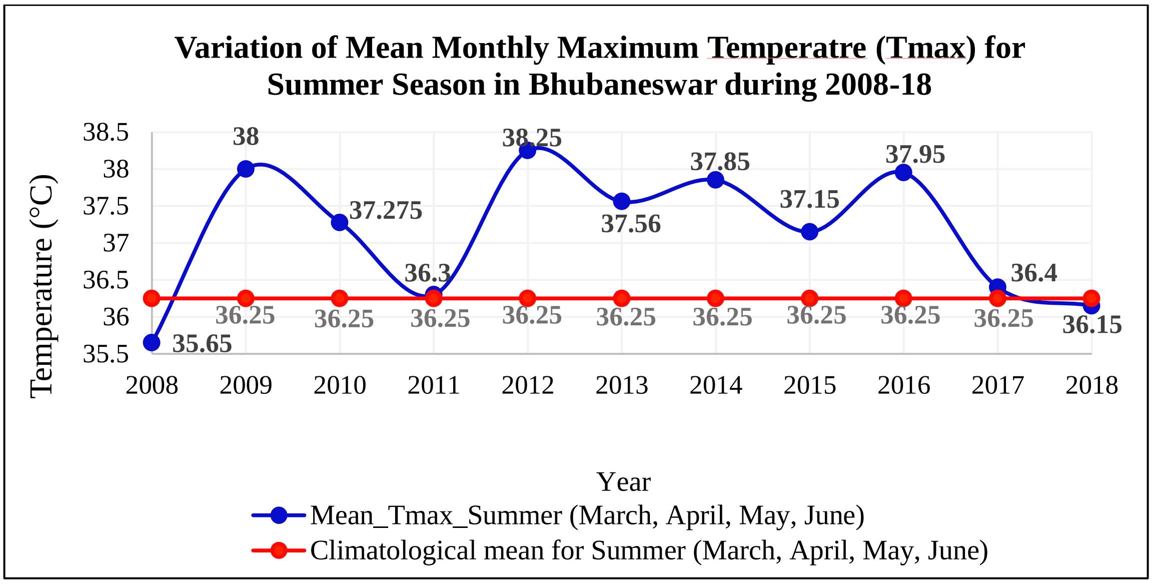


Figure 5- Variation of Monthly Mean Maximum Temperature in Bhubaneswar for Summer Season 2008-2018

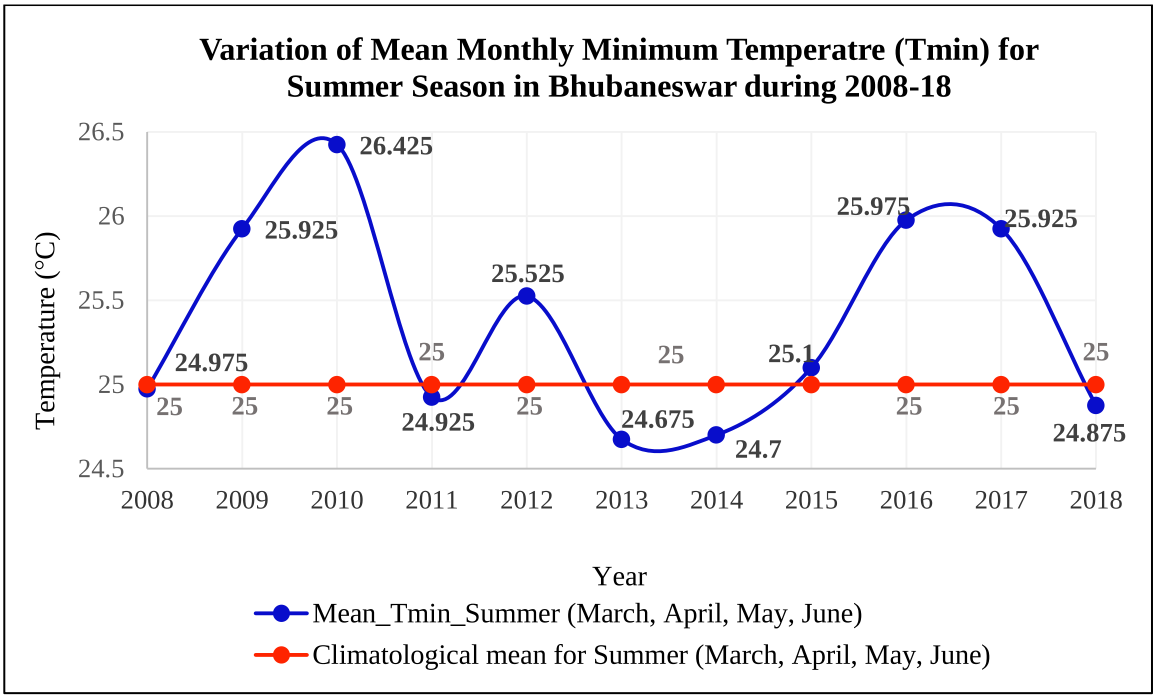


Figure 6- Variation of Monthly Mean Minimum Temperature in Bhubaneswar for Summer Season 2008-2018

Month 2004-2017)	**RH (830) (%)**	**Average Mean RH (830) (%)**	**Deviation from Mean RH (830) (%)**	**RH (1730) (%)**	**Average Mean RH (1730) (%)**	**Deviation from Mean RH (1730) (%)**
March	+76.65	+74.37	-2.28	+57.61	+64.58	+6.97
April	+72.65		+1.72	+63.08		+1.50
May	+74.82		-0.45	+66.73		-2.15
June	+81.64		-7.27	+76.27		-11.69
RH – Relative Humidity Source: IMD						

Table 8-- RH 830, RH1730, Average Mean, and Deviation from Mean for the City of Bhubaneswar between 2001-2017

Maximum deviation for RH (830) was observed in the summer of 2008 (5.38 %), followed by 2010 (3.88 %). The average deviation over the 11-year study period comes out to be 2.07%. Maximum deviation in RH (1730) was observed in the summer of 2008 (5.17 %) and 2010 (5.17 %), followed by 2018 (3.17 %). After 2015, an increase is observed every year till 2018. The average deviation over the 11-year study period comes out to be 1.34 %.

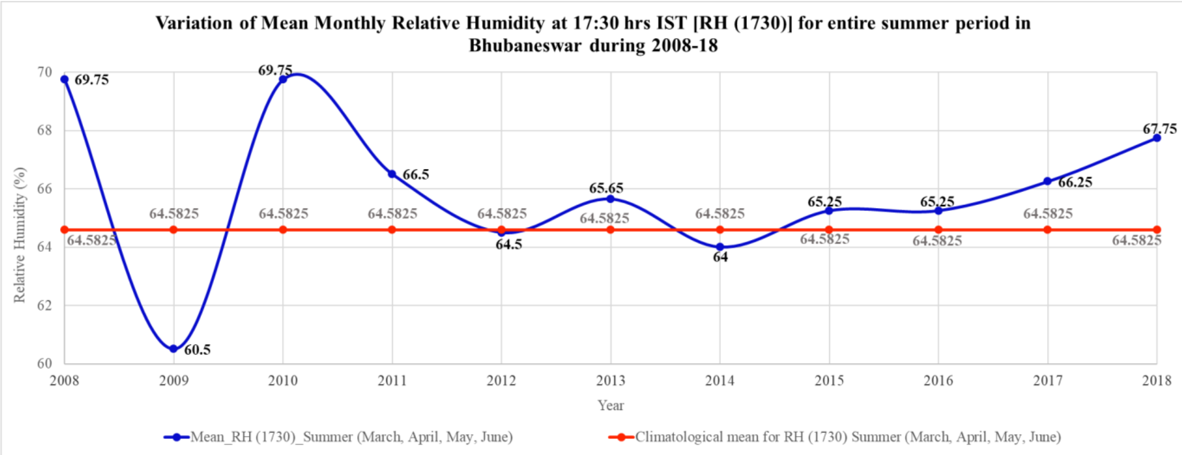


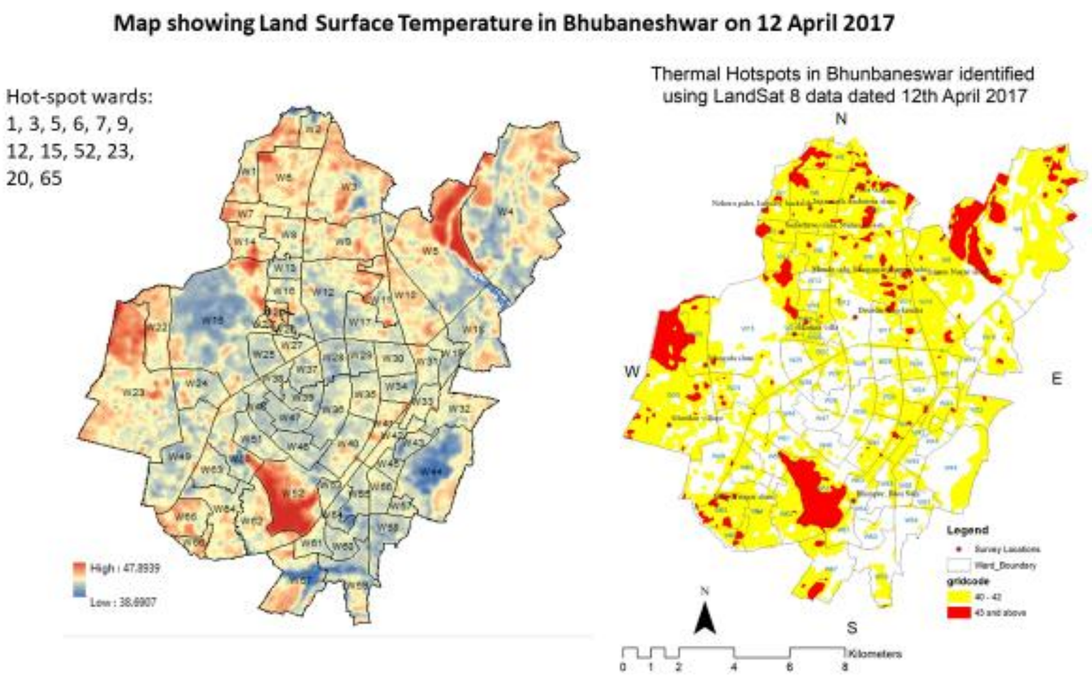
Figure 7- Variation of Monthly Mean Relative Humidity 1730 in Bhubaneswar for Summer Season 2008-2018

> The climate parameters, show a sharp increase in the month of March, which suggests Bhubaneswar is experiencing relatively more heat in the month of March. Increase in minimum temperature along with evening humidity too will lead to increase in Heat Stress.

There is clear evidence of climate variability leading to increase in number of heat wave events as well as early arrival of hot days. Local authorities need to be prepared earlier in the month of March. March is usually considered the transition month between winter and summer, and such a sharp increase in temperature and relative humidity in March will not provide people sufficient time to acclimatize, which may lead to an increase in human morbidity and mortality.

3.3 Thermal Hotspot Maps for Bhubaneshwar

The surface temperature maps of the city is 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 40 degrees Celsius were delineated across the city.



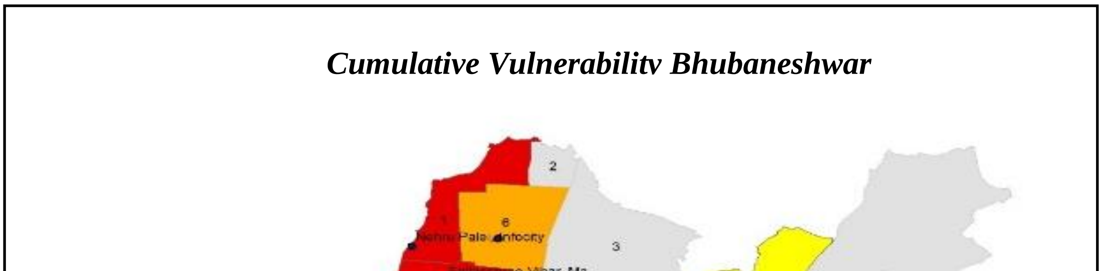
***Map**: Ward level Hot Spot Map of Bhubaneshwar city*

3.3 Identification of Ward- level vulnerability- Bhubaneshwar

Bhubaneshwar Surveyed Hotspots	Ward Number
Neheru palei, Infocity backside	1
Sriram Nagar slum	5
Jagannath Ambatota slum	6
Sailashree vihar, Mahavir vasti	7
Munda sahi, Rangamatia upara sahi	9
Doordarshan kendra	12
Ekamra villa	15
Ghatikia village	23
Mangala slum	20
Subash nagar slum	65

Heat stress vulnerability across the above identified wards in hot spot areas of Bhubaneshwar were analyzed 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 **cumulative ward wise heat stress vulnerability analysis** indicated, nearly 4 wards in west Bhubaneshwar are highly vulnerable and minimum basic amenities available to the vulnerable group to cope with heat stress



Vulnerable wards	Wards Number (Out of 10 Thermal Hotspots)	Total
Low	(20 , 12 , 15 , 5 , 65)	**4**
Medium	(6)	**1**
High	(7 , 23 , 9 , 1)	**4**

3.4 Impact on Health and Livelihood

Effect of heat stress on health and productivity of high risk population in Bhubaneswar. The study aimed to assess the impact of heat-stress on vulnerable population. A survey was conducted during May-June 2018 on vulnerable households and individuals with high risk occupations. It identified 10 hot-spot clusters in Bhubaneswar city and interviewed 25 to 30 randomly selected households, and about 100 individuals with high-risk occupation (HRO).

Key Findings

Household

1. At household level, the frequently reported symptoms of exposure to heat stress were: sweating (91.4%), headache (45.4%), dizziness (41.9%), %), dehydration (37.1%), excessive thirst (30.2%), and heat rash (29.9%). The median discomfort period ranges from 10 am to 4 pm. Majority of respondents were aware of the treatment facilities available within the city, though the most preferred methods for receiving heat-stress information were Radio/TV (78.4%) and Newspapers (27.5%).

2. Comfortable clothing, using hand fans, electric fans/AC/cooler, and drinking water frequently were frequently used mechanisms to cope with heat-stress at individual level. About 77% and 63% households sought treatment from public and private healthcare providers, respectively. Distance and poor quality were the major reason for not availing public health care services. Though majority of households (84%) used piped water as principle source of drinking water, about 28% didn't have access to toilet at the household level.

3. With respect to financial risk protection, it was found that about 83% households did not have any health insurance.

High Risk Population

1. 99% of high risk population faced problem due to heat-stress. Some of the frequently reported symptoms were: sweating (95%), excessive thirst (53%), dizziness (52%), headache (41%), heat rash (41%), dehydration (29%), and heat cramp/muscle cramp (17%). With respect to their health seeking behavior, it was found that 79.8% of respondents sought treatment from public healthcare providers. Distance to health centers of service(48.4%) and poor quality (25.8%) have emerged as the main reasons for not availing public health care services for those who didn't seek treatment. On an average, each respondent spent INR 182/- towards treatment. Further, 90% Heat Related Illness (HRI) has no health insurance.

2. Drinking water frequently (92%), comfortable clothing (57%), frequently splashing face with water/ wet cloth (38%) were most sought-after mechanisms to cope with heat-stress, since almost none (98%) had cooling facilities at workplace.

3. Two third of respondents reported that they had taken leave during summer due to excessive heat and the average length of such leaves was found to be 6 days. About 52% respondents reported loss in monthly income between INR 1,000 and INR 10,000.

5.5 Wage and Productivity Loss due to Heat Stress

Wage loss occupation wise: Casual workers are the ones majorly affected by the heat stress. The majority wage loss is observed in the casual labours across various occupation as they are highly exposed to the direct heat. The average wage loss in the city is the range INR 1 to 999.

Wage loss gender wise: Majority of the males reported wage loss due to heat. The average monthly wage loss for women is INR 600 while meals it is INR 700.

Productivity loss: 40 % of the people reported productivity loss ranging from either 1-15 days, which include number of reduced working hours and absenteeism from the work. It is observed that majority of the males have reported maximum productivity loss. In addition, the average loss in number of days due to extreme heat event in both males and females is 1 day. Casual laborers are the most vulnerable and have reported majority of productivity loss across all the occupations. This could be due to the prolonged exposure to heat.

Casual laborers are the most vulnerable and have reported majority of productivity loss across all the occupations. This could be due to the prolong exposure to heat.

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 poor working women with inadequate access to resources and information and control over the available resources. Heat stress vulnerability of pregnant women can even be higher.

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 Bhubaneswar, 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. 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 as well as the data received from 1 AWS station installed within the city by BMC. Landsat 8 provided a range of open-source data at a spatial resolution of 30 m. Data of the years 2017, 2018 and 2019 were employed to map LST. Shapefile of Bhubaneswar municipal wards and slum distribution data was obtained by BMC. LANDSAT data captures the Land surface at 10:30 AM (IST) in the morning. The methodology flow chart is shown below.

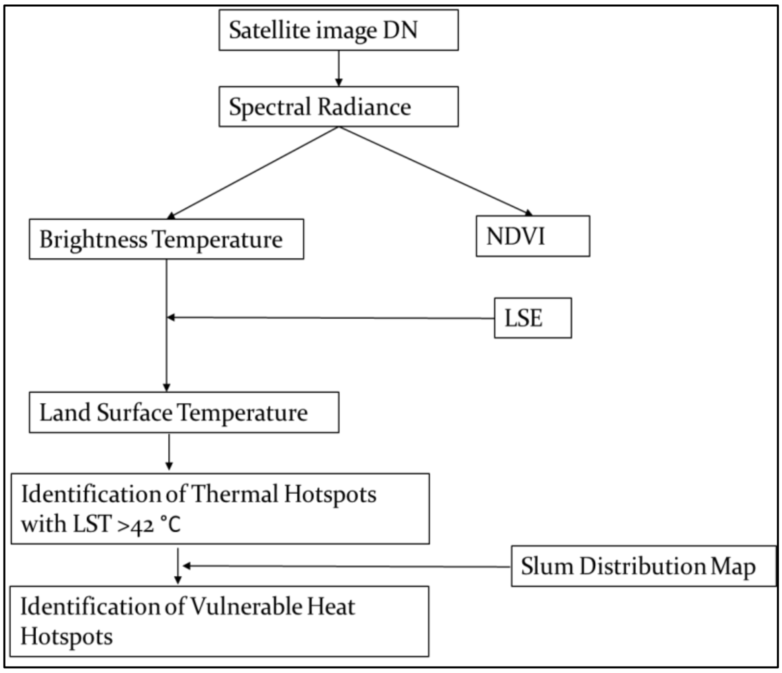
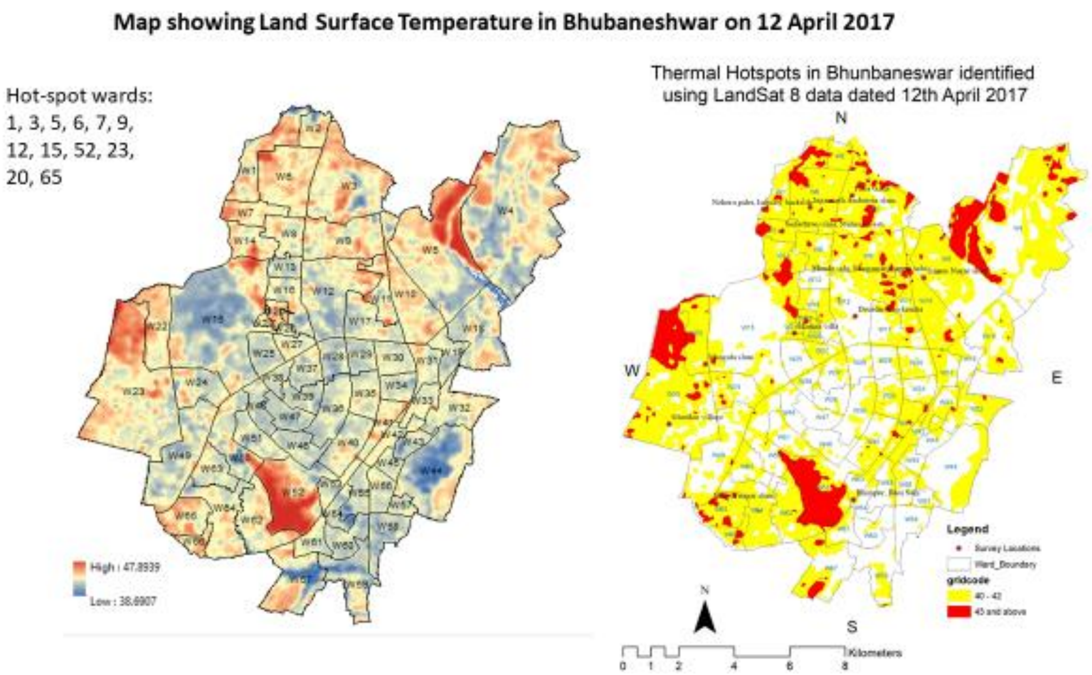
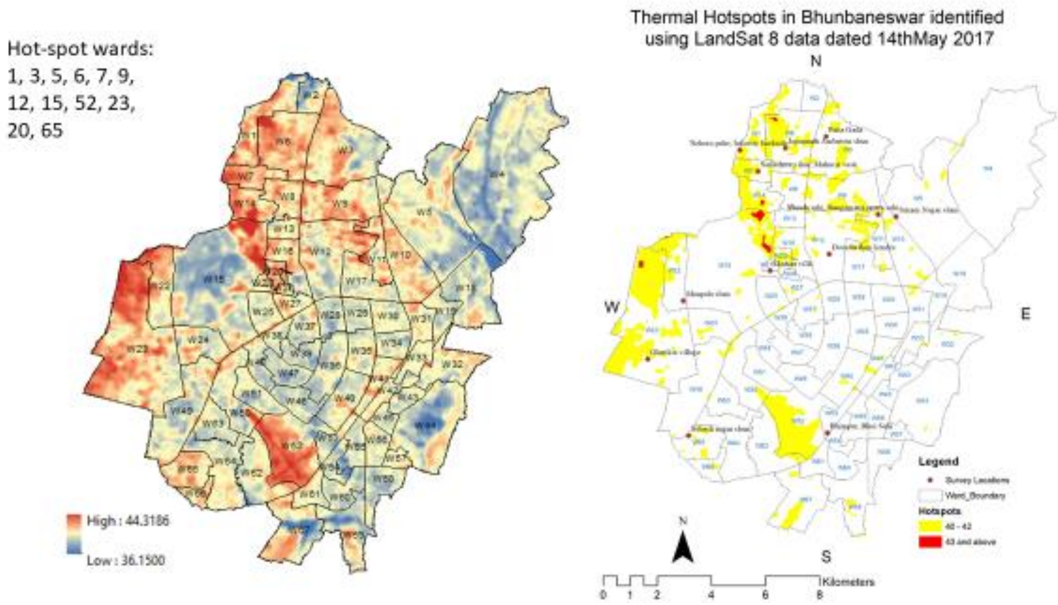


Figure 8-GIS Methodology for identification of vulnerable heat hotspots

The LST derived from satellite data was validated with ambient air temperature recorded by IMD station within the city as well as the data received from 20 AWS stations installed within the city by RMC. To mark the high temperature areas within Bhubaneswar city, thermal hotspot maps were prepared to map areas with temperature higher than 40^{o}C, and were marked as thermal hot-spots. Landsat 8 data of April and May of 2017 were employed to map Land Surface Temperature (LST).



Map showing Land Surface Temperature in Bhubaneshwar on 14 May 2017



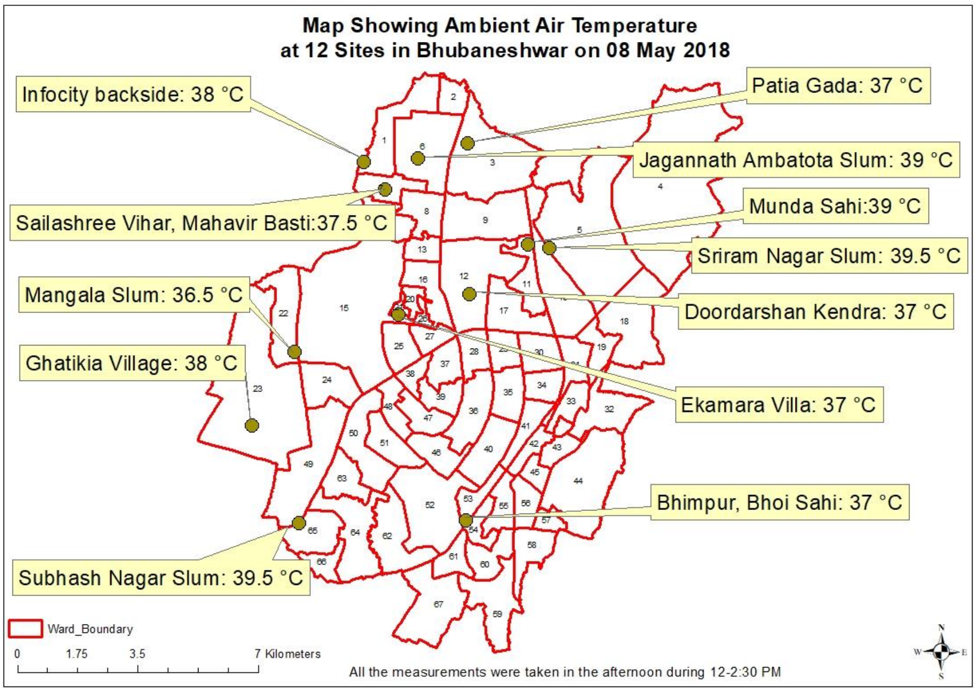
> Looking at the LST maps of April and May 2017, it is observed higher temperature is consistently experienced in ward numbers 1, 3, 5, 6, 7, 9, 12, 15, 52, 23, 20, and 65.

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 Bhubaneswar city due to urbanization and land use patterns.

> Within the city it was observed there was maximum temperature deviation up to + 1.15-degree C and maximum deviation in Minimum Temperature was +2.7 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. The map showing distribution of ambient air temperature across Bhubaneswar for 08 May 2018 is shown below.



Map: Distribution of ambient air temperature across Bhubaneswar for May 2018

5. Vulnerability Mapping

5.1 Vulnerable Areas

The hot temperatures during the heat wave often result in some parts of the city getting much hotter than rest the city. The air, surface and soil temperatures in these areas are influencing the overall temperatures often result in considerable discomfort to people occupying these spaces. Henceforth, making it important to identify such areas in order to minimize any potential medical 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 in the city.

Vulnerable areas within the city is classified as under:

Slums: The poor 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 neighborhoods: The inhabitants of these neighborhoods constantly suffer from heat stress due to poor built up environment, limited access to basic services and poor housing material. It has been observed that people living in higher floors, with poor ventilation and bad housing material compounds the impacts of heat related impacts. People with disabilities and chronic diseases are worst suffers and women in some localities can't even leave their front door open due to their safety and security issues.

Heat wave Vulnerability 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 getting affected during heat waves and experience huge heat- health implications.

(For more information on how local factors of vulnerability impact the population, refer to Annexure 3.)

5.2 Vulnerable Group Mapping

The heat wave has huge health outcomes and makes specific group of people more vulnerable to heat related mortality and morbidity. Among these, infants, children, woman, elderly, construction workers and people from economically weaker sections are affected the most.

Identification of these groups is much needed as it allows the medical professionals to efficiently prioritize actions to effectively treat heat related illnesses. This makes it even more essential to identify these vulnerable groups in order to minimize and decrease any potential threats of heat waves.

The vulnerable groups are as follows:

Infants: 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: They are physiologically more vulnerable to heat stress unlike adults. The heat related illnesses are associated with their physical activity, production of more metabolic heat/ kilogram, in comparison to 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. Their heat related illnesses are further intensified due to social norms and gender discrimination embedded in society. Lack of timely access to information on heat alerts increases their risk to heat stress.

Elderly Citizens: 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 by 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 is exceeded on a regular basis and exposure to heat for long duration leads to dehydration, compromised normal activities, chronic kidney disease, cardiovascular and pulmonary illnesses. The cultural aspects such and clothing and use of PPE may also hinder worker's ability to cool itself through sweat.

Economically Weaker Sections of Society: They often lack awareness and means to undertake any measures for protecting them against any heat related illnesses. Most of the people suffer from chronic diseases which often gets aggravated with intensification of the heat wave. Poor quality housing, lack of access to basic services of water, health services and sanitation further their compounds the vulnerability during heat wave.

People with Disabilities: They are most 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 doesn't allow body to sweat, inhibiting body to cool from overheating. Besides, any form of physical or mental disability add to their vulnerability to heat wave. To add to this, high social risk factors further adds to these challenges. It has been observed that heat wave messages are not always designed or delivered in a way that makes it easy for them to comprehend for eg people with hearing loss, blind or reduced mental health. There by making them largely dependent 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 temperature 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.

5.3 Ward Level Vulnerability zones

To identify high temperature areas within Bhubaneswar city, IRADe prepared thermal maps of Bhubaneswar. It used Land Surface Temperature (LST) imageries between 2017 and 2019 to delineate areas with persistent high temperature from March to July.

These thermal maps had unique application as they provided land surface temperature (LST) variations at the ward level, which was a first for the Bhubaneswar city. As these maps are produced using high resolution satellite data (Landsat 8, having spatial resolution 30 m), the LST can be correlated with ambient air temperatures provided by on-ground sensors. The maps produced using satellite images provide city-wide variations of LST, which is very difficult to produce using handful (in many cases we have only one on-ground sensor to report temperature for entire city) of on-ground sensors. These maps are also better correlated with local land use changes as they are very sensitive to temperature variations. These maps are very helpful in identifying thermal hotspots and in determining "local" level adaptation and mitigation measures.

These thermal maps identified areas with temperature higher than 40 ^{o}C and marked them as thermal hotspots. Therefore, in the context of this report, hotspots are those parts of the city that experience ambient temperature in excess of the average monthly maximum temperature for most of the days in that month.

Vulnerability to heat is defined as a function of: the degree of exposure to the heat hazard, sensitivity to changes in weather/climate (the degree to which a person or system will respond to a given change in climate, including beneficial and harmful effects), and adaptive capacity (the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate) (*IPCC, 2001*).

Slum distribution in Bhubaneswar was mapped in GIS (Geographic Information System), and slum distribution map was overlaid on LST maps to identify vulnerable thermal hotspots. Satellite images of Bhubaneswar were downloaded from Earth Explorer portal of United States Geological Survey and processed using TRS Tool Box (Thermal Remote Sensing) *(Walawender, Hajto, & Iwaniuk, 2012*) in ArcGIS software.

> The various areas identified as thermal hotspots in Bhubaneswar city include: Nehru palei, Infocity backside, Sriram Nagar slum, Jagannath Ambatota slum, Sailashree vihar, Mahavir vasti, Munda sahi, Rangamatia upara sahi, Doordarshan Kendra, Ekamra villa, Ghatikia village, Mangala slum and Subash nagar slum

It is usually found that both men and women are affected by heat stress, with children and elderly being more susceptible to heat stress (*McGeehin, 2001)* (*Oudin Åström, 2011) (Lundgren, 2013)* (*Li, 2015)*. People with low socio economic status (Harlan, 2006), i.e. the economically weaker section, are also found to be more susceptible to heat stresses. Pregnant women are also susceptible to increasing ambient temperatures and heat waves since their ability to thermos-regulate is compromised (Wells J.C, 2002) pregnant women working in extreme heat are more prone to dizziness and fainting.

Vulnerable population in Bhubaneswar are those who have to stay outside for work all day long and have limited options to protect themselves, for example, vendors, beggars, shopkeepers, policemen, auto/rickshaw drivers. Lack of adequate measures to combat the effects of heatwave results in health issues such as diarrhea, heat stroke, rashes, dehydration, dizziness.

6. Heat Action Plan — Strategy, Roles and Responsibilities

Benefits of Heat Stress Action Plan

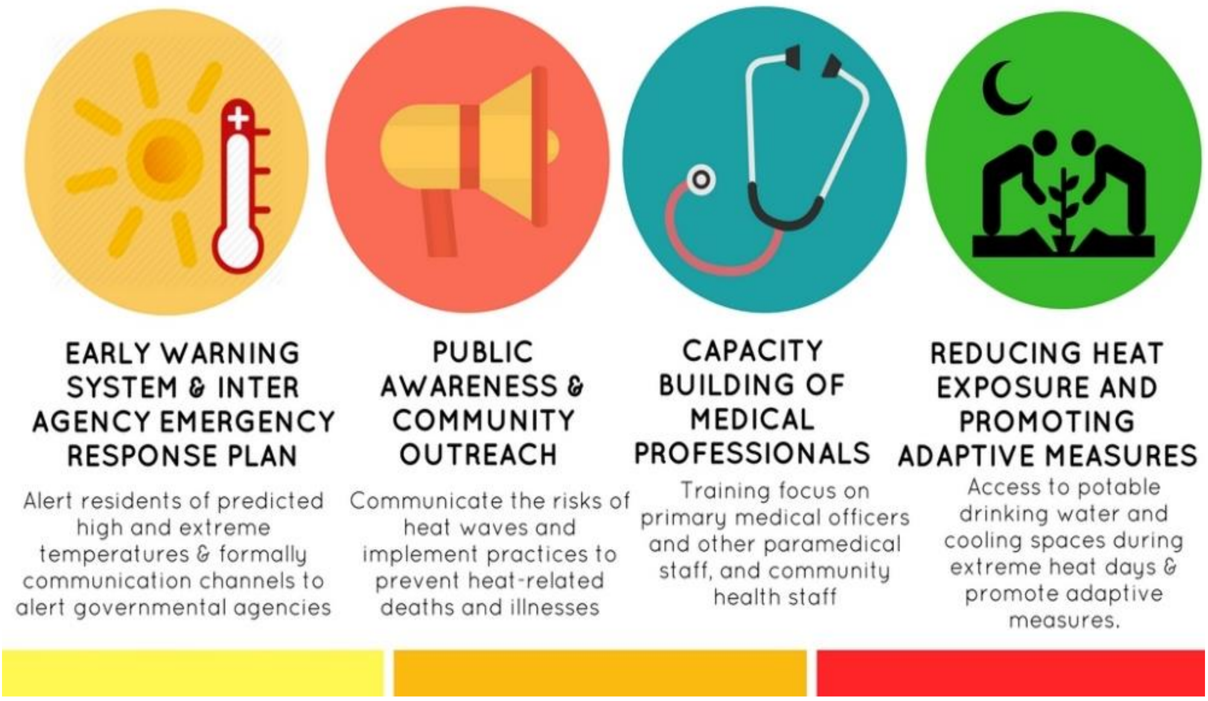
1. Prevents deaths associated with heat strokes.
2. Government commitment to protect the poor and vulnerable citizens.
3. Reduces chances of illness due to heat waves.
4. Making Indian cities future ready, Climate resilient cities.
5. Better preparedness of hospitals/health centers.
6. Economic losses- 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 Bhubaneswar 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 Bhubaneswar and guides on mitigative 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, mitigative 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.

Key Strategies

Severe and extended heat waves can also cause disruption to general, social and economic services. Government agencies will have acritical role to play in preparing and responding to heat waves at the local level, working closely with health and related departments on a long-term strategic plan.

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

This Heat Action Plan details coordinating role and responsibilities of RMC 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 RMC, 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 Bhubaneswar Municipal Corporation as part of Bhubaneswar 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 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.

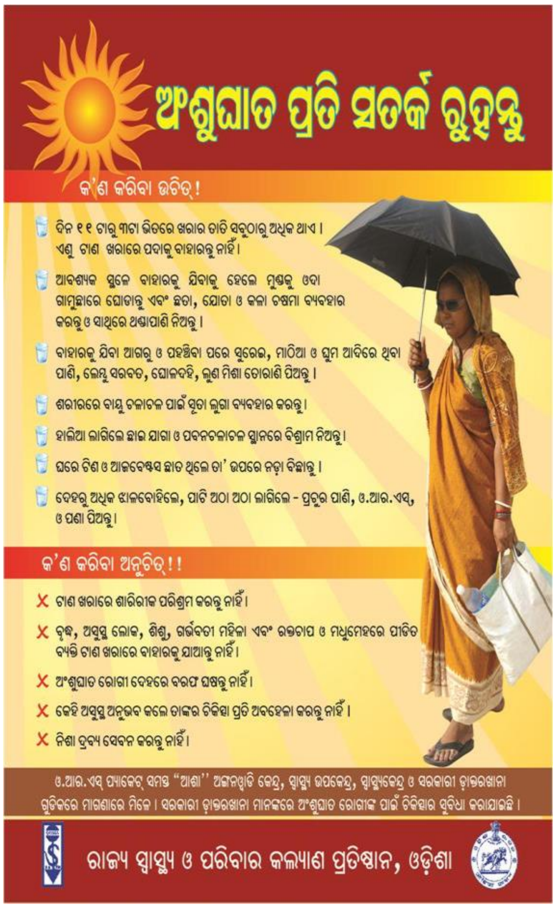


Figure 9-Heat Advisory Issued by Bhubaneswar Municipal Corporation

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.

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

BMC Nodal Officer

- Convenes a meeting of key stakeholders (Odisha State Disaster Management Authority, 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 BMC 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 BMC 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.

BMC 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 BMC 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.

BMC 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.

BMC, 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, BMC 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)

BMC Nodal Officer

- Activates the citywide **heat alert** and response mechanism based, on the Department of Meteorology’s weather forecast, by notifying the key stakeholders, BMC Deputy Municipal Commissioners and the state agencies in accordance with the Communication Plan (See figure titled Communication Plan When the BMC 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, BMC-run 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 BMC 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.

BMC 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.

BMC 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 BMC 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.

BMC 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**.

Communication Plan When the BMC Nodal Officer Activates a Heat Alert

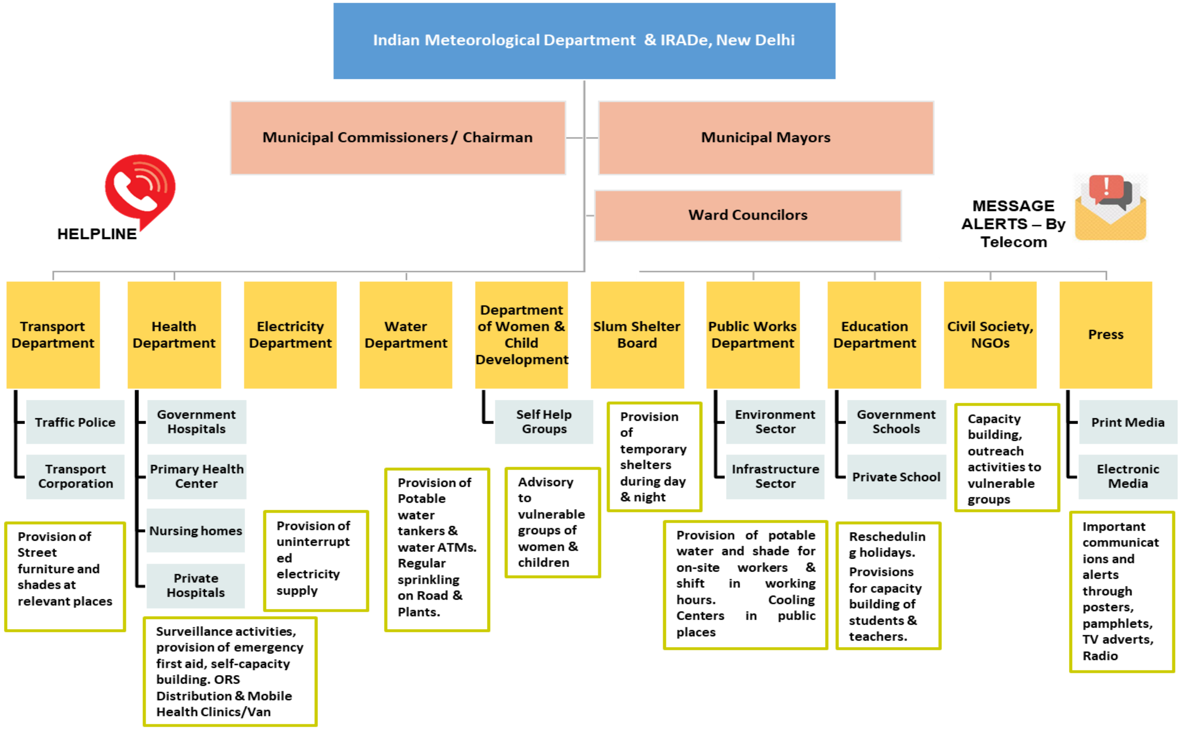


Figure 3: Communication Flow for HAP Activation

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

BMC Nodal Officer:

- Organizes annual Heat Action Plan evaluation meeting with key agency leaders and relevant stakeholders.
- Evaluates the Plan process based on performance and revises accordingly.
- Evaluates the reach and impact of the Plan and revise accordingly.
- Posts the revised Plan on the BMC 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.

BMC 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.

Detailed information on the roles and responsibilities can be found in Annexure 1

BMC 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 BMC 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 BMC 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 BMC 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

BMC 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

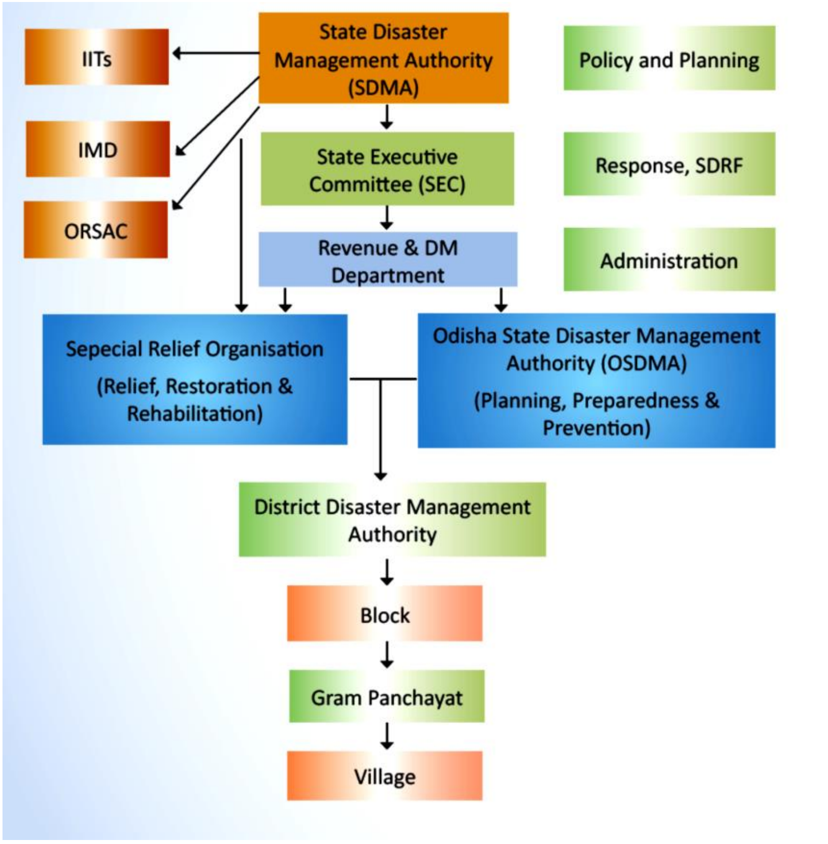


Figure 10-Institutional Mechanism for Heat Wave Management, OSDMA

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 Bhubaneswar and Odisha 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 Bhubaneswar's medium-term development planning especially in prioritizing and integrating adaptive resilience within the agenda of climate-resilient smart cities.

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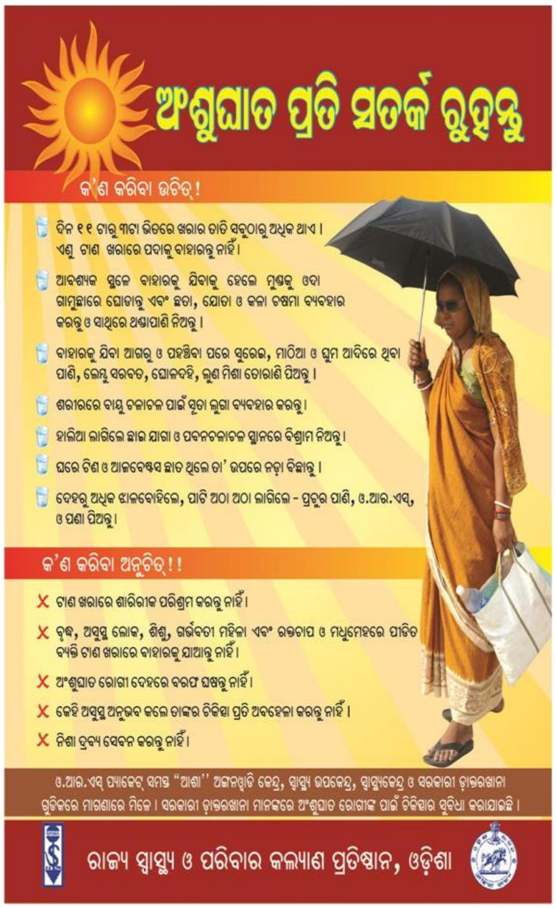
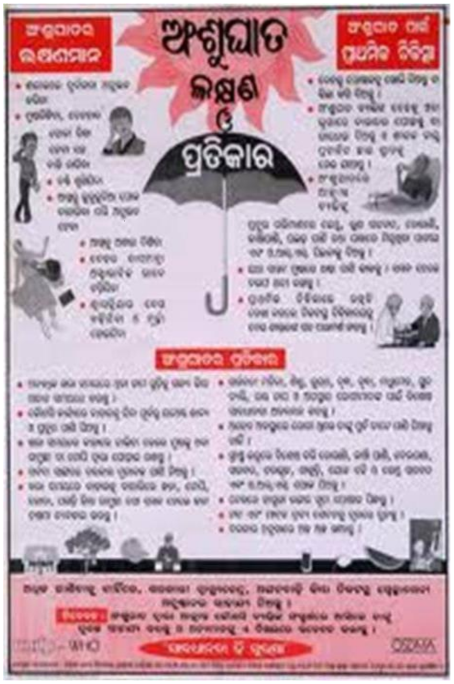
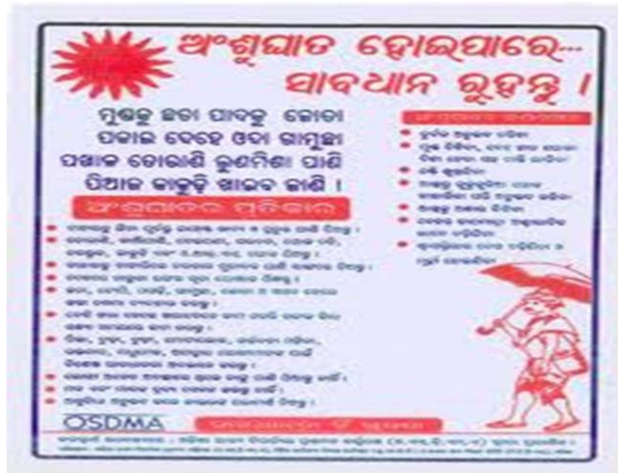
ANNEXURES

Annexure 1 – Heat Advisory Issued by the Government of Odisha







Information booklet published by OSDMA for Heat Wave situation during summer

ଗ୍ରୀଷ୍ମ ପ୍ରବାହ (Heat Wave)

ଗ୍ରୀଷ୍ମ ପ୍ରବାହ କ'ଣ ?

ଯଦି କୌଣସି ସ୍ଥାନର ତାପମାତ୍ରା ୪୦° ସେଲ୍‌ସିଅସ ପାଖାପାଖି ଥାଏ ଏବଂ ଏହା ସେହି ସ୍ଥାନର ସାଧାରଣ ତାପମାତ୍ରା ଠାରୁ ୫°–୬° ସେଲ୍‌ସିୟସ ବୃଦ୍ଧି ହୋଇଥାଏ, ତାହାକୁ ଗ୍ରୀଷ୍ମ ପ୍ରବାହ ଓ ୭° ସେଲ୍‌ସିୟସରୁ ଅଧିକ ବୃଦ୍ଧି ହୋଇଥିଲେ, ପ୍ରବଳ ଗ୍ରୀଷ୍ମପ୍ରବାହ କୁହାଯାଏ ।

ଯଦି କୌଣସି ସ୍ଥାନର ସର୍ବୋଚ୍ଚ ତାପମାତ୍ରା ୪୦° ସେଲ୍‌ସିୟସରୁ ଊର୍ଦ୍ଧ୍ୱ ଥାଏ ଏବଂ ଏହା ସାଧାରଣ ତାପମାତ୍ରା ଠାରୁ ୪–୫° ସେଲ୍‌ସିୟସ ବୃଦ୍ଧି ପାଇଥାଏ ତେବେ ତାହାକୁ ଗ୍ରୀଷ୍ମ ପ୍ରବାହ ଓ ୬° ସେଲ୍‌ସିୟସରୁ ଊର୍ଦ୍ଧ୍ୱ ବୃଦ୍ଧିକୁ ପ୍ରବଳ ଗ୍ରୀଷ୍ମପ୍ରବାହ କୁହାଯାଏ ।

ଯଦି କୌଣସି ସ୍ଥାନର ତାପମାତ୍ରା ୪୫° ସେଲ୍‌ସିୟସ ବା ତଦୁର୍ଦ୍ଧ୍ୱ ହୁଏ, ତେବେ ସେ ସ୍ଥାନରେ ସାଧାରଣ ତାପମାତ୍ରା ଯାହା ହେଲେବି ଏହାକୁ ଗ୍ରୀଷ୍ମପ୍ରବାହ କୁହାଯାଏ ।

ବେଳେବେଳେ ଅତ୍ୟଧିକ ଗ୍ରୀଷ୍ମପ୍ରବାହ ହେତୁ ମଣିଷ ମୃତ୍ୟୁମୁଖରେ ପଡିଥାଏ । ୧୯୯୮ ମସିହା ଏପ୍ରିଲ୍‌ରୁ ଜୁନ୍ ମାସ ମଧ୍ୟରେ ଗ୍ରୀଷ୍ମପ୍ରବାହ ହେତୁ ଓଡ଼ିଶାରେ ୨୦୪୨ ଜଣଙ୍କର ମୃତ୍ୟୁ ଘଟିଥିଲା । ଏହାକୁ ଅଂଶୁଘାତ ଜନିତ ମୃତ୍ୟୁ ବୋଲି କୁହାଯାଏ ।

ସୁରକ୍ଷା ଉପାୟ –

ଗ୍ରୀଷ୍ମ ପ୍ରବାହ ଓ ଅଂଶୁଘାତର ପ୍ରଭାବ କମ୍ କରିବା ପାଇଁ ନିମ୍ନଲିଖିତ ସୁରକ୍ଷା ବ୍ୟବସ୍ଥା ଗ୍ରହଣ କରିବା ଉଚିତ ।

୧. ଟାଣ ଖରାରେ ବାହାରକୁ ବାହାରନ୍ତୁ ନାହିଁ । ହାଲୁକା, ଫିକା, ଢ଼ିଲା ସୂତା ଲୁଗା ବ୍ୟବହାର କରନ୍ତୁ । ଘରେ ପରଦା ଟାଣନ୍ତୁ । ରାତିରେ ଝରକା ଖୋଲା ରଖନ୍ତୁ, ଫଳରେ ଘର ଥଣ୍ଡା ରହିବ । ଯେତେଥର ସମ୍ଭବ ଥଣ୍ଡା ପାଣିରେ ଗାଧାନ୍ତୁ ।

୨. ଶୋଷ ନଥିଲେ ମଧ୍ୟ ପ୍ରଚୁର ପାଣି ପିଅନ୍ତୁ । ଓ.ଆର୍.ଏସ୍. ପାଉଡର କିମ୍ବା ଘରେ ଉପଲବ୍ଧ ପାନୀୟ ଯଥା : ଲସି, ଘୋଳ ଦହି, ତୋରାଣି, ଲେମ୍ବୁ ପାଣି, ଦୁଧ ଇତ୍ୟାଦି ପ୍ରଚୁର ପରିମାଣରେ ପିଅନ୍ତୁ । ଗରିଷ୍ଠ ଖାଦ୍ୟ ଖାଆନ୍ତୁ ନାହିଁ ।

୩. ଚା, କଫି, ମାଦକଦ୍ରବ୍ୟ ଓ କାର୍ବନଯୁକ୍ତ ଥଣ୍ଡା ପାନୀୟ ବ୍ୟବହାର କରନ୍ତୁ ନାହିଁ ।

୪. ଯଦି ବାହାରକୁ ଯିବାକୁ ପଡେ, ନିଜକୁ ରକ୍ଷା କରିବା ଭଳି ଉପକରଣ ଯଥା : କଳା ଚଷମା, ଜୋତା ବା ଚପଲ ଏବଂ ଧଳାଛତା ବା ଟୋପି ବ୍ୟବହାର କରନ୍ତୁ । ସାଙ୍ଗରେ ପାଣି ନେବାକୁ ଭୁଲନ୍ତୁ ନାହିଁ ।

୫. ଭୀଷଣ ଖରାରେ ବିଶେଷକରି ଦିନ ୧୨ଟା ଠାରୁ ୩ଟା ପର୍ଯ୍ୟନ୍ତ କଷ୍ଟକର ଶାରୀରିକ ପରିଶ୍ରମ କରନ୍ତୁ ନାହିଁ ।

୬. ବାହାରେ କାମ କରୁଥିଲେ, ଛତା ବା ଟୋପି ବ୍ୟବହାର କରିବା ସହ ଓଦା ଗାମୁଛାରେ ମୁଣ୍ଡ, ବେକଆଦି ଶରୀରର ବିଭିନ୍ନ ଅଂଶକୁ ଘୋଡାଇ ରଖନ୍ତୁ ।

୭. ଅସୁସ୍ଥ ଅନୁଭବ କଲେ ତୁରନ୍ତ ଡାକ୍ତରଙ୍କ ପରାମର୍ଶ ନିଅନ୍ତୁ ।

୮. ବନ୍ଦ ଗାଡ଼ି ଭିତରେ ଛୋଟ ପିଲାଙ୍କୁ ଛାଡି ଆସନ୍ତୁ ନାହିଁ ।

୯. ଗୃହପାଳିତ ପଶୁମାନଙ୍କୁ ମଧ୍ୟ ଛାଇରେ ରଖି ପ୍ରଚୁର ପାଣି ପିଇବାକୁ ଦିଅନ୍ତୁ ।

ଅଂଶୁଘାତରେ ପୀଡିତ ବ୍ୟକ୍ତିର ଚିକିତ୍ସା

୧. ପୀଡିତ ବ୍ୟକ୍ତିର ଦେହ ଉତ୍ତାପକୁ କମାଇବା ପାଇଁ ଥଣ୍ଡା ଓ ଛାଇ ସ୍ଥାନରେ ଶୁଆଇ ରଖି ପ୍ରଥମେ ଓଦା କନା ବା ଗାମୁଛାରେ ତାଙ୍କୁ ପୋଛି ଦିଅନ୍ତୁ । ଆବଶ୍ୟକ ହେଲେ ମୁଣ୍ଡରେ ଥଣ୍ଡା ପାଣି ଢାଳନ୍ତୁ ।

୨. ଓ.ଆର୍.ଏସ୍. ପାଉଡର ପାଣି, ତୋରାଣି କିମ୍ବା ଲେମ୍ବୁ, ଦହି ସର୍ବତ ଇତ୍ୟାଦି ପିଆଇ ଦେହର ଜଳୀୟଅଂଶ ପରିମାଣକୁ ଠିକ୍ ରଖିବାକୁ ଚେଷ୍ଟା କରନ୍ତୁ ।

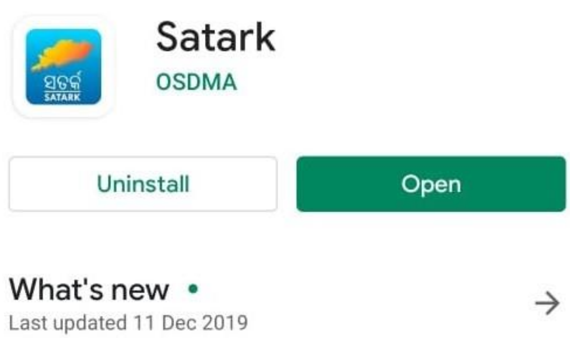
୩. ଅଂଶୁଘାତ ବେଳେବେଳେ ମୃତ୍ୟୁର କାରଣ ହୋଇଥାଏ । ଆଘାତପ୍ରାପ୍ତ ବ୍ୟକ୍ତିକୁ ତୁରନ୍ତ ନିକଟସ୍ଥ ସ୍ୱାସ୍ଥ୍ୟକେନ୍ଦ୍ରକୁ ପଠାଇବାର ବନ୍ଦୋବସ୍ତ କରନ୍ତୁ ।

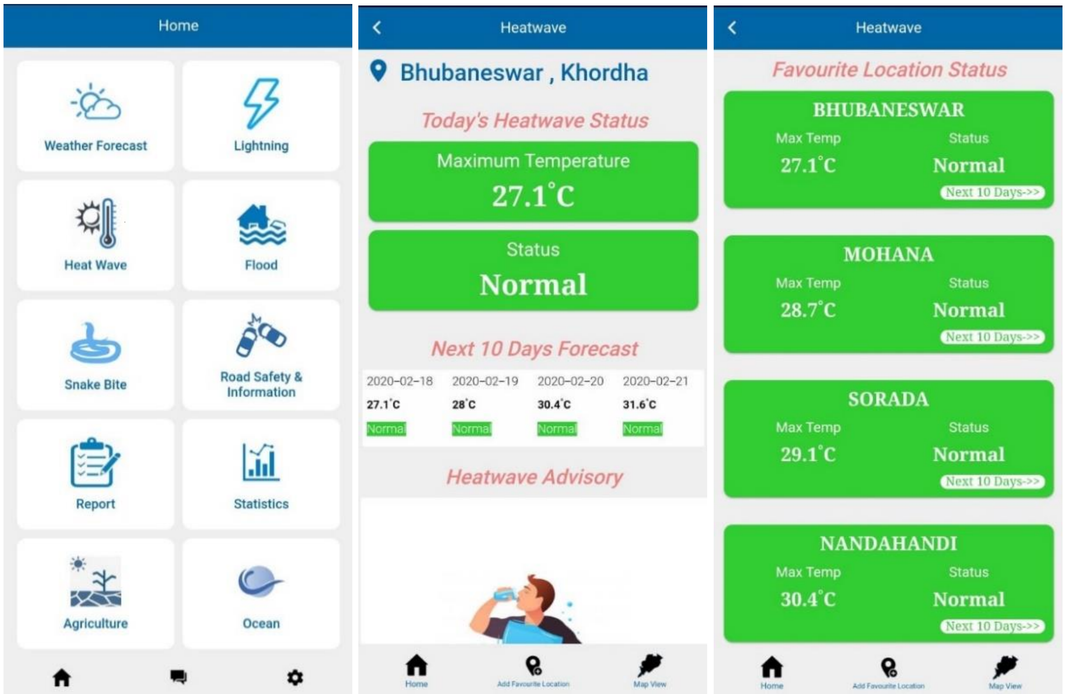
ମନେରଖନ୍ତୁ :

ଅଂଶୁଘାତରେ ପୀଡ଼ିତ ବ୍ୟକ୍ତିଙ୍କୁ ଏକାବେଳକେ ଅତ୍ୟଧିକ ପାନୀୟ ପିଇବାକୁ ଦିଅନ୍ତୁ ନାହିଁ । ସୁସ୍ଥ ହେବା ପର୍ଯ୍ୟନ୍ତ ପ୍ରତି ଅଧ ଘଣ୍ଟାରେ ଅଧା ଗ୍ଲାସ ପାନୀୟ ଦେବା ଉଚିତ ।

SATARK Web & Mobile App (IMD and OSDMA)

Web Link : https://satark.rimes.int/Login/login_form





SATARK Mobile App is available in the App Store for Android & IOS.

Annexure 2 – Climatology Profile of Bhubaneswar

Bhubaneshwar is the capital city of Indian state Odisha (formerly called Orissa). It is located on the Eastern Ghats, about 40 km west of North Bay of Bengal (with an average elevation of 45 meters above mean sea level) in Khordha district. It lies on the west bank of river Kuakhai, which is a tributary of River Mahanadi that flows about 30 km southeast of Cuttack. The river Daya branches off, at Kathjodi and flows along the southeastern part of the city. The city has a spatial spread of 135 sq. km with 67 Census wards and a population of more than 8 Lakhs (as per 2011 census). It has a population density of 6,228 person/ sq km. The city registered a growth rate of 176.67% during 1961-71 which was highest in India for that period. The decadal growth rate of the city is very high at 30.2%.

Bhubaneswar has become one of the hottest Indian cities with scorching summers in the recent time. Extremely high increase in average monthly mean maximum temperature, continuous increase in the number of hot days and rising temperature difference between Bhubaneswar and the nearby cities provide an impression of gradual emergence of the city as an urban heat island. The city in the past has recorded a history of heat waves in 1998, 2002, 2004 and 2008.Though the city also gets impacted by various other disasters (such as cyclone), heat waves have emerged as recurring threat, which gets exacerbated due to increasing urbanization.

Table 1: Climatological Parameters for Bhbaneswar

Average annual *Maximum Temp*	**32.9 °C**
Average annual *Minimum Temp*	**22.4 °C**
Mean *Maximum* Temp. of *Hottest Month (May)*	**37.2 °C**
Mean *Minimum* Temp. of *Hottest Month (May)*	**26.4 °C**
Mean *Maximum* Temp. of *Coldest Month(Dec)*	**28.9 °C**
Mean *Minimum* Temp. of *Coldest Month(Dec)*	**15.4 °C**
Ever Recorded Maximum Temperature	**46.5 °C on 22nd May 1972**
Ever Recorded Minimum Temperature	**8.6°C on 05th Jan 1992**
Average *annual Rainfall*	**161.1 cm**

Average *annual Rainy days*	**74**
Mean *monthly highest rainfall* observed in August	**39.1 cm**
Mean *monthly lowest rainfall* observed in December	**0.7 cm**

Climatology Analysis of Bhubaneswar

We have analysed the climatological variation over a period of 11 years (2008-18) in Bhubaneswar. The climatological parameters analysed are: Maximum Temperature (Tmax), Minimum Temperature (Tmin), Relative Humidity measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)]. The mean monthly values of these parameters for the summer months of March, April, May and June were plotted against the long-term climatological mean for these parameters for the respective months, to see the deviation in these parameters for the mentioned months over the 11 year period. In addition, the variation in these climate parameters for the entire summer season (for all 122 days together) is also presented. The climatological means for different cities of India for each month of the year are published by National Data Centre, Indian Meteorological Department (IMD), Pune. The data for Tmax, Tmin, RH (830) and RH (1730) for the decadal period 2008-2018 were procured from the regional centre of IMD situated at Bhubaneswar. The mean climatological values for each of the selected parameters for each of the summer months, calculated for a period of 1952-2000 by IMD is presented in the following table:

Table 2: Mean monthly climatological value for Bhubaneswar

Month	**Tmax (° C)**	**Tmin (° C)**	**RH (830) (%)**	**RH (1730) (%)**
March	35.1	22.3	74	56.83
April	37.2	25.1	70.83	62.5
May	37.5	26.5	72.83	65.67
June	35.2	26.1	79.83	73.33

Variation of Mean Monthly Maximum Temperature (Tmax) for the individual summer months in Bhubaneswar during 2008-18

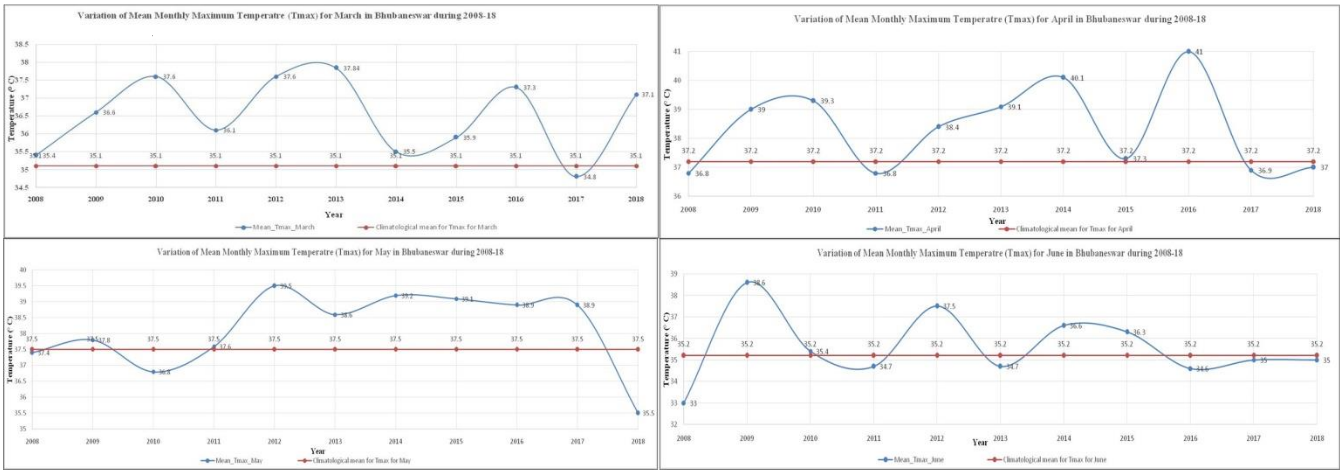


Fig 1: Variation of Tmax for March, April, May and June in Bhubaneswar during 2008-18

1. On an average, maximum departure from climatological mean has been observed for the month of March (1.42 °C) in Bhubaneswar, followed by April (1.14 °C), May (0.61 °C) and June (0.38 °C) during the study period. This means for Bhubaneswar, increase in Tmax is more in March compared to other summer months. **Thus, March is getting heated at relatively faster rate than rest of the summer months.**

2. For March, maximum deviation in Tmax from climatological mean was observed in 2013 (2.74 °C), while for April maximum deviation was recorded in 2016 (3.8 °C). For May, maximum deviation was recorded in 2012 (2 °C) and 2018 (2 °C). For June, maximum departure was observed in 2009 (3.4 °C). These departures appear significant, considering that we have analysed data for 10 years only.

3. Looking at the trend,it seems the average monthly Tmax value in Bhubaneswar for March has increased by 1.42 degree C during the study period. Please note that climatological mean for March is 35.1 degree C which itself seems higher for the month of March. Further increase in average maximum monthly temperature value may have significant impact on people living there.

Variation of Mean Monthly Maximum Temperature (Tmax) for the entire summer period in Bhubaneswar during 2008-18

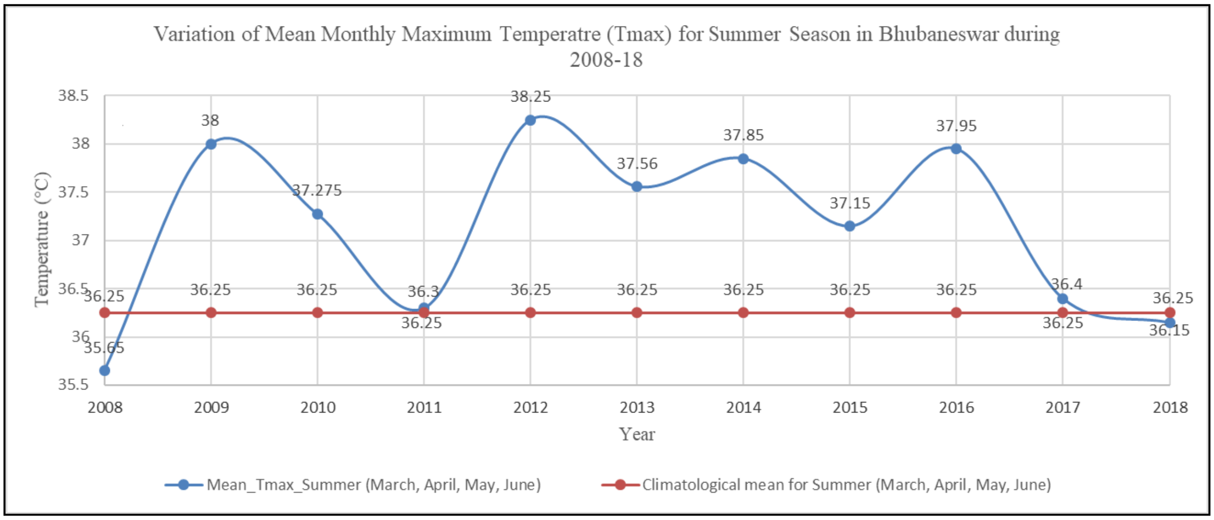


Fig 2: Variation of Tmax for the entire summer season in Bhubaneswar during 2008-18

1. **Out of the 11 summers studied, nine showed Tmax values above the climatological mean of the season.**

2. Considering that summer lasts four months, mean of summer going above the climatological mean in nine out of 11 studied years is significant.

3. **The average deviation in Tmax value for entire summer period over the study duration of 11 years comes out to be 0.89 °C.**

4. All of these seven summers have shown, the mean Tmax value above 37 °C. Please note for Bhubaneswar, heat threshold is considered in between 36.2- 40.5 °C (OSDMA, 2019: Heat Action Plan for Odisha, 2019).

5. The last two years (2017 and 2018) have shown reduction in mean summer values of Tmax compared to earlier five years (2012, 13, 14, 15, 16).

Variation of Mean Monthly Minimum Temperature (Tmin) for the individual summer months in

1. As observed for Tmax, here also **the maximum deviation in Tmin value has been observed in the month of March (0.59 °C). Thus, March is relatively getting more hot than other summer months in Bhubaneswar.**

2. **All the summer months have shown increase in mean Tmin value over the period of 2008-18**, with March registering maximum departure followed by April (0.35 °C), June (0.35 °C) and May (0.18 °C).

3. For March, maximum deviation was observed in 2010 (2.4 °C). For April, we had maximum deviation in 2010 (1.8°C) and 2016 (1.8°C). For May, maximum positive deviation was observed in 2015 (0.8 °C) and 2017 (0.8 °C) whereas 2014 (-1 °C) recorded maximum negative deviation. For June, maximum deviation was recorded in 2009 (1.4 °C).

Bhubaneswar during 2008-18

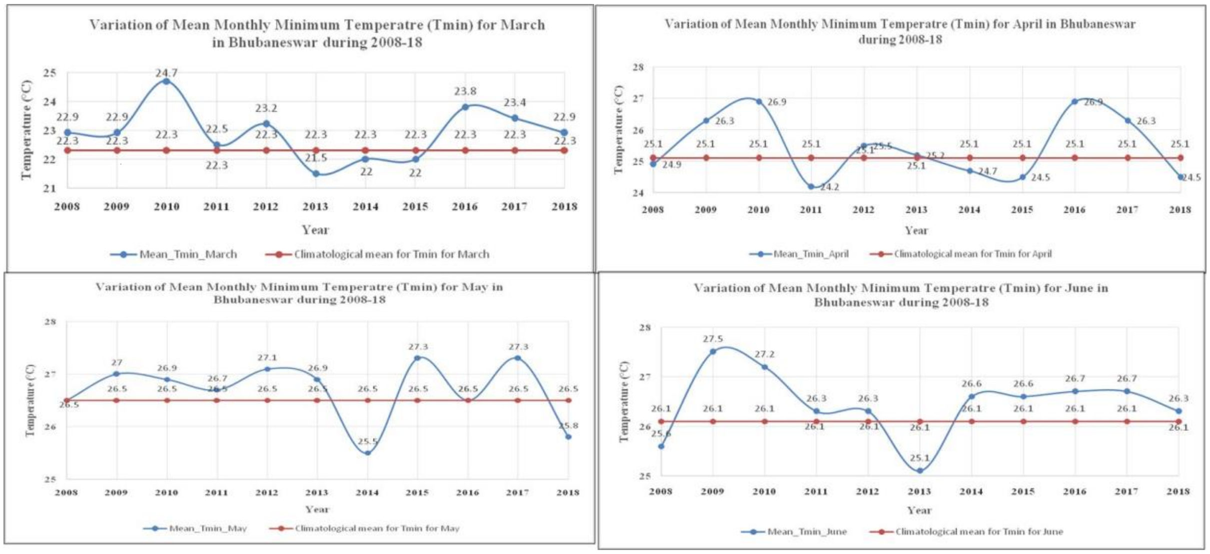


Fig 3: Variation of Tmin for March, April, May and June in Bhubaneswar during 2008-18

Variation of Mean Monthly Minimum Temperature (Tmin) for the entire summer period in Bhubaneswar during 2008-18

1. Six, out of eleven studied years, have registered mean monthly minimum temperature (Tmin) for the entire summer period in excess of climatological mean values.
2. **The average deviation in Tmin value for the entire summer season over the 11 year period comes out to be 0.37 °C.**
3. Maximum deviation in seasonal Tmin value was observed in 2010 (1.425 °C).
4. The years, 2008 and 2018, both have shown a decline in seasonal Tmax and Tmin values relative to seasonal climatological mean.

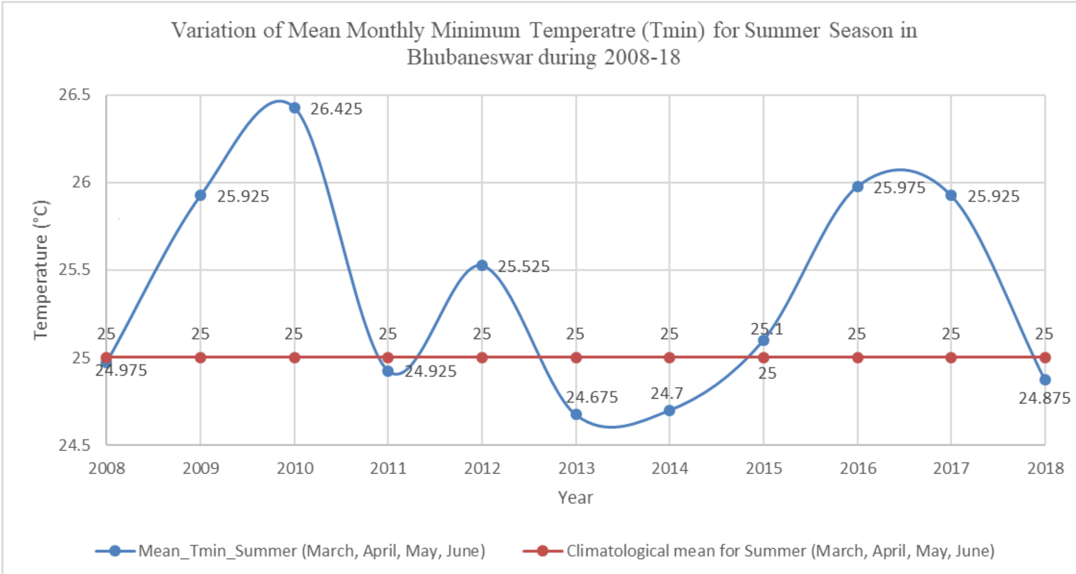


Fig 4:Variation of Tmin for the entire summer season in Bhubaneswar during 2008-18

Variation of Mean Monthly Relative Humidity (RH) measured in the morning at 8:30 AM [RH(830)] for the individual summer months in Bhubaneswar during 2008-18

1. **Mean RH at 8: 30 hrs has increased by nearly 2.65% in March**, 1.82% in April, 1.98% in May and 1.80% in June during the decade of 2008-18.
2. For the month of March, maximum deviation from climatological mean was observed in 2008, followed by 2012 and 2017.
3. For the month of April, maximum deviation was observed in 2017, followed by 2008.
4. For the month of May, maximum deviation was observed in 2018, followed jointly by (2010, 2011 and 2013).
5. For June, 2008 showed maximum deviation followed by 2011 and 2016.

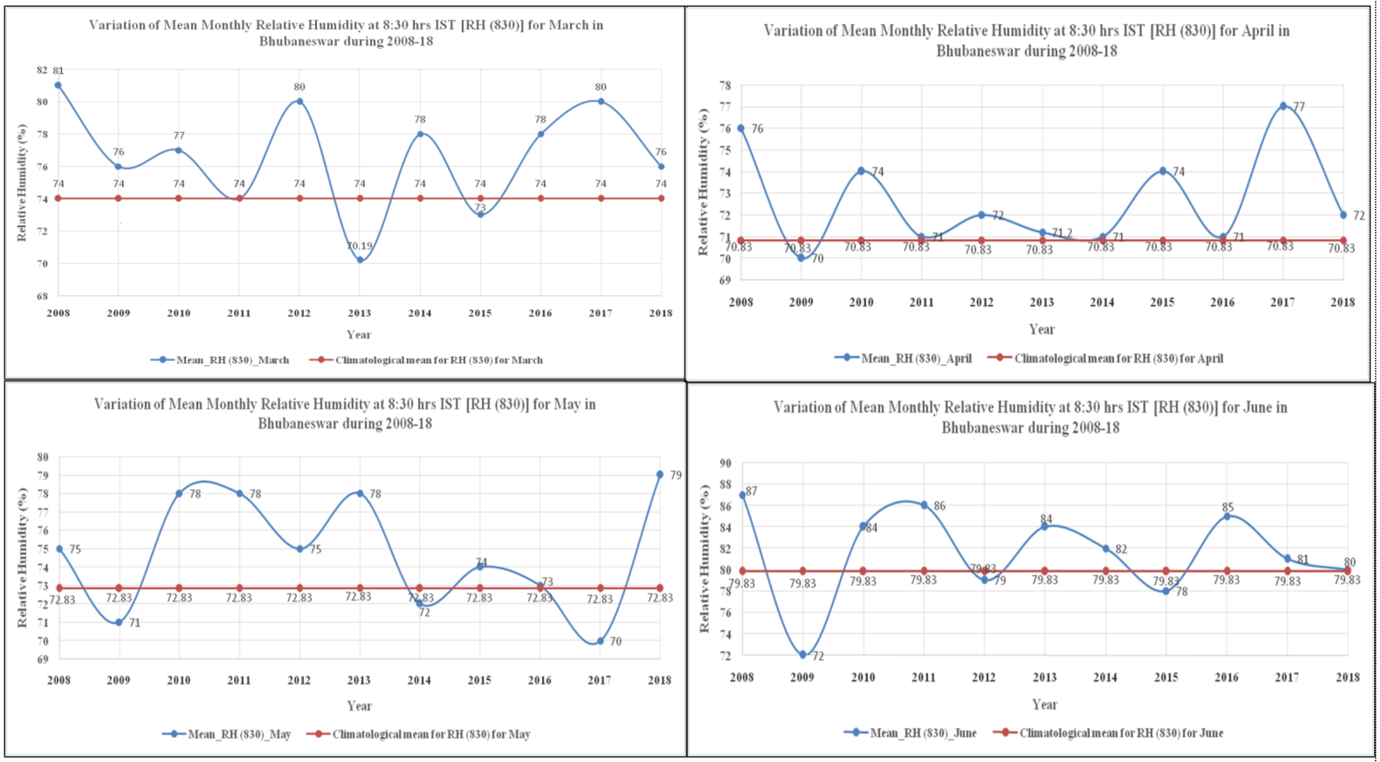


Fig 5: Variation of RH at 8:30 hrs for March, April, May and June in Bhubaneswar during 2008-18

Variation of Mean Monthly Relative Humidity (RH) measured in the morning at 8:30 AM [RH(830)] for the entire summer period in Bhubaneswar during 2008-18

1. **The RH values measured in morning were above the climatological mean for 10 out of 11 years studied.**
2. Maximum deviation was observed in the summer of 2008 (5.38 %), followed by 2010 (3.88 %).
3. **The average deviation over the 11-year study period comes out to be 2.07%**.

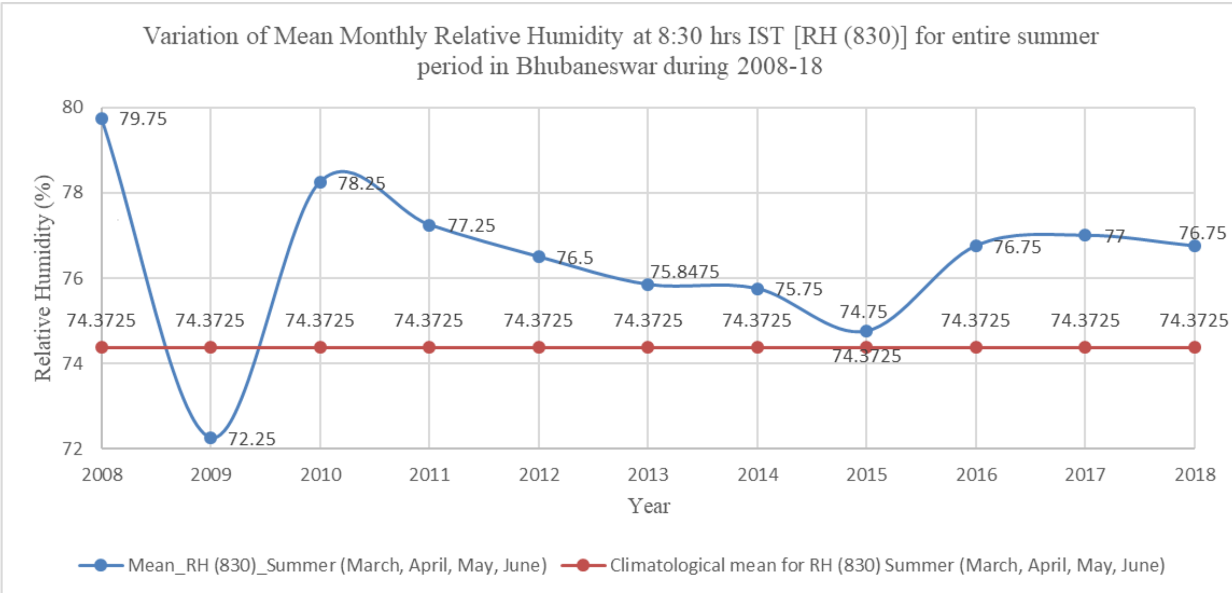


Fig 6: Variation of RH at 8:30 hrs for entire summer period in Bhubaneswar during 2008-18

Variation of Mean Monthly Relative Humidity (RH) measured in the evening at 5:30 PM [RH(1730)] for the individual summer months in Bhubaneswar during 2008-18

1. Maximum variation during the study period was observed for the month of June: 2.94%; followed in sequence for May (1.05%), March (0.78%) and April (0.58%).

2. For the month of June, maximum positive deviation was observed in 2008; whereas maximum negative deviation was observed in 2009. An analysis of rainfall data may help understand this contrasting deviation in consecutive years.

3. For March, maximum positive deviation was observed in 2010, followed by 2008 and then 2017.

4. For the month of March, negative deviations were observed in seven years (2009, 2011, 2012, 2013, 2015, 2016, 2018) out of total eleven years under study. However, the negative deviations were not as alarming as positive deviations!! The positive deviation values of 6.17 (2008), 7.17 (2010), 3.17 (2014) and 4.17 (2017) are relatively quite high when we compare with negative deviation values (Except 2013 value). Please note we are talking about RH values measured at 17:30 hrs. It is expected that evening humidity values will be lower than morning values (average mean for morning humidity in March is 74 and for evening it is 56.83). But if evening humidity values will approach closer to morning values; it will add to the discomfort already experienced during the day. It is also worthwhile noting that morning humidity values showed maximum increase in the March during the last decade.

5. For April and May, the deviation values were not as alarming as observed for March. Looking at the Tmax, Tmin, and RH analysis; March is very crucial month for Bhubaneswar for heat stress and needs special attention.

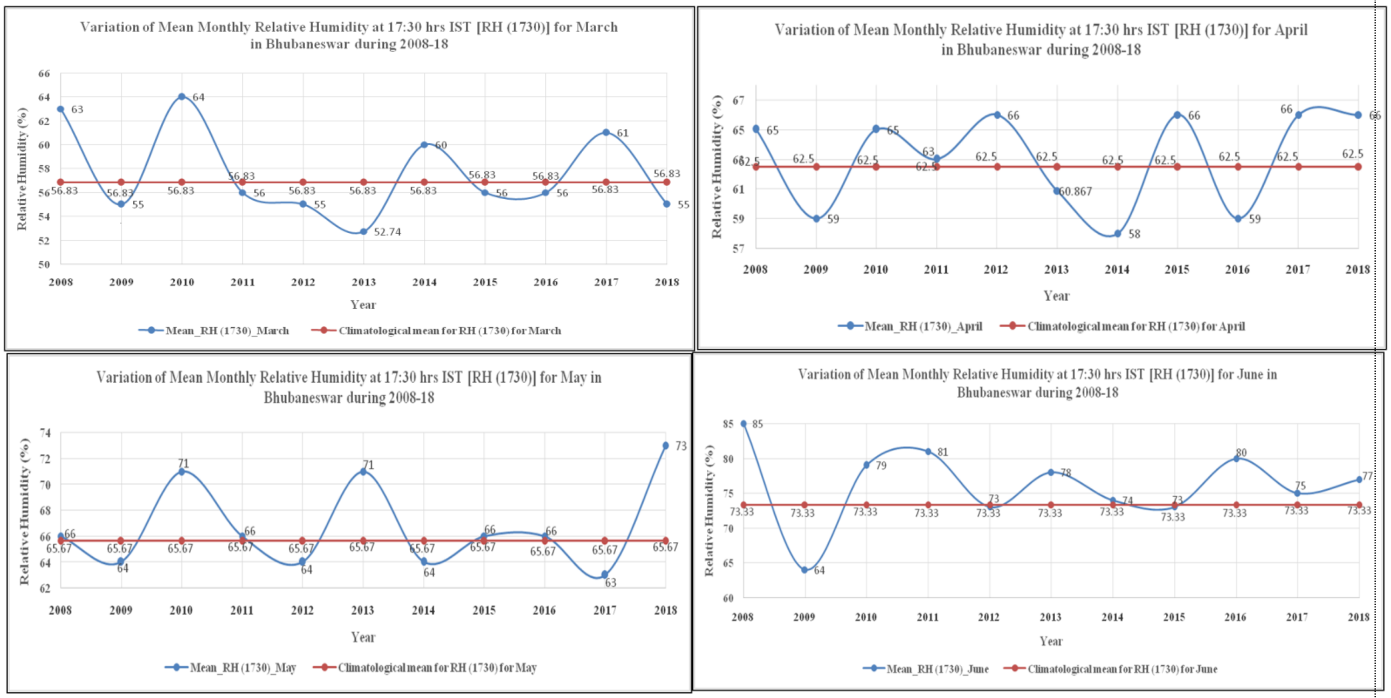


Fig 7: Variation of RH at 17:30 hrs for March, April, May and June in Bhubaneswar during 2008-18

Variation of Mean Monthly Relative Humidity (RH) measured in the evening at 5:30 PM [RH (1730)] for the entire summer period in Bhubaneswar during 2008-18

1. The RH values measured in the evening were above the climatological mean for 8 out of 11 years studied.
2. Maximum deviation was observed in the summer of 2008 (5.17 %) and 2010 (5.17 %), followed by 2018 (3.17 %). After 2015, an increase is observed every year till 2018.
3. **The average deviation over the 11-year study period comes out to be 1.34 %.**
4. The year 2009 reported a sharp dip in the RH values for both morning and evening time.
5. **Normally, the evening humidity levels are considered lower than the morning values. However, as observed for 2008, 2010 and 2018; the evening levels are approaching closer to the morning values which will make life more difficult for general masses, as they can't expect the comfortable ambience even in the evening.**

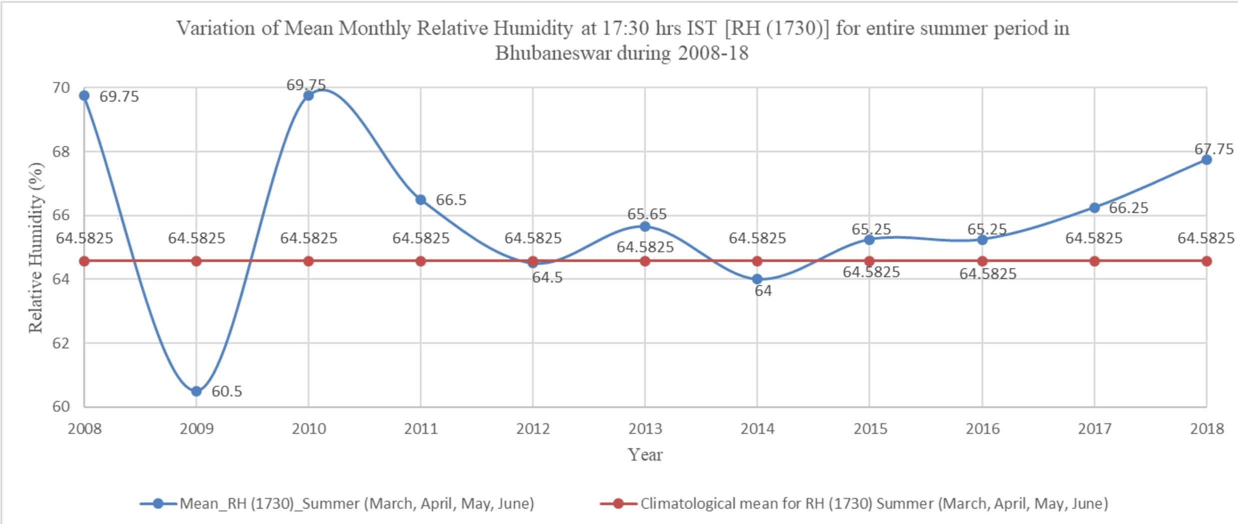


Fig 8: Variation of RH at 17:30 hrs for entire summer period in Bhubaneswar during 2008-18

Conclusion

The analysis of climatological parameters, viz, Tmax, Tmin and Relative Humidity, presents an increasing trend in Bhubaneswar in summer months. **In particular, the climate parameters, show a sharp increase in the month of March, which suggests Bhubaneswar is experiencing relatively more heat in the month of March.** In particular, increase in minimum temperature along with evening humidity will not allow the ambience to cool in the evening and thus will make life more difficult for people living there. The local authorities should take more care in the month of March as March is usually considered the transition month between winter and summer, and such a sharp increase in temperature and relative humidity in March will not provide people sufficient time to acclimatize, thereby, leading to an increase in human morbidity and mortality.

Annexure 3 - Impact of Heat Stress on Health, Livelihood and Productivity

Low-income groups living in the slums were particularly vulnerable as the thermal hotspot in the city were in the slums and squatter settlements. The surveyed households included construction workers, street vendors, domestic helpers and sweepers. An average household comprised 4 members. The survey captured information on the resident population's occupation, working hours, occupational pattern, mode of transportation, the impact of heat stress, and their coping capacity.

Health Impact of Heat Stress

Case Definitions

Clinical Entity	Case Definition
Heat rash	Diffused, pruritic, maculopapular or vesicular rash in the setting of heat exposure, often with insulating clothing or swaddling
Heat cramps	Painful contractions of frequently used muscle groups in the setting of heat exposure, often with exertion
Heat exhaustion	Syndrome of generalized weakness and or exhaustion, often with light headedness, limiting functioning in a hot environment, without history of recent infection. May or may not be exertional.
Heat syncope	Brief loss of consciousness in the setting of heat exposure without evidence of seizure activity, stroke, or medication overdose.
Heat stroke	Altered mental status (including disorientation, delirium, seizure, obtundation) with elevated core body temperature ≥ 40°C in the setting of heat exposure, without signs of stroke, history of infection, or signs of medication overdose. May or may not be exertional.

Heat Illness- Typical Presentations

Clinical Entity	Age Range	Setting	Cardinal Symptom	Cardinal Signs	Pertinent Negatives	Prognosis

Heat Rash	All, But frequently children	Hot environment; +/- insulating clothing or swaddling	Itchy Rash with small red bumps at pores in setting of heat exposure; bumps can sometimes be filled with clear or white fluid	Diffuse maculopapular rash, occasionally pustular, at hair follicles; pruritic	Not focally distributed like a contact dermatitis; not confluent patchy; not petechial haemorrhages	Full recovery with elimination of exposure and supportive care
Heat Cramps	**All**	Hot environment typically with exertion; +/- insulating clothing or swaddling	Painful spasms of large and frequently used muscle groups	Uncomfortable appearance may have difficulty fully extending affected limbs /joints	No contaminate wound/tetanus exposure; no seizure activity	Full recovery with elimination of exposure and supportive care
Heat Exhaustion	**All**	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling overheated, lightheaded, exhausted and weak, unsteady, nauseated, sweaty and thirsty, inability to continue activities	Sweaty/Diaphoretic; Flushed skin; hot skin; normal core temperature; +/- dazed, +/- generalized weakness, slight disorientation	No coincidental signs and symptoms of infection, no focal weakness, no aphasia, /dysarthria, no overdose history	Full recovery with elimination of exposure and supportive care; progression if continued exposure
Heat Syncope	Typically, adult	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling hot and weak; light-headedness followed by brief loss of consciousness	Brief Generalized loss of consciousness in hot setting, short period of disorientation if any	No seizure activity, no loss of bowel or bladder continence, no focal weakness, no aphasia/dysarthria	Full recovery with elimination of exposure and supportive care, progression if continued exposure

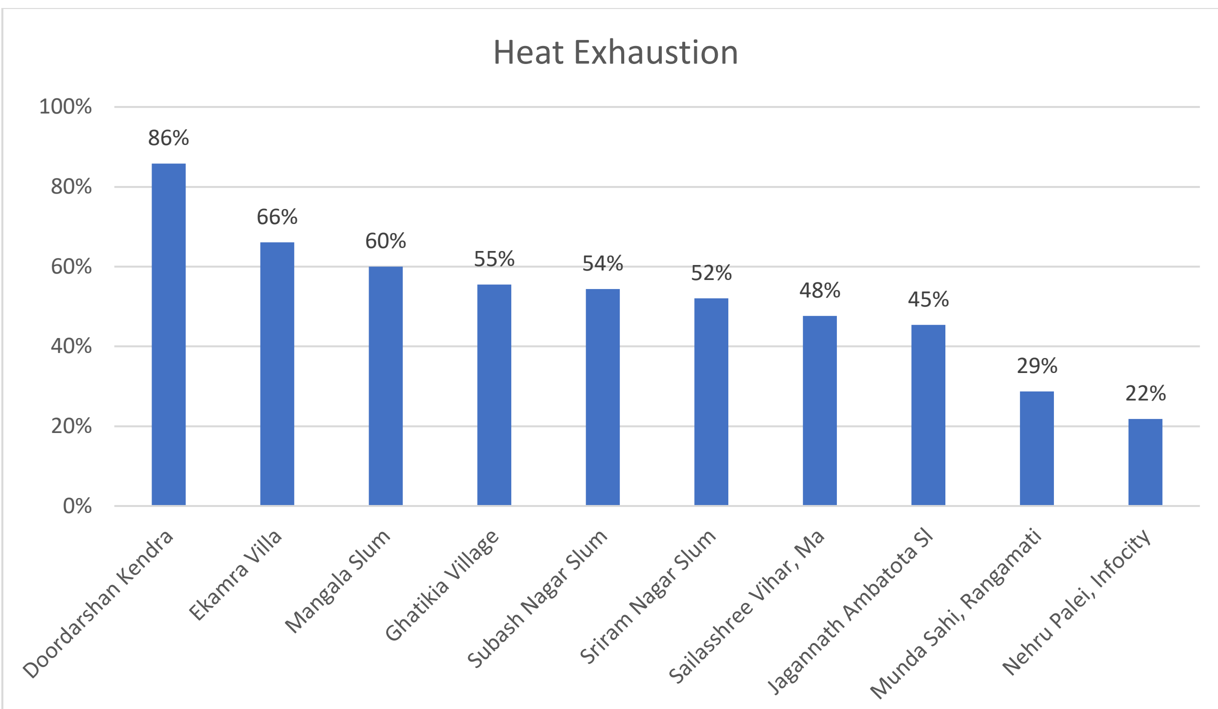
Heat Stroke	**All**	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Severe overheating, profound weakness, disorientation, obtundation, seizures or other altered mental status	Flushed dry skin (not always), core temperature ≥ 40-degree C, altered mental status with disorientation, possibly delirium, coma, seizures, tachycardia, +/- hypotension	No coincidental signs and symptoms of infection; no focal weakness; no aphasia/dysarthria, no overdose history	25-50% mortality even with aggressive care, significant morbidity if survive

Ward-level Analysis of Heat Stress in Vulnerable Communities of Bhubaneswar

KEY FINDINGS

- ❖ Doordarshan Kendra ward was the most affected by Heat Exhaustion
- ❖ Nehru Palei Infocity ward was the most affected by Heat Stroke
- ❖ Jagannath Ambatota SI ward had the lowest Heat Stroke cases
- ❖ More than half of the sample population in six wards experienced heat exhaustion
- ❖ Outdoor workers are more affected than indoor workers in all wards

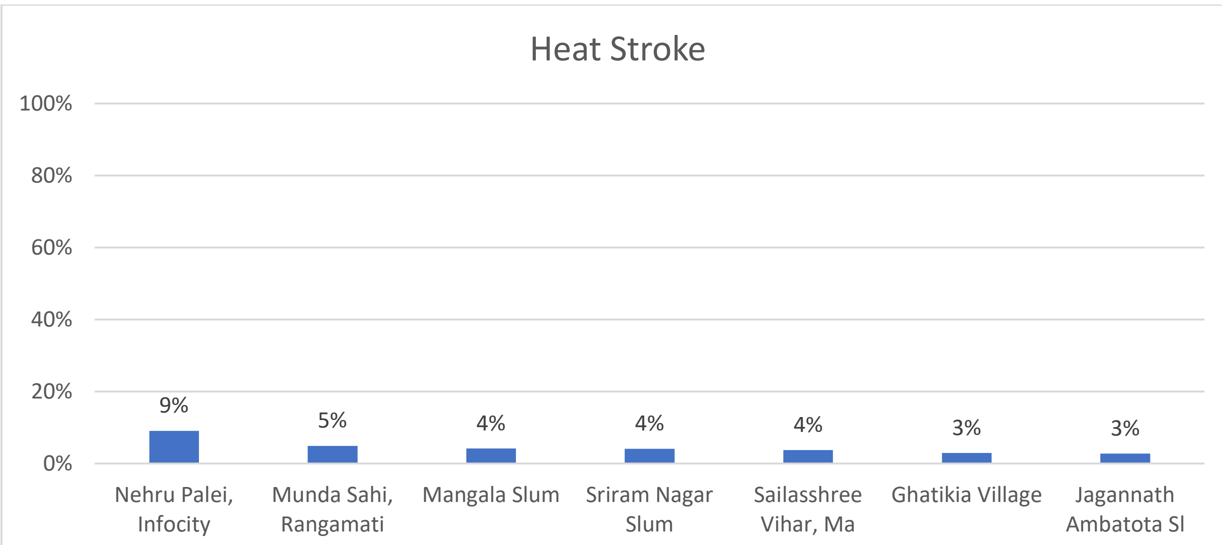
Overall Impact of Heat Exhaustion



Heat Exhaustion cases are prevalent more in Doordarshan Kendra (86%) in least in Nehru Palei Infocity (22%). Heat Exhaustion is affecting most of the population in Bhubaneswar and more so in the vulnerable groups. Our study found out that irrespective of the occupation and nature of work (indoor/outdoor), the population is impacted by heat stress and experience heat exhaustion. In six wards, more than 50% of people suffered from Heat Exhaustion.

Heat Stroke

Compared to Heat Exhaustion, Heat Stroke cases were comparatively lower. The percentages of Heat Stroke were very low in all wards. However, Nehru Palei was an exception, with 9% experiencing heat stroke.

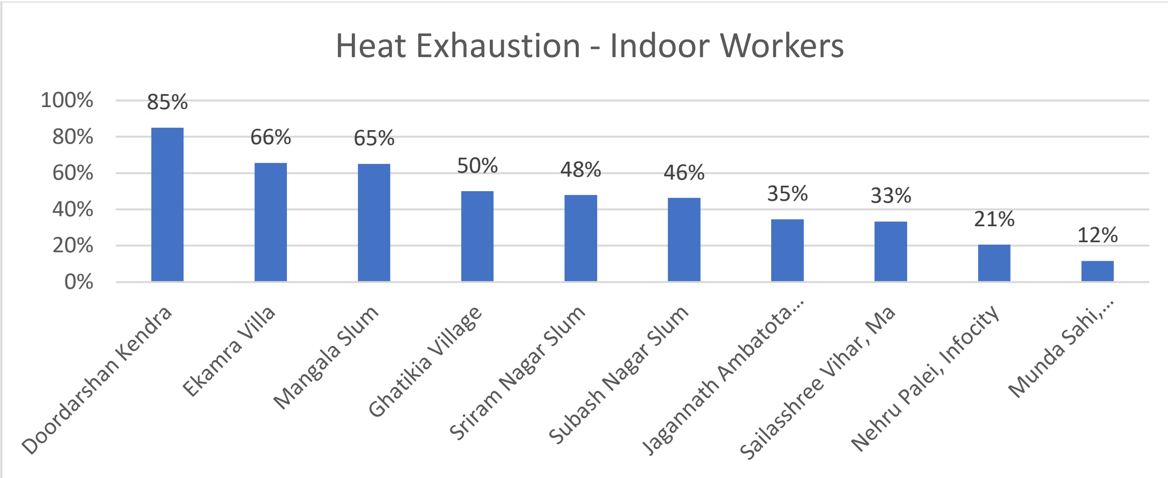


Work Environment

In order to assess the impact of work environment, we studied the percentage of Heat Exhaustion and Heat Stress among indoor workers and outdoor workers.

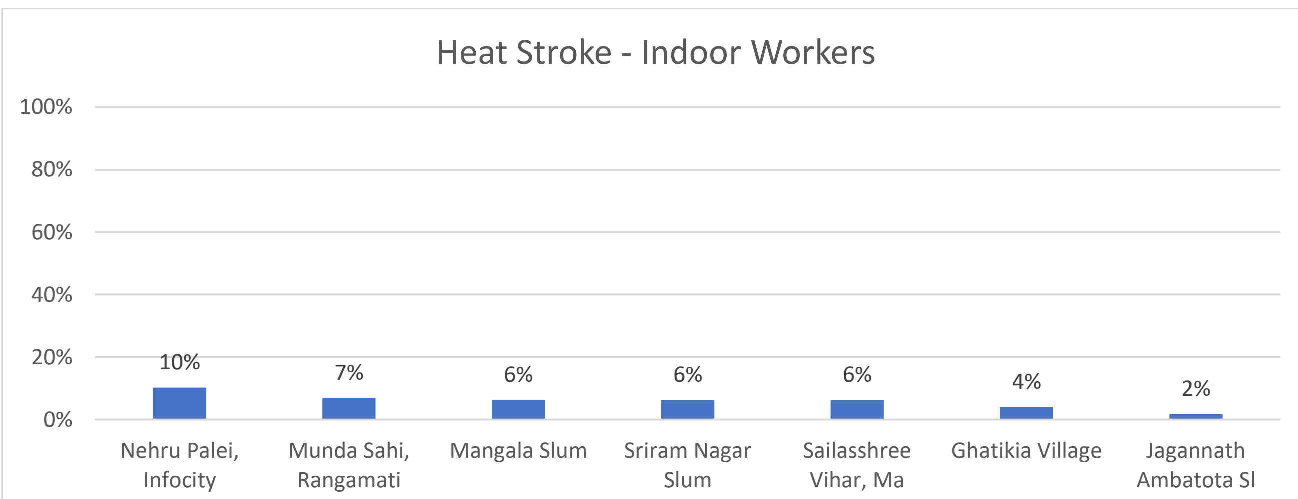
Indoor Workers – Heat Exhaustion

Majority (45 percentage or more) of indoor workers in six wards suffered from heat exhaustion, with Doordarshan Kendra being the worst affected. Munda Sahi Rangamati indoor workers were the least affected by heat exhaustion.



Indoor Workers – Heat Stroke

None of the wards experienced high heat stroke levels among indoor workers. Nehru Palei infocity (10%) had the highest Heat Stroke level.



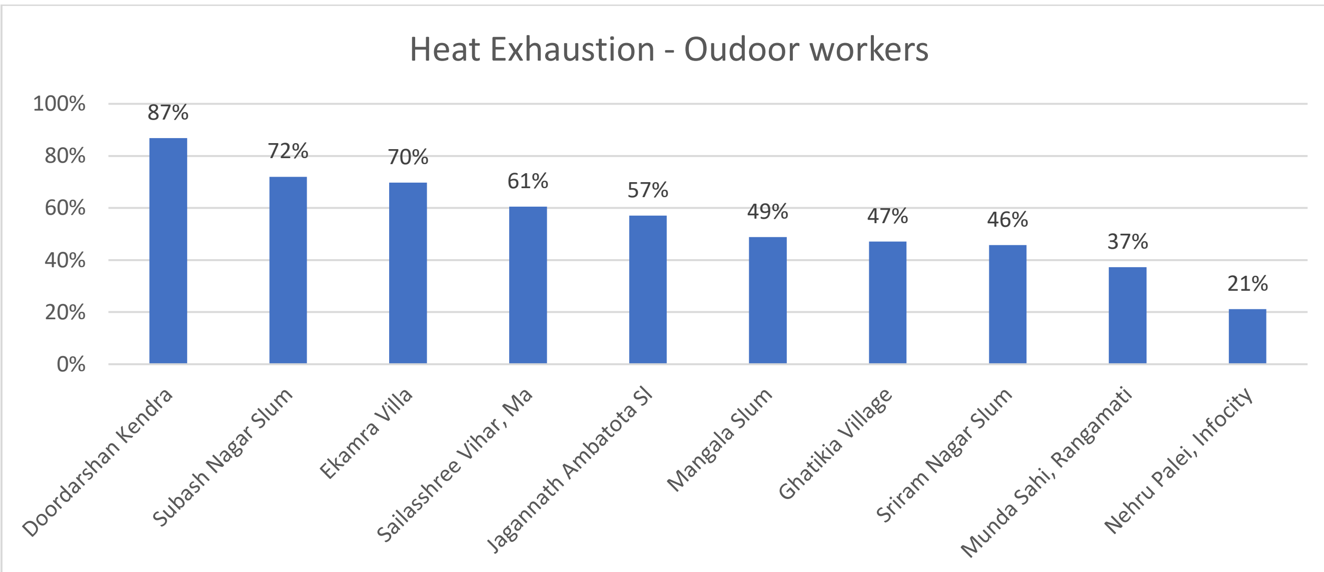
Outdoor Workers – Heat Exhaustion

Heat exhaustion was a major problem in at least eight wards (all recording above 45%). Outdoor workers in Doordarshan Kendra were the worst affected and those in Nehru Palei Infocity were least affected by heat exhaustion.

Most Impacted Wards

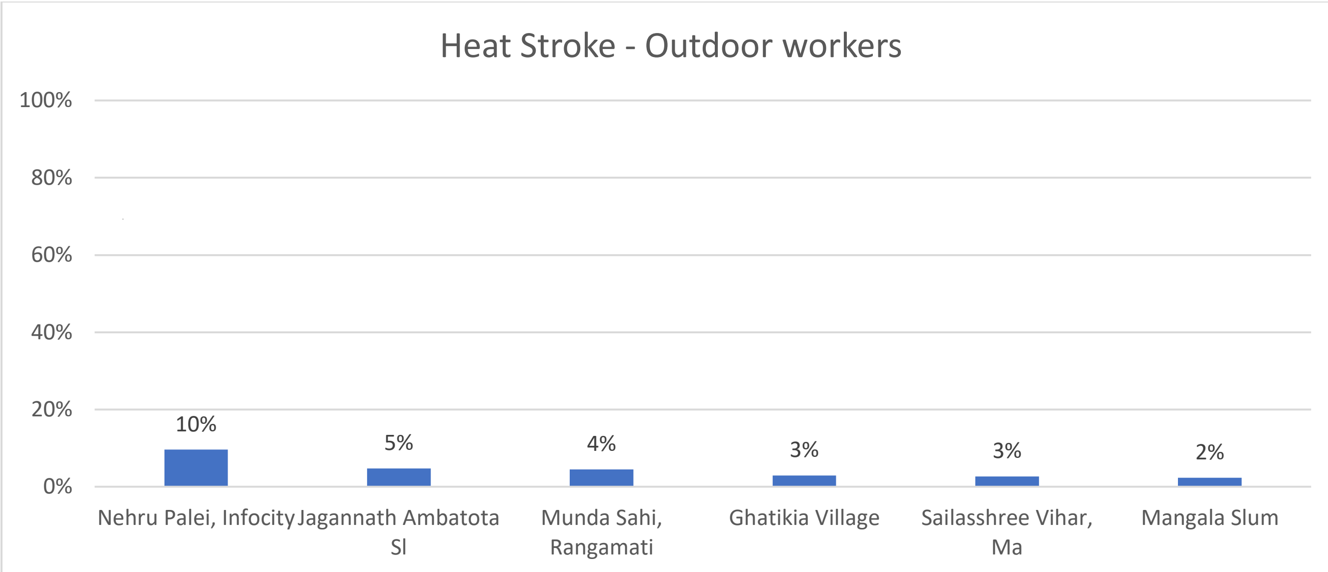
Wards	% of Outdoor Workers Impacted by Heat Exhaustion

Doordarshan Kendra	87
Subash Nagar Slum	72
Ekamra Villa	70



Outdoor Workers – Heat Stroke

Heat Stroke was not a significant problem in any of the wards. The ward with most heat stroke cases was Nehru Palei.



10% of outdoor workers in Nehru Palei infocity suffered from Heat Stroke, while only 2% of those in Managla slum suffered from Heat Stroke.

Heat Stress Impact on Different Age Groups

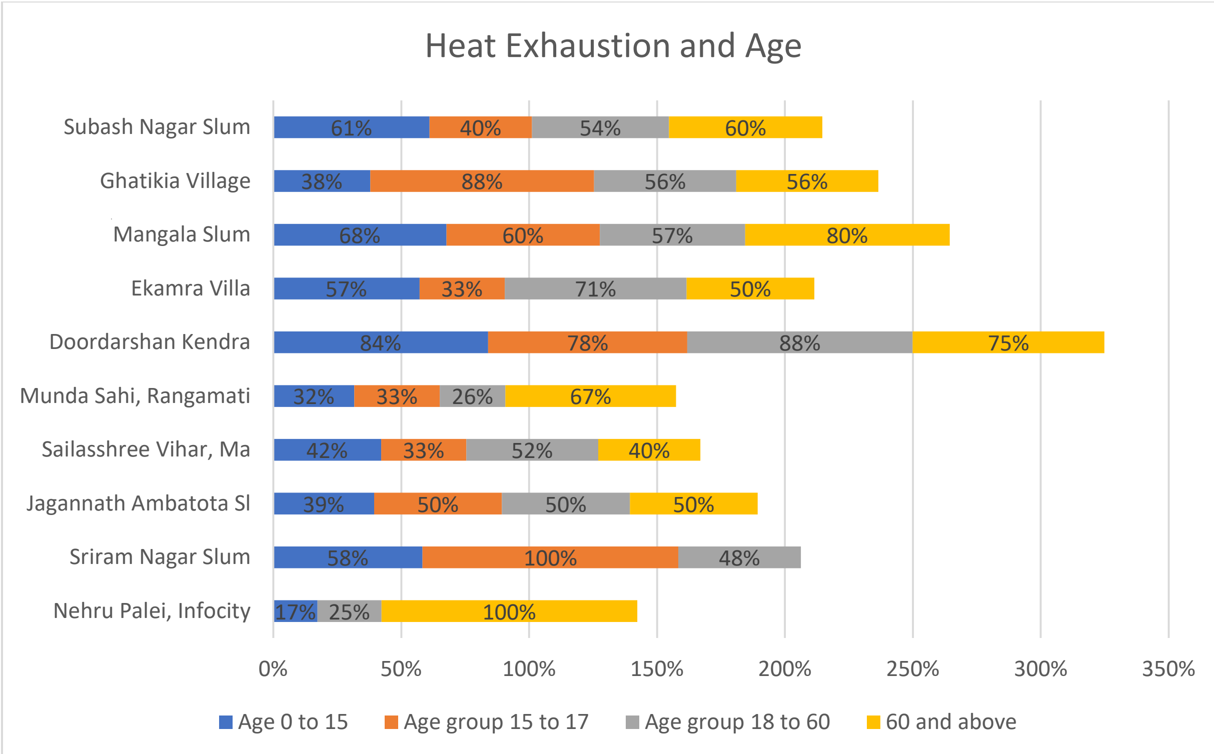
KEY FINDINGS

- ❖ All age groups were highly impacted by Heat Exhaustion.
- ❖ Senior citizens (60+ age group) were the most impacted by Heat Exhaustion.
- ❖ Heat Stroke Impact was very minimal and insignificant, in comparison to Heat Exhaustion.

Heat Exhaustion – Age Group

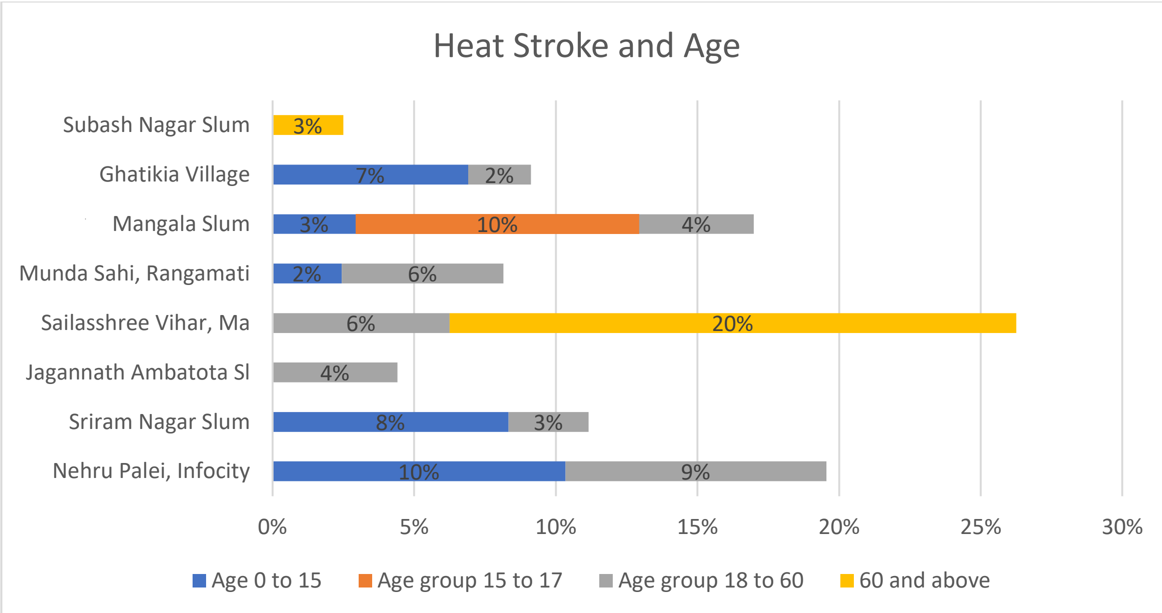
Heat Exhaustion impacted all age groups. Senior citizens were the worst affected, with more than 40% of senior citizens affected by Heat Exhaustion in all wards. The working age group (18-60) were also impacted by Heat Exhaustion. Special measures are required to protect senior citizens from heat exhaustion.

Age Group	**Worst Affected Wards**
60 & Above	Nehru Palei, Infocity
	Managala Slum
	Doordarshan Kendra
18 to 60	Ekamra Villa
	Doordarshan Kendra
15 to 17	Sriram Nagar Slum
	Ghatikia Village
	Doordarshan Kendra
0 to14	***Doordarshan Kendra***



Heat Stroke – Age Grou

Heat stroke percentage was relatively low among the sample population. Senior citizens at the Sailasshree Vihar were the most affected. Children (0-15 age group) were the most affected in Nehru Palei Infocity.



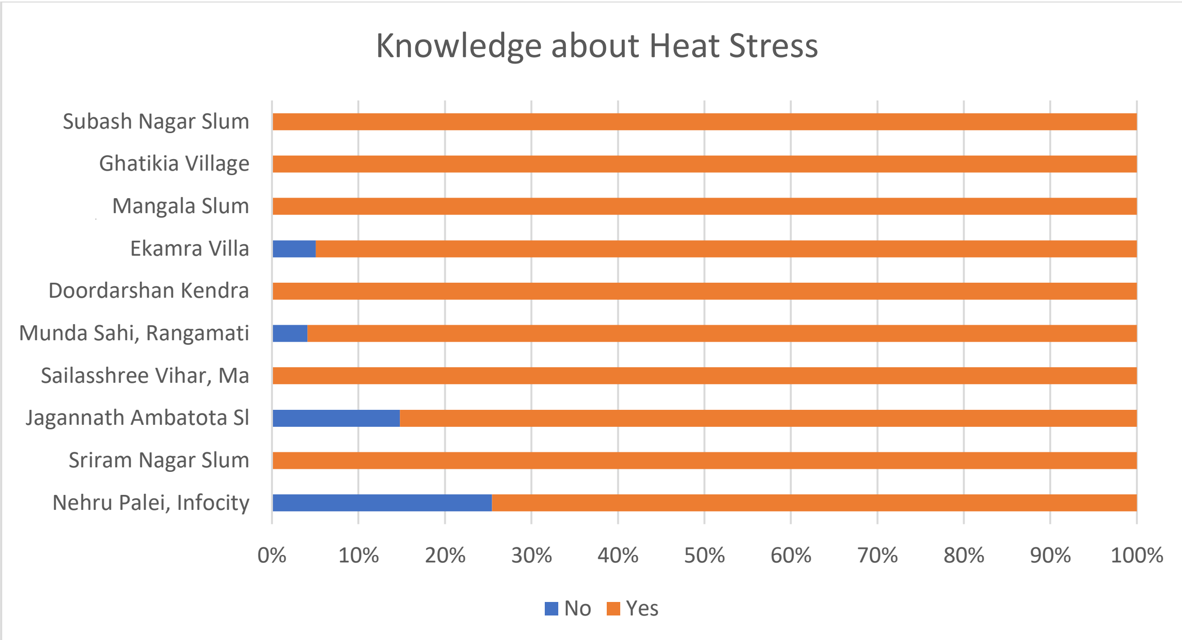
Heat Stress Awareness

KEY FINDINGS

- ❖ All wards had very high awareness about Heat Stress
- ❖ However, many wards did not have knowledge about Hospitals where Heat Stress treatments were available.
- ❖ Likewise, many wards did not have awareness about the programs run by Urban Local Bodies to tackle heat stress.

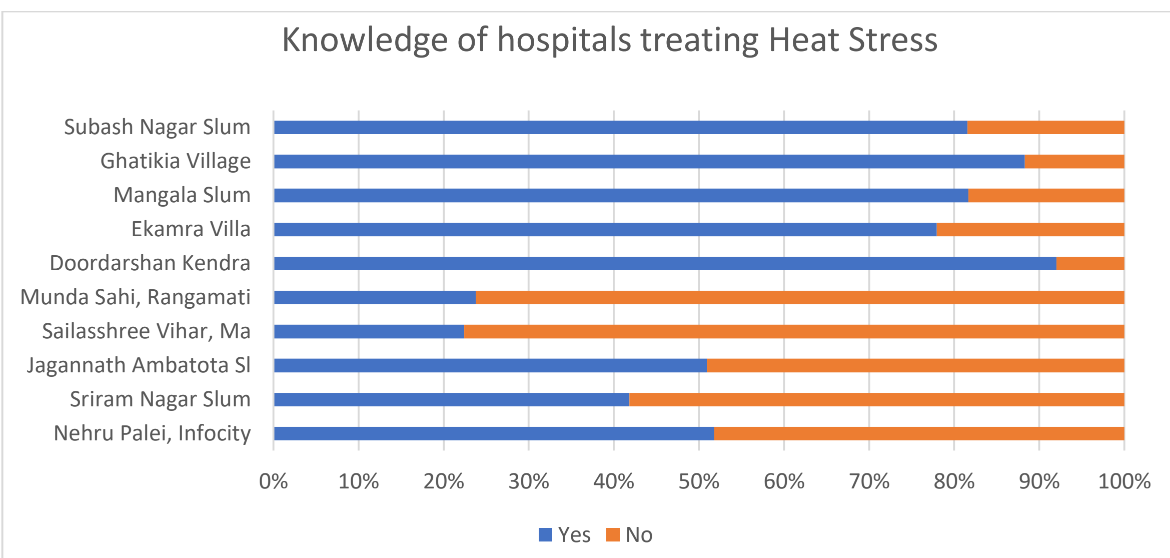
Knowledge about Heat Stress

Majority of sample population in all wards had awareness about heat stress. Nehru Palei ward's sample population was least aware about Heat Stress.



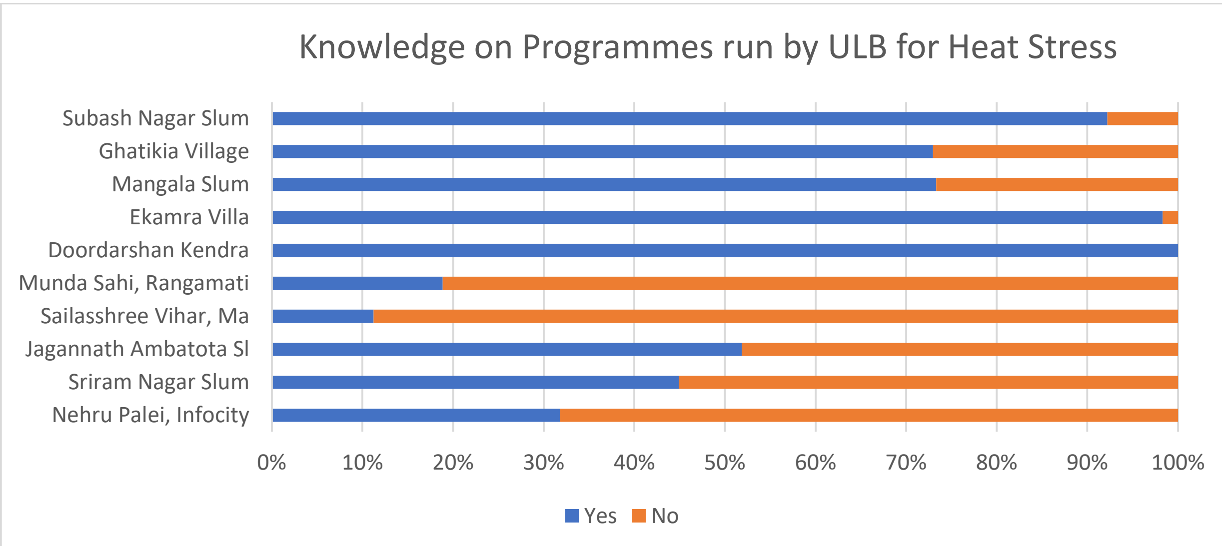
Knowledge about Hospitals treating Heat Stress

Majority of the sample population were aware of hospitals treating heat stress. People in Doordarshan Kendra had the highest awareness about hospitals treating heat stress. It is observed that the vulnerable wards with the least share of awareness about hospitals are at Sailasshree Vihar and Munda Sahi.



Knowledge about Heat Stress Programs run by Urban Local Bodies

Majority are aware of the programs run by the ULB to combat heat stress. Doordarshan Kendra ward displayed most awareness to the ULB programmes. Sailasshree Vihar followed by Munda Sahi are the vulnerable wards due to least awareness about ULB programmes. This could be the reason why Munda Sahi ranks high in the reported cases due to heat stroke.



Priority Wards for Creating Heat Stress Awareness

Ward	Knowledge About		
	Heat Stress	Hospitals	ULB Programs
Nehru Palei Infocity, Jagannath Ambatota SI Munda Sahi	Low	Low	Low
Sriram Nagar Slum, Sailasshree Vihar Ma	High	Low	Low

Five wards that needs immediate Awareness Programs: Nehru Palei Infocity, Jagannath Ambatota SI, Sriram Nagar Slum, Sailasshree Vihar Ma and Munda Sahi.

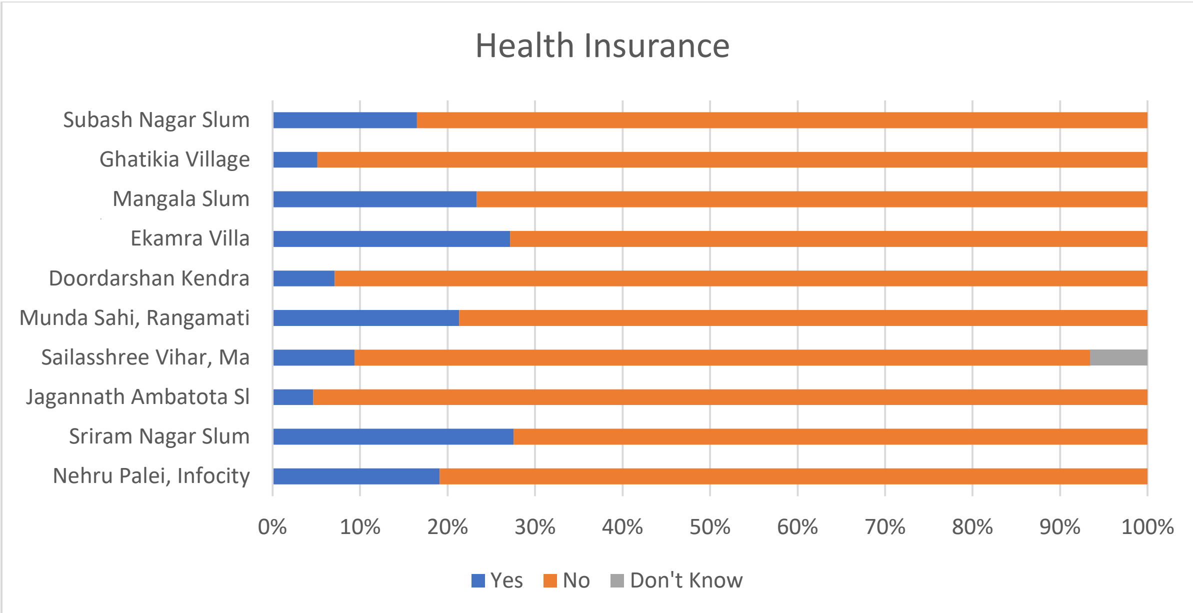
Adaptation to Heat Stress

Health Insurance

Health insurance is an important adaptation means to combat heat stress. Access to health insurance will result in less morbidity and mortality. Majority of wards do not have health insurance making them vulnerable to heat stress. Ekamra Villa and Sriram Nagar Slum had higher percentage of health insurance than other wards.

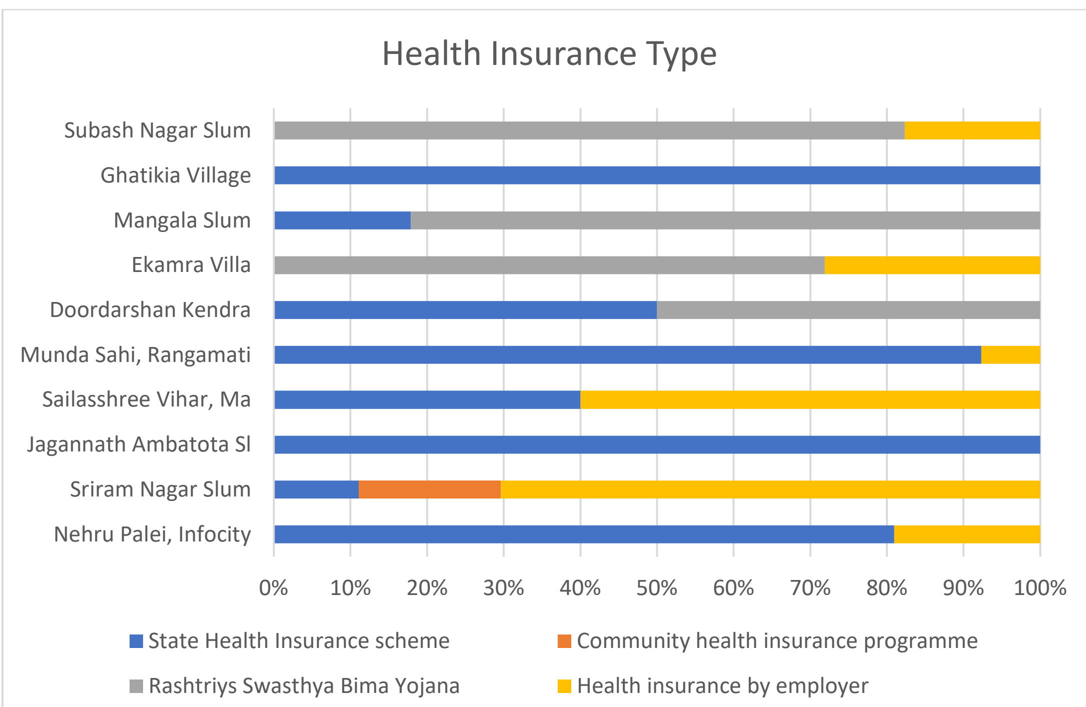
KEY FINDINGS

- Most of the sample population in all wards did not have health insurance
- Among those with access to health insurance, majority have access to State health insurance scheme followed by Rashtiys Swasthya Bima Yojana.
- The only ward with community health insurance program is Sriram Nagar Slum.



Preferred Health Insurance Type

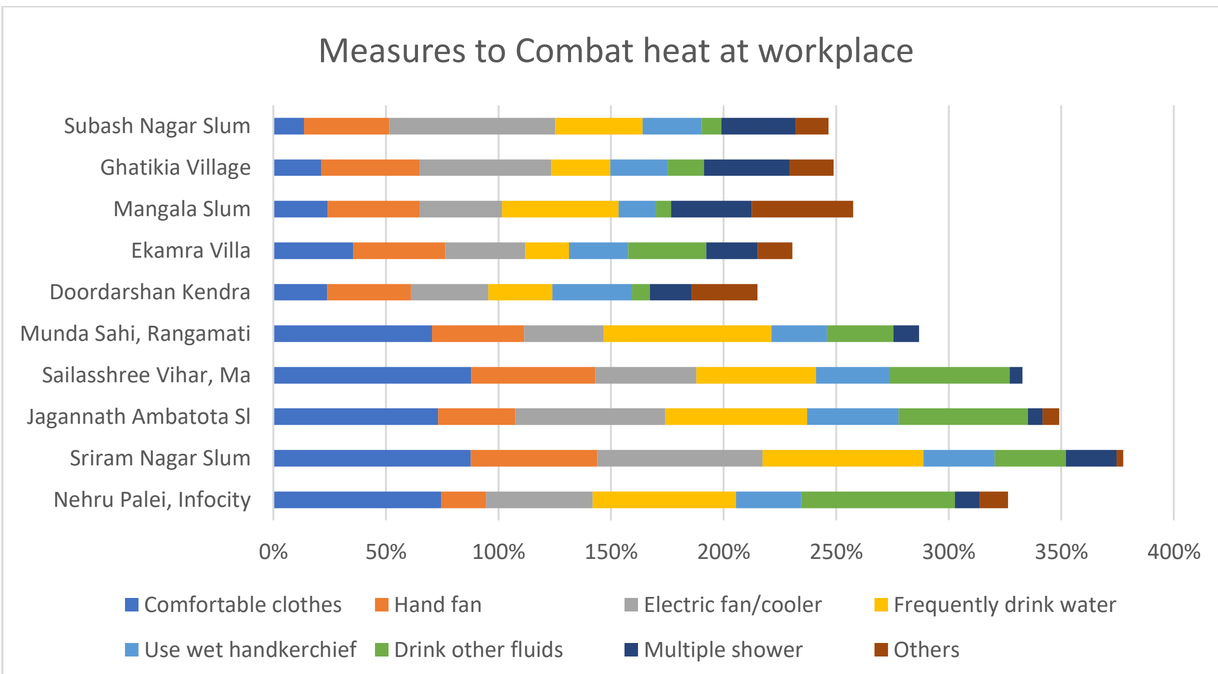
State health insurance scheme and Rashtiys Swasthya Bima Yojana were the most popular. Community health insurance was the last used.



Mitigation Measures

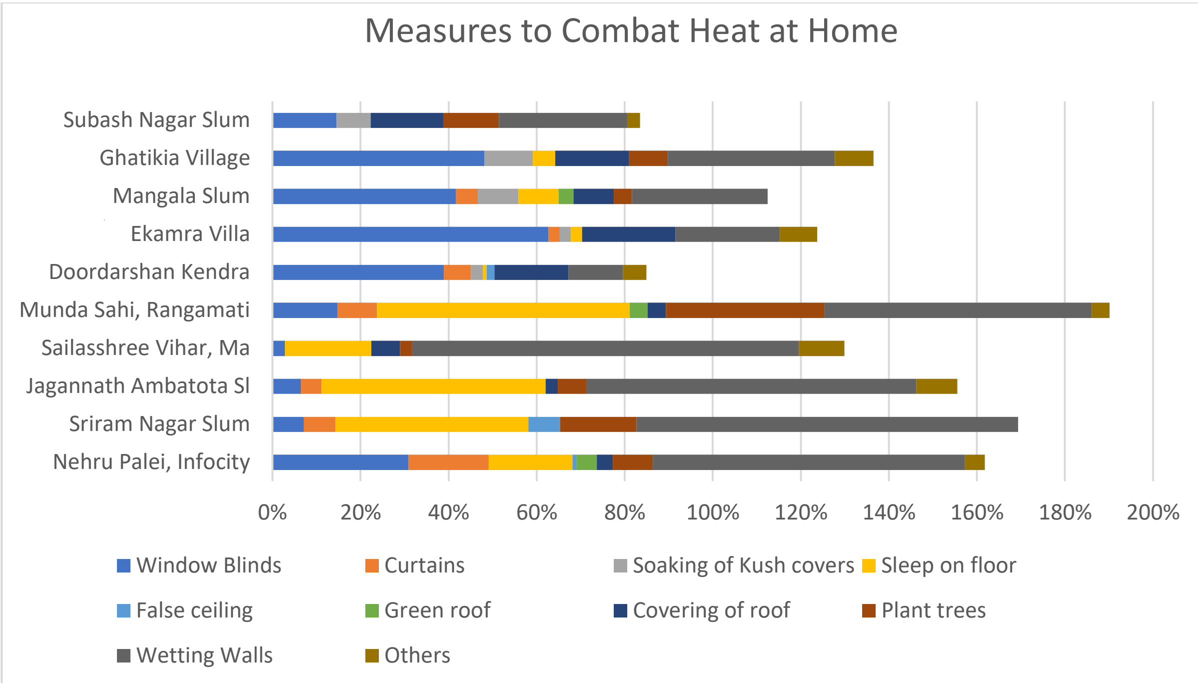
Various Measures Employed by People to Combat Heat Stress Workplace and Home

Majority of sample population prefer wearing comfortable clothes to work in order to combat Heat Stress. It was followed by the usage of electric fan or cooler. In Doordarshan Kendra and Ekmara Villa, the sample population opted for wide range of methods to combat heat on high temperature days and there is no clear indication of a preferred method. Hydration through fluids was highly preferred in Nehru Palei Infocity, while handfan was most preferred in Sailasshree Vihar and Sriram Nagar slum.



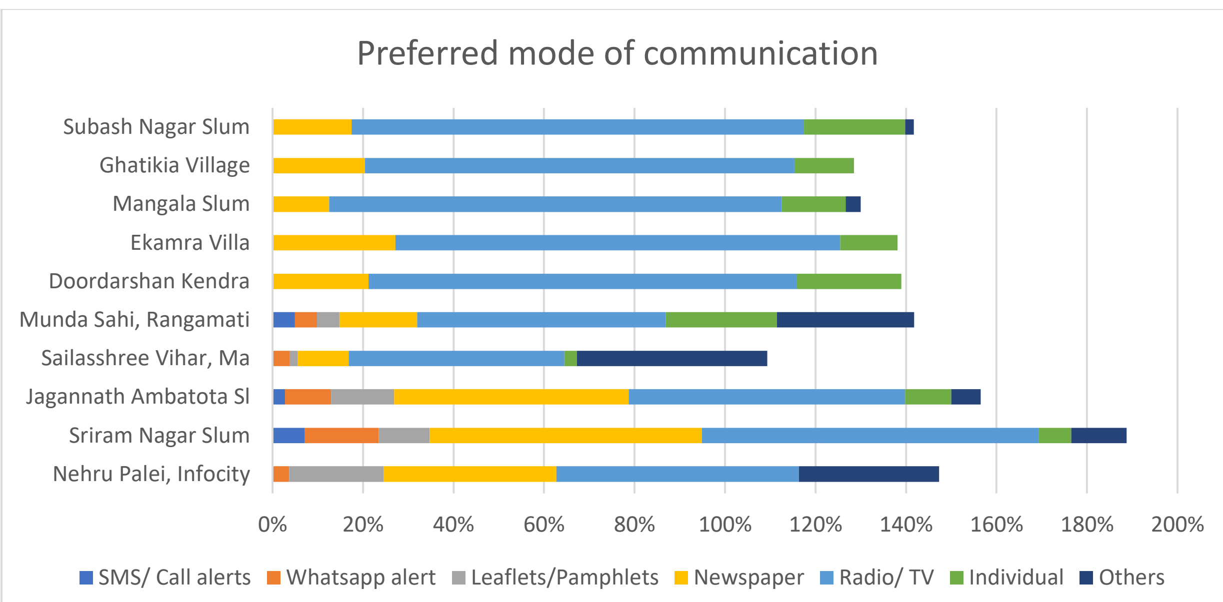
At home, people in different wards preferred different methods to deal with heat stress. Wetting walls and using Window blinds were the two most commonly used methods.

Ekamra Villa used the highest percentage of window blinds but did not wet walls significantly. In contrast, Sailasshree Vihar used very less Window blinds, but used Wet walls as a preferred method to cope with climate stress. Sample population in Munda Sahi Rangamati preferred combating heat stress by planting trees.



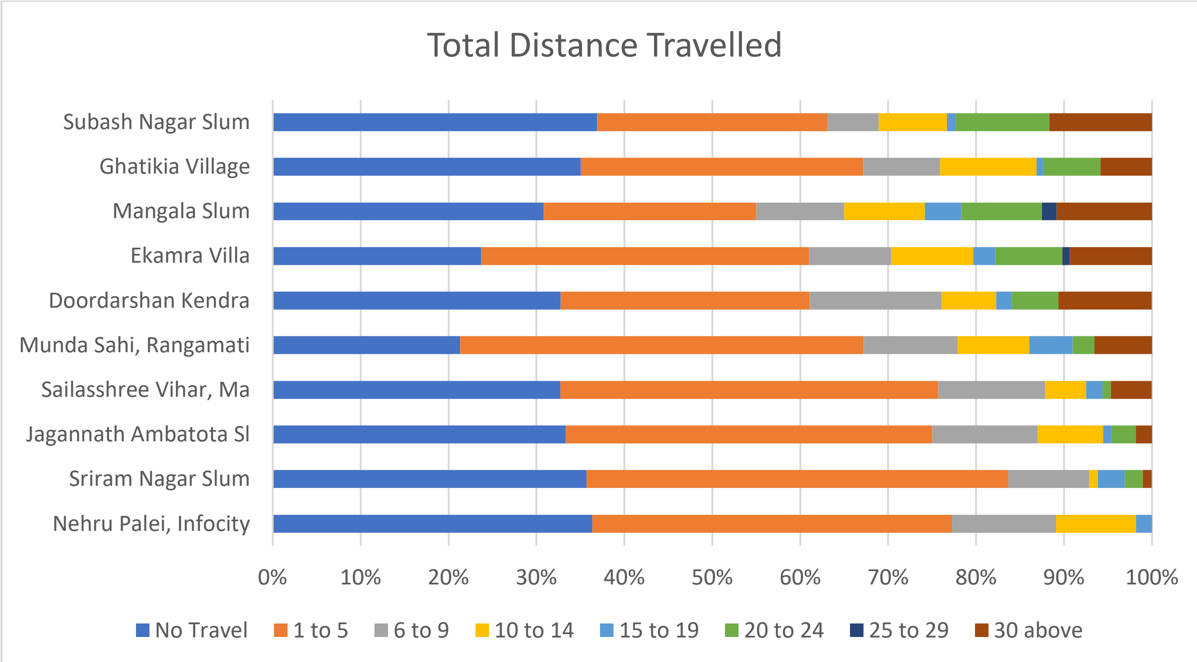
Preferred Mode of Communication

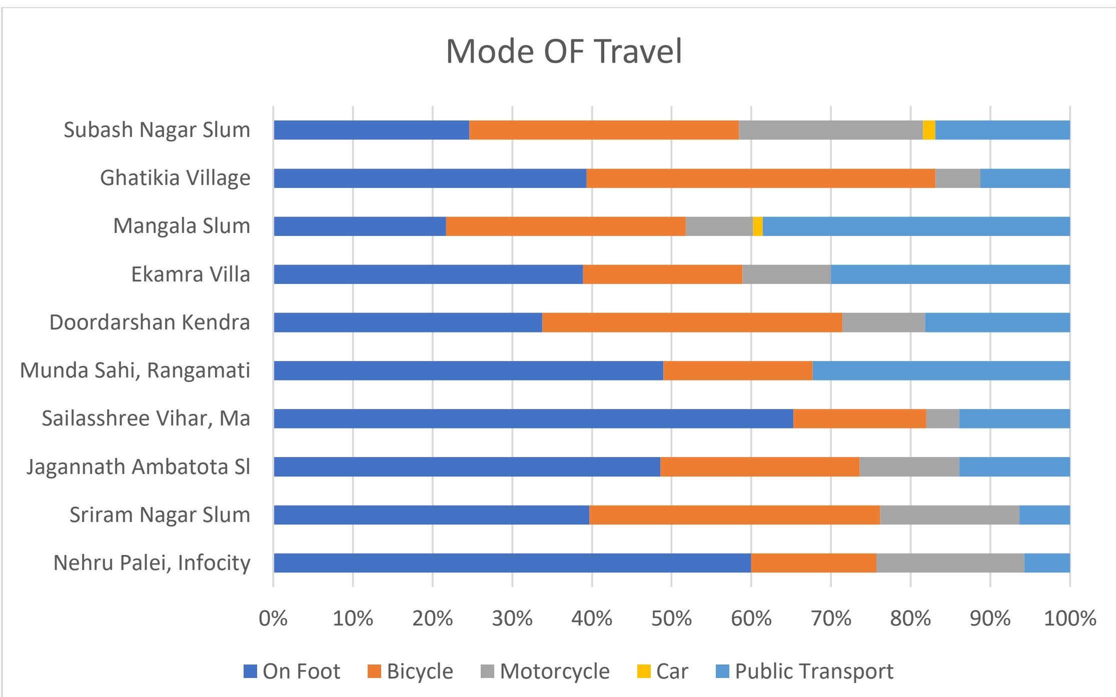
Majority of the sample population in all wards preferred Radio/TV communication. Newspaper was the second most preferred mode of communication.



Distance Travelled and Mode of Travel

Sriram Nagar slum sample population travelled the least, while Mangala Slum travelled the most.



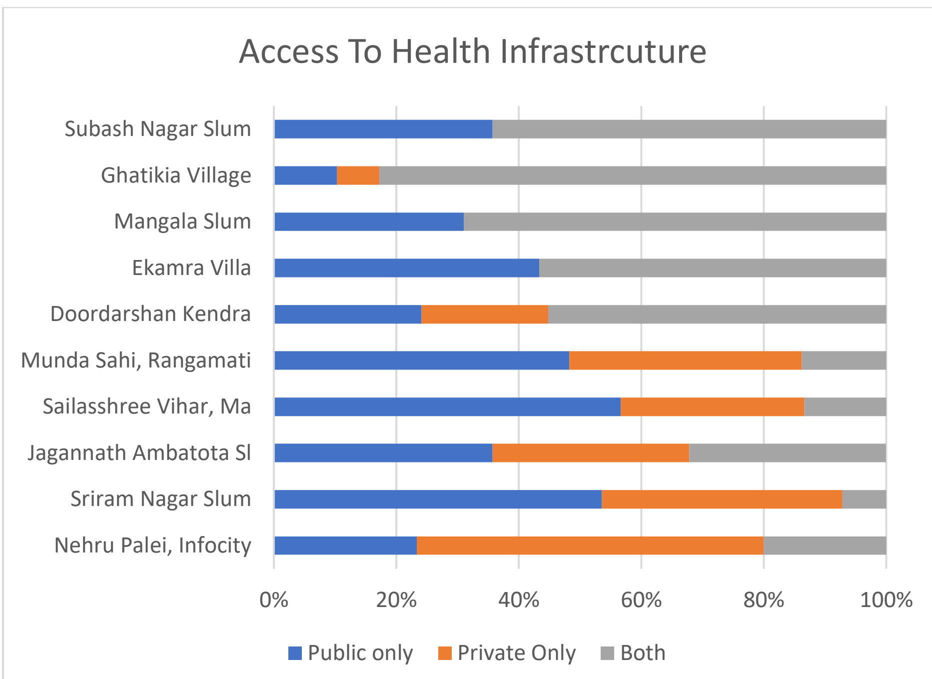


Ward	Most Preferred Mode of Travel

Nehru Palei Infocity, Sailasshree Vihar Ma, Munda Sahi Rangamati, Jagannath Ambatota Sl, Ekamra Villa	Walking
Ghatika Village, Doordarshan Kendra	Bicycle
Mangala Slum	Public Transport

Walking and Bicycle were the two most common modes of travel across all wards. The most vulnerable wards are Nehru Palei Infocity, Sailasshree Vihar Ma, Munda Sahi Rangamati, Jagannath Ambatota Sl, and Ekamra Villa.

Access to Health Infrastructure

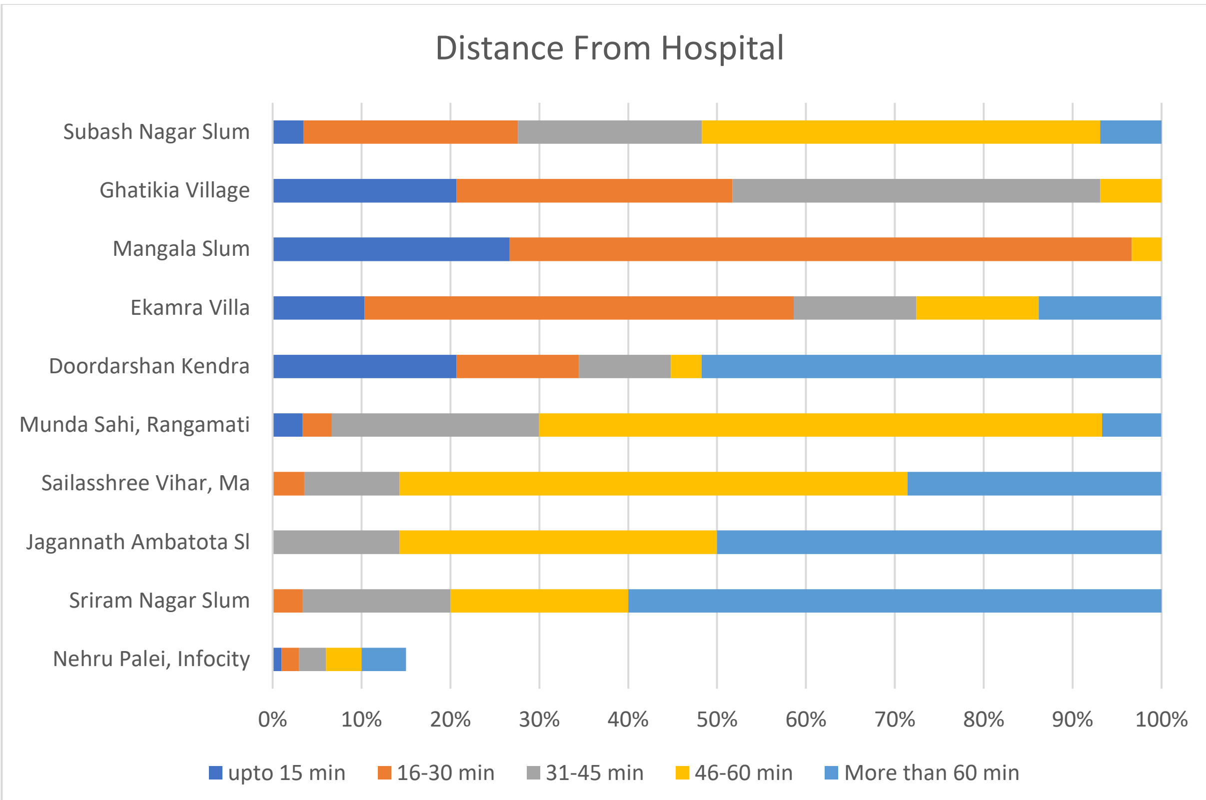


Among those who had access to health infrastructure, the percentage of private and public health infrastructure was different in different wards. Ghatikia Village had the highest percentage of respondents with both public and private health infrastrucutre. In Sriram Nagar slum people had either private or public insurance, but less than 10% had both.

Distance to Health Infrastructure

Sriram nagar slum people lived the farthest away from hospital, with 60% of sample population living in places which are more than 60 minutes from the hospital. More than 95% of the people in Mangala slum live under 30 minutes from the hospital, making them the least vulnerable to heat stress from travel distance.

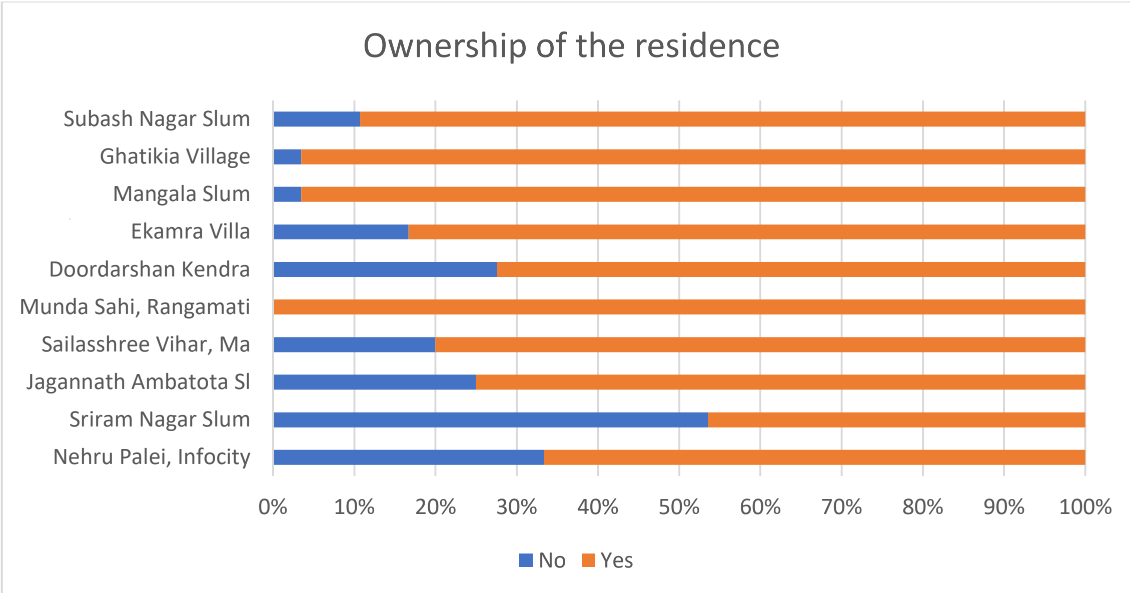
Vulnerable wards: Sriram nagar slum, Doordarshan Kendra, Jagannath Ambatota SI



Residence Ownership

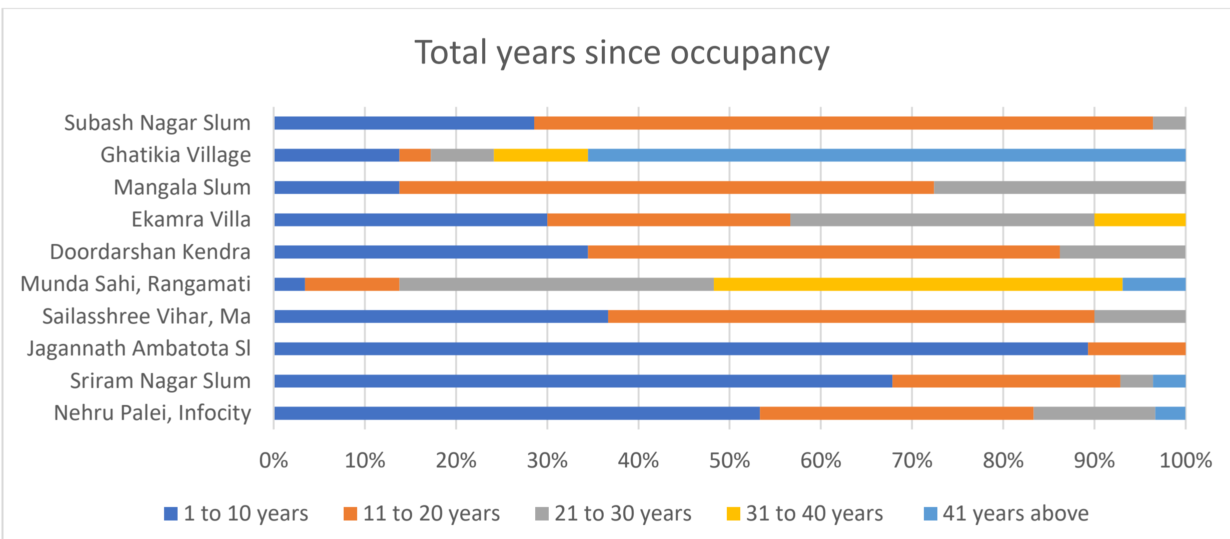
Sriram nagar slum had the least residence ownership, implying high migrant workers. This makes them more vulnerable to heat stress. All of the sample population in Munda Sahi Rangamati owned their house, making them the least vulnerable to heat stress.

Most Vulnerable wards: Sriram Nagar Slum and Nehru Palei Infocity



Residence Occupancy Duration

Duration of occupancy was observed to be the highest in Ghatikia village, followed by Munda Sahi Rangamati, making them both least vulnerable to heat stress. All the sample population in Jagannath Ambatota Sl had an occupancy of less than 20 years, making them the most vulnerable ward.



Annexure 4 – Overall City Level Impact of Heat Stress

Methodology

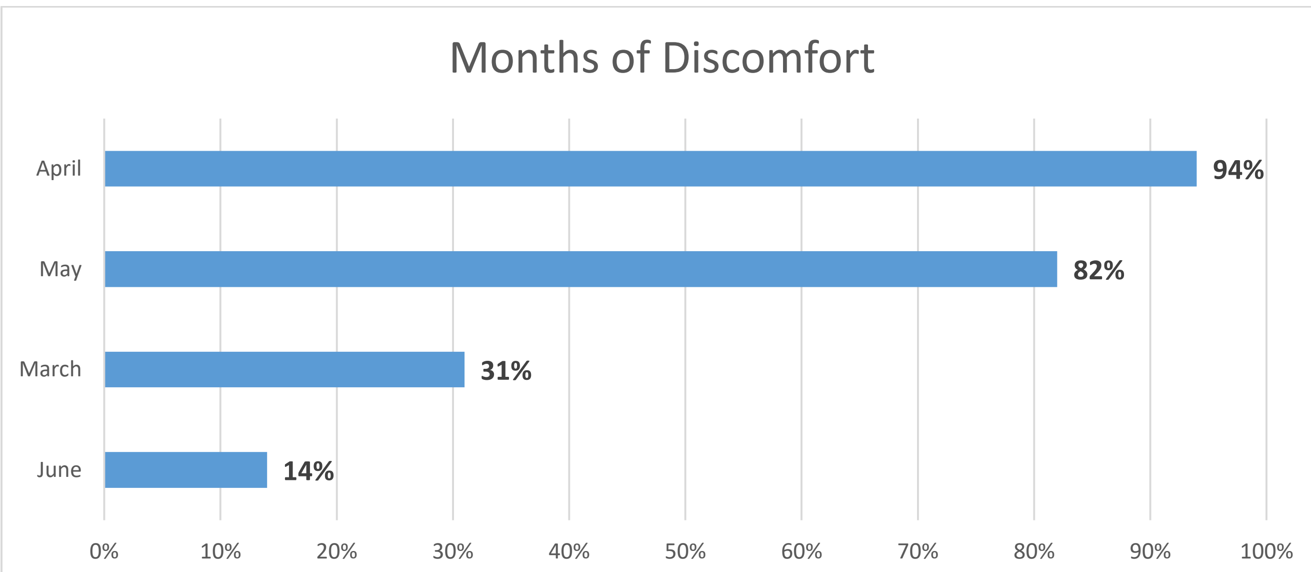
Multi-level random stratified sampling method was used while conducting primary and fortnight surveys for Bhubaneswar city. The surveys were conducted in the slums and squatter settlements and the vulnerable sections of the society. A total of 290 HHs were surveyed for the primary round, 290 for fortnight 1 and 281 for the fortnight 2 survey.

The primary survey provided the basic household information about heat stress and its implications, the other set were longitudinal tool to monitor the impact of heat stress on the selected household members over the period of 14 days. Most of the families were Below Poverty Line and their occupational pattern included construction workers, street vendors, domestic helpers and sweepers. Average household size consists of 4 members.

Primary

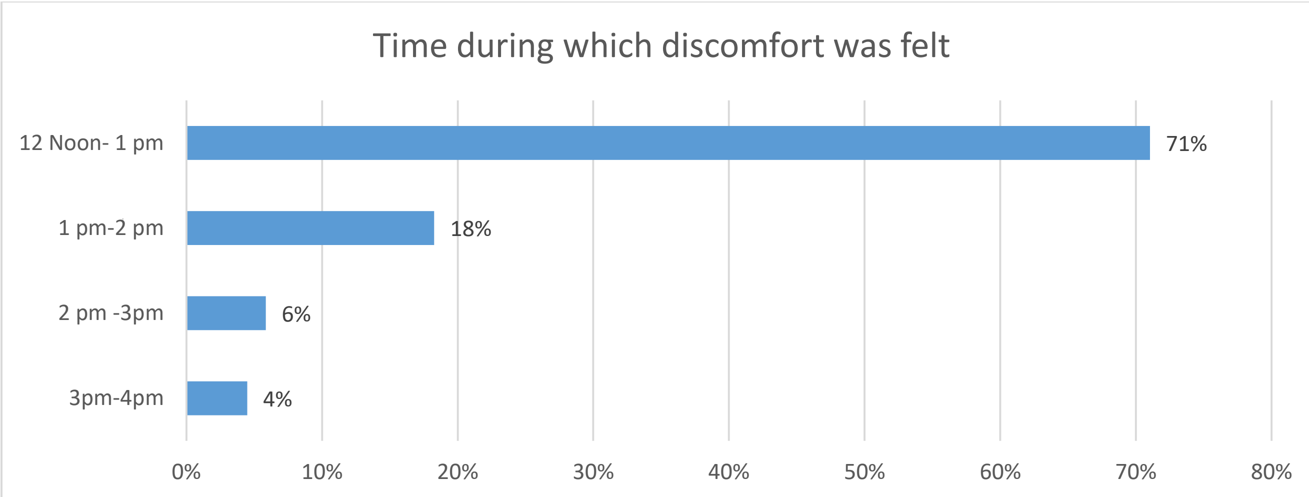
Impact of heat on Health

Mapping the High Heat Period:



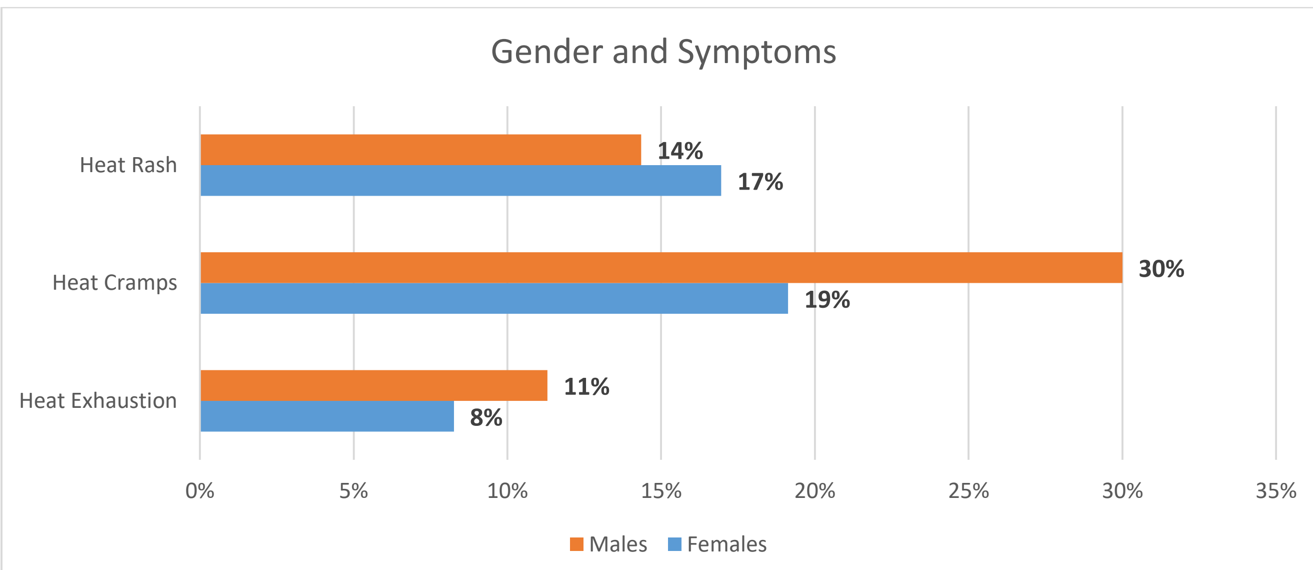
April (94%) is reported as the hottest month followed by May (82%) and March(31%)

Time of Heat discomfort during the day:



Excessive heat is experienced from noon 12 to 1 (71%). Around 18% and 6% experience discomfort from 1pm to 2pm and 2pm to 3pm respectively.

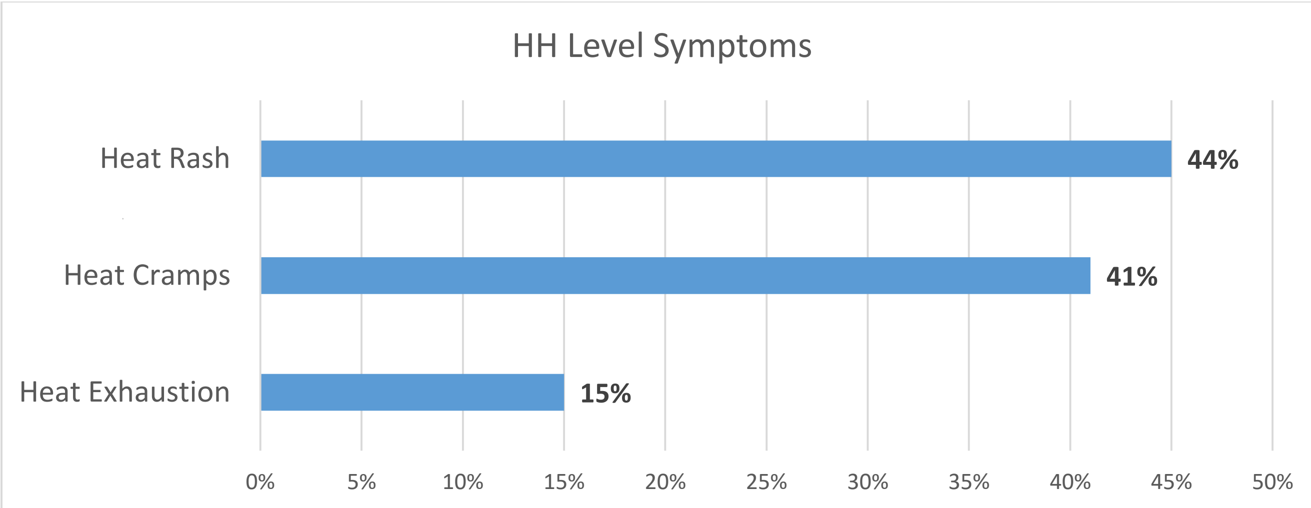
Differential Impact of heat on heat stress symptoms:



In males' symptom of heat cramp (30%) is observed the most. Heat rash (14%) is the second most prominent symptom.

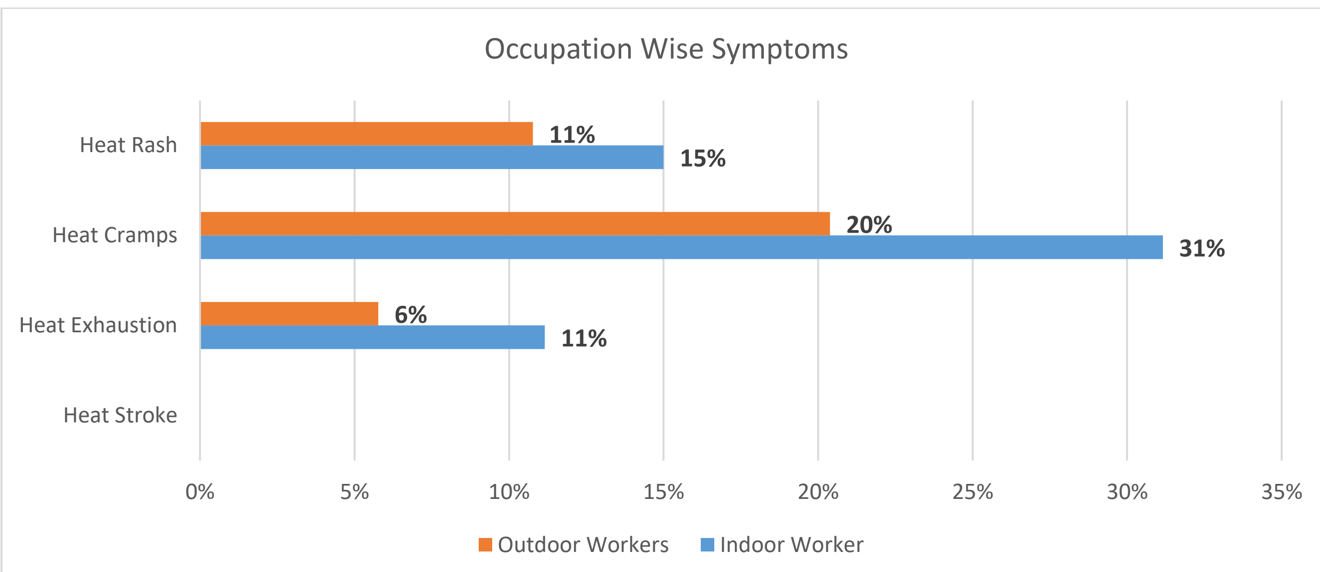
Females are most prone to heat cramps (19%). It is also noticed that after heat cramps, they suffer from heat rash (17%) the most.

Household Reporting Heat Stress Symptoms:



Maximum people at HH level from sample population reported 1st signs of Heat Stress that is Heat rash (44%). Heat cramps is the second stage and the number of household experiencing it were found to be near (41%) to heat rash. Heat exhaustion (15%) was reported least.

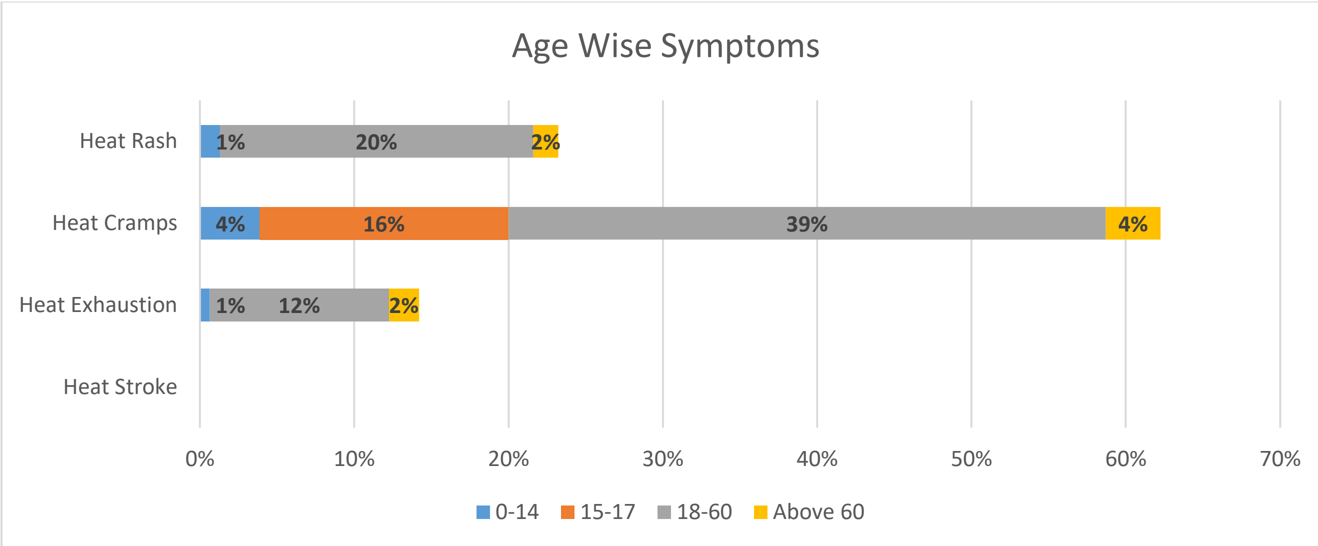
Occupation Wise Symptoms:



2nd and 1st Stages of Heat Stress, Heat Cramps (31%) and Heat Rash (15%) were seen most in indoor workers.

Similarly, Heat cramps (20%) and heat rash (11%) were noticed most in the outdoor workers.

Age wise Symptoms:



From the sample population surveyed:

Children have reported suffering from Heat Cramps (4%).

Maximum adolescence shows signs of Heat cramps (16%).

Adults report Heat cramps (39%), followed by Heat rash (20%) and maximum percentage of Heat exhaustion (12%). Looking at the above they are most vulnerable of all.

Senior citizens struggle from Heat Cramps (4%) the most.

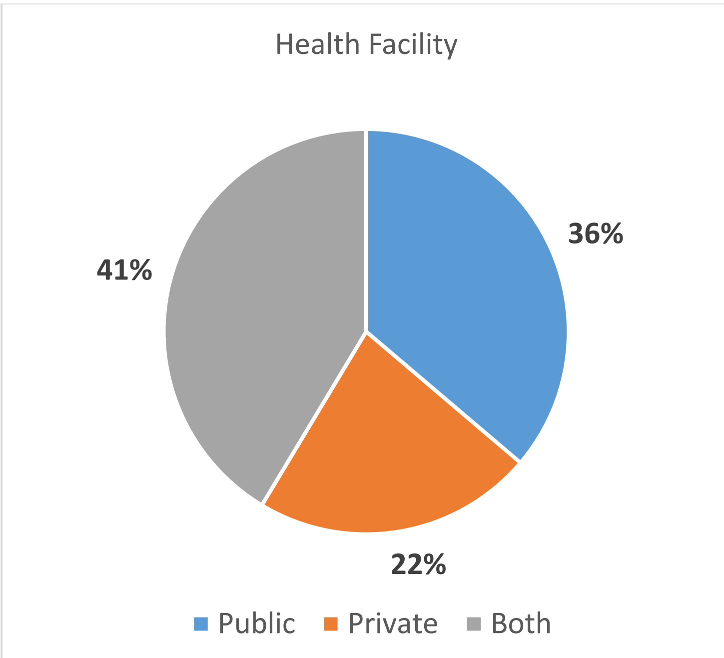
Mortality due to heat stress

No deaths have been recorded due to heat stress in the sample survey.

Infrastructure

Health:

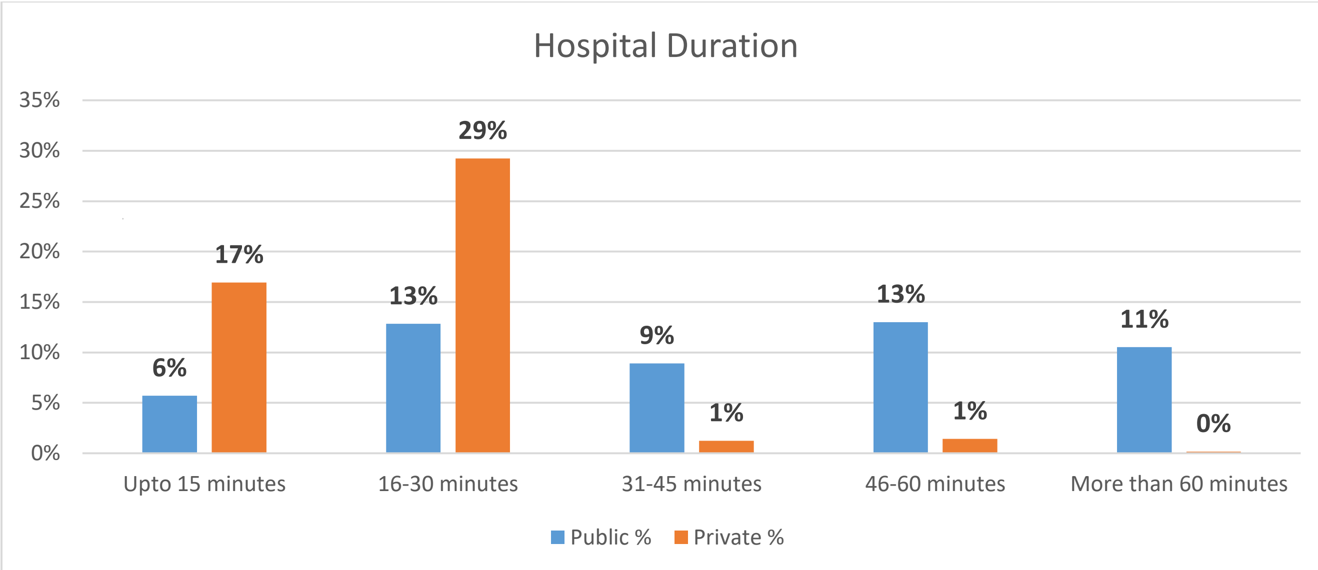
Access to Health Infrastructure:



Out of the available infrastructure:

- 36% of the sample Household access only public health care.
- 22% of the sample household access only private health care.
- 41% of the sample household access both public as well as private health care facilities for treatment.

Distance form nearest health centre



The average time taken to reach nearest a Public Health Facility is 55 minutes.

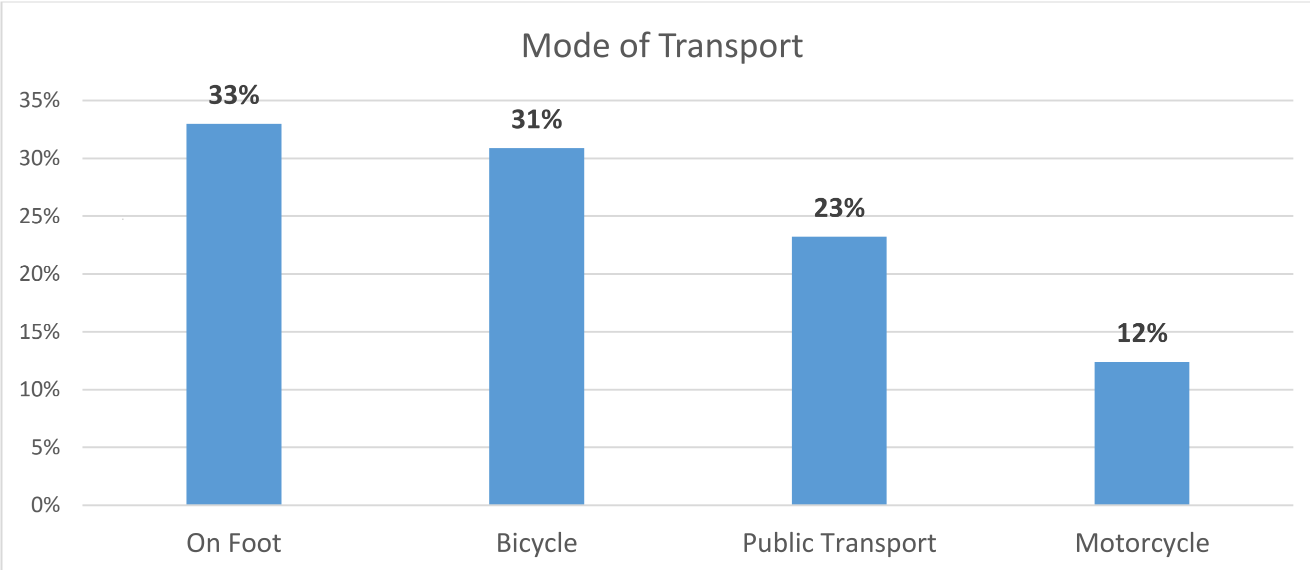
The average time taken to reach a nearest private Health Facility is 35 minutes.

The above figures justify that the amount of time taken is one of the prime reasons for the household members for not availing government facilities.

Only Public health care facilities are not used by the majority of sample households, due to the non – availability of the government facility in their vicinity.

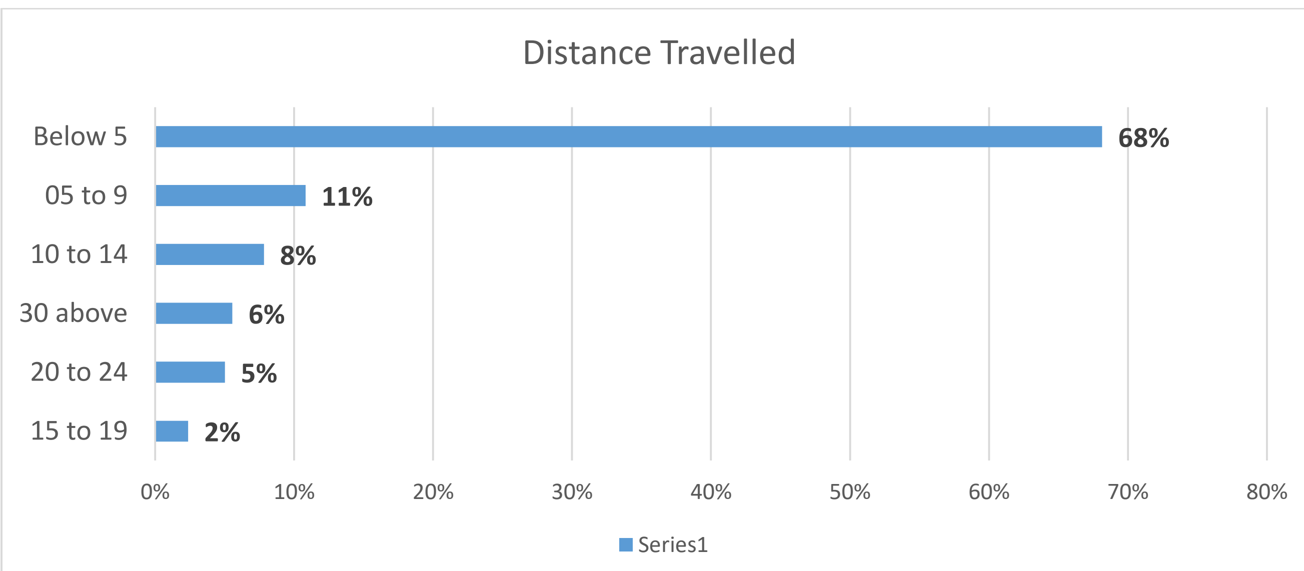
Transport:

Methods used for commuting (workplace/school):



Foot (33%), Bicycle (31%) and public transport (23%) are the most common ways used for commuting.

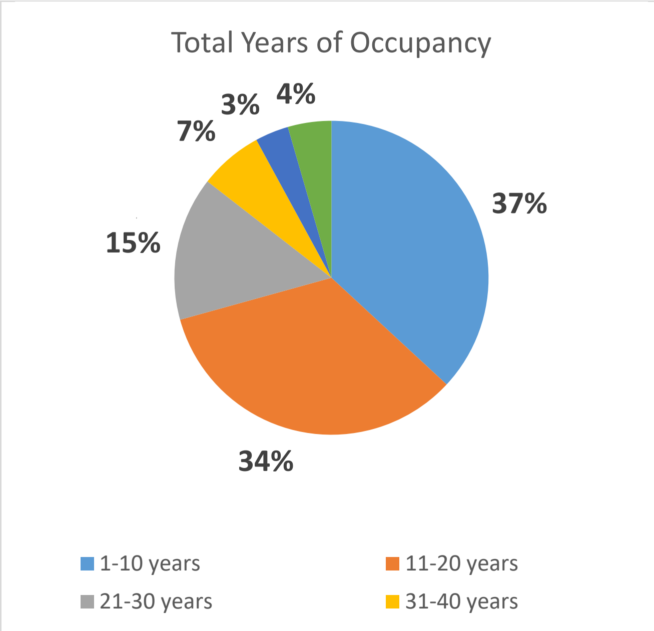
Total Distance Travelled:

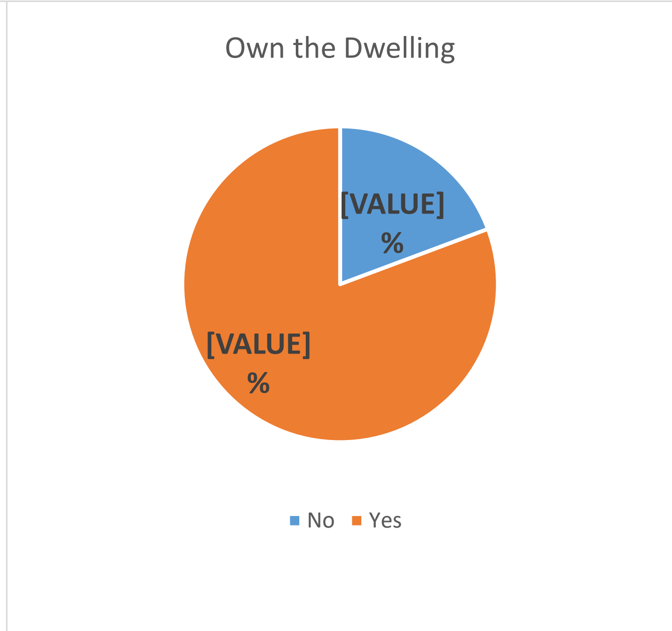


The maximum (68%) sample households travel within the vicinity of 5 Km to reach to their respective workplace/schools. Only 6% travel maximum distance of above 30 km.

Housing:

Dwelling Ownership and Years of House Occupancy:





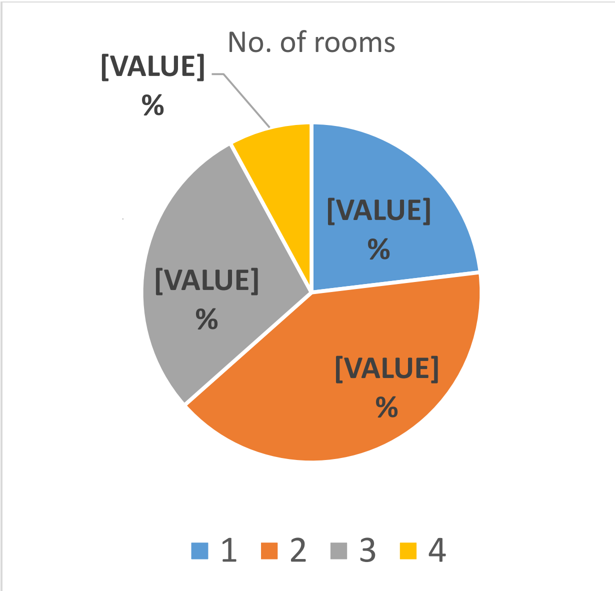
Out of the total sample households, 81% of the dwelling units are owned by the current residents.

The sample survey depicts that 71% of the households are residing in the locality for 10 to 20 years. This portrays that majority of the population are migrants and have settled in the past 20 years.

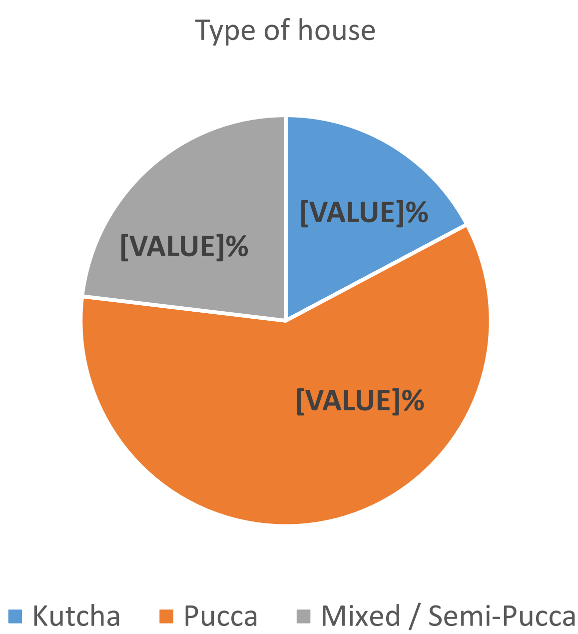
Floor/storey and Total number of rooms:

From the sample survey it is found that all the dwelling unit's height do not exceed ground floor. Lower density built up curbs the heat accumulation due to huge concrete mass stacking.

The average dwelling unit size in the sample survey is found to be 2 rooms. Although, according to the sample survey the average household size is 4. This clearly depicts overcrowding in majority of the dwelling units.



Type of housing structure, Floor material, Wall material and Roof material

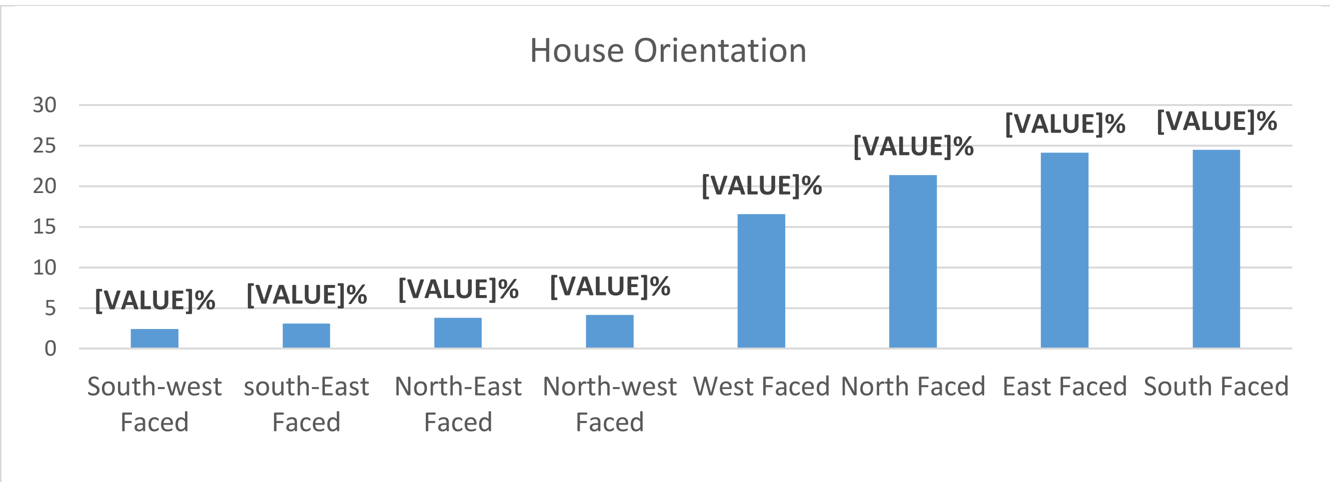


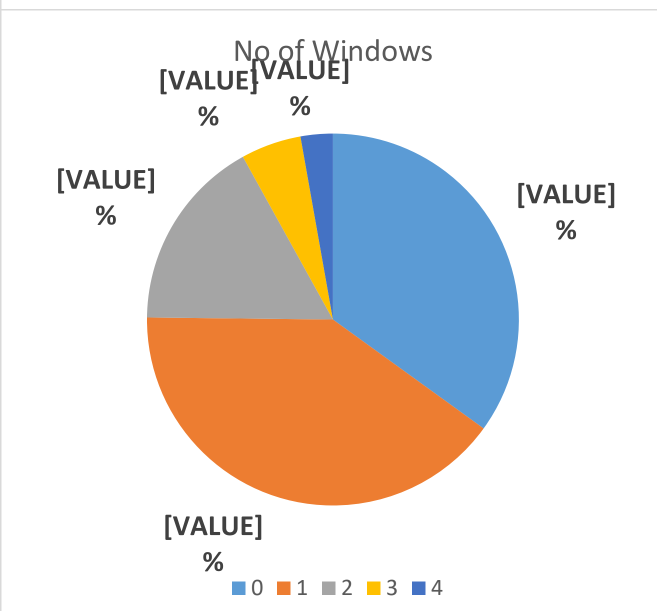
Most (60%) of the houses in the sample household are pukka housing.

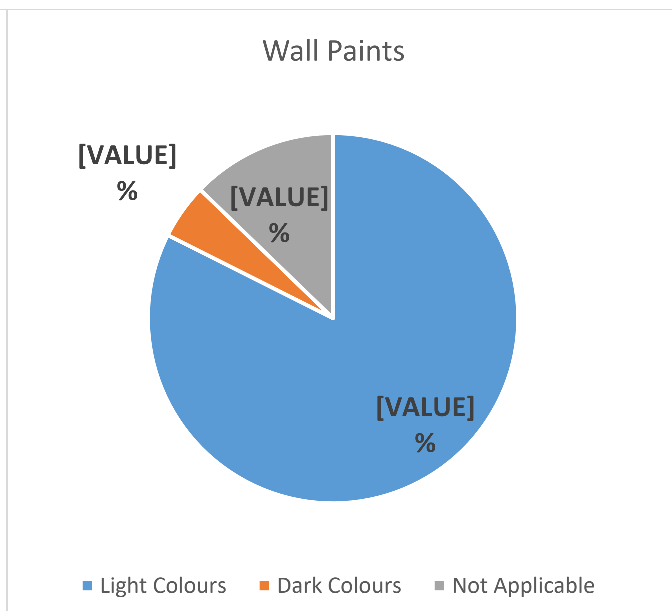
The most common material used for building walls, floors and roof are, cement (85%) for the floor, cement (78%) for the walls and asbestos sheets (75%) for the roof.

As it ca be seen from the sample survey that people have high retention of heat due to the usage of materials like cement and asbestos. Therefore, there is a need for an alternative building materials, other than the mentioned above.

Orientation of House, No of windows, Exterior wall paints:







Around 24% of the dwelling units are either south faced or east faced. This is followed by 21% of the dwelling units north faced and 17% west faced.

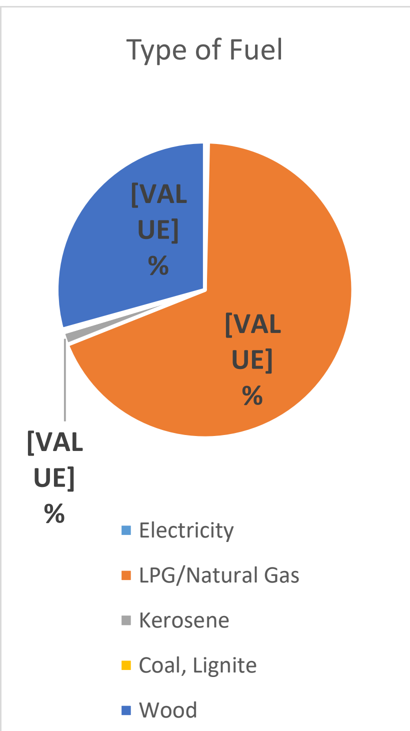
Bhubaneswar being a warm and humid region, the east – west slopes receives more radiation as compared to the north –south slopes.

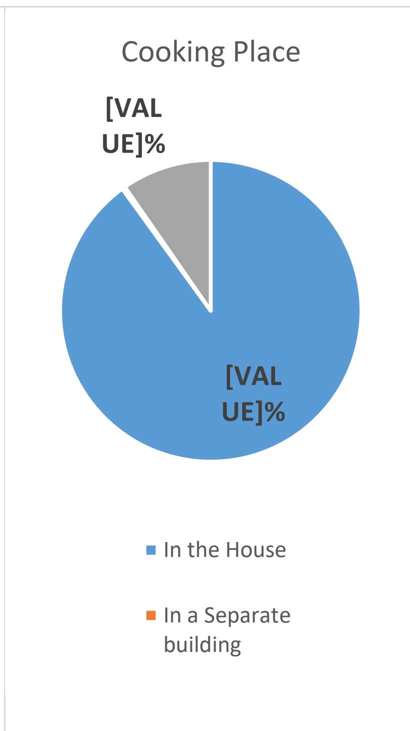
Most of the dwelling units (40%) have just 1 window, 34% of the dwelling units still have no window at all. A poorly ventilated and confined dwelling unit might cause lack of airflow, resulting as one of the causes for heat related illness.

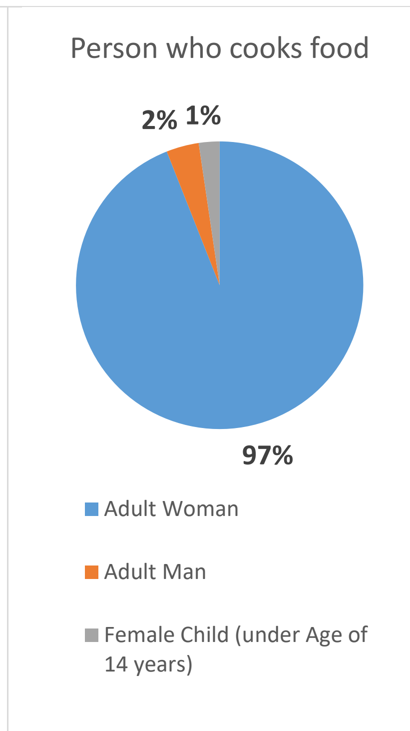
82% of the sample households have light colors on the exterior walls. This practice will help in combating heat. Therefore, it is not an impeding factor.

Cooking:

Type of fuel







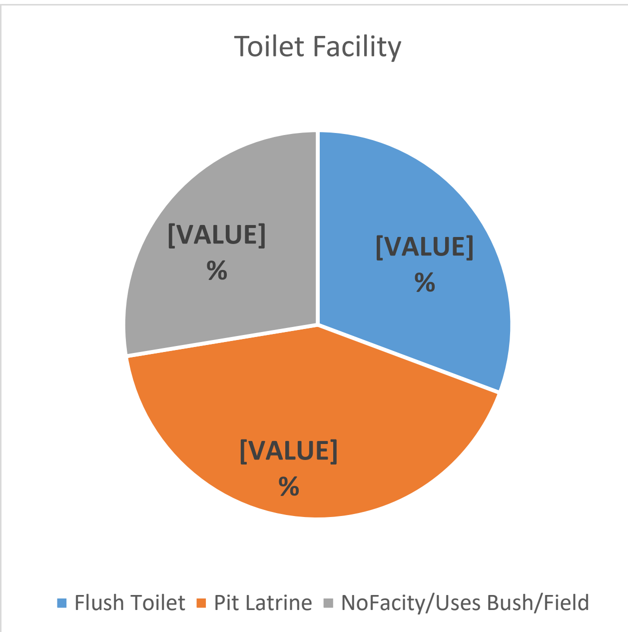
It is seen from the sample survey that a greater number of households (69%) have access to LPG/natural gas for cooking purposes. The issue is with 29% of the sample HH who still rely on woods as a source of fuel for cooking.

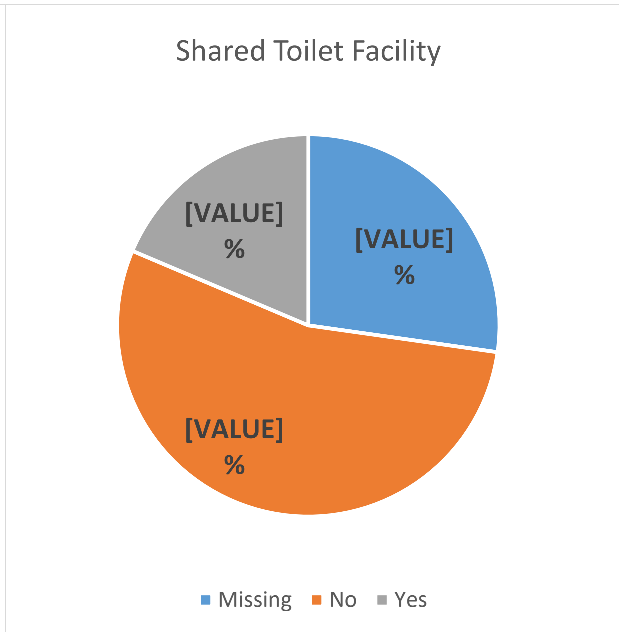
Since, it can be seen that around 90% of the HH have facility to cook food in house. The switch from woods to an alternate source of cooking is much needed. This is so as the heat trapped inside while cooking the food using wood might lead to heat related illness.

Adult women are most vulnerable to heat related illness as 97% of the cases out of the total sample households surveyed it is found that an adult woman is responsible for cooking food for all.

Sanitation:

Kind of toilet facility and No. of Household with shared toilet facility



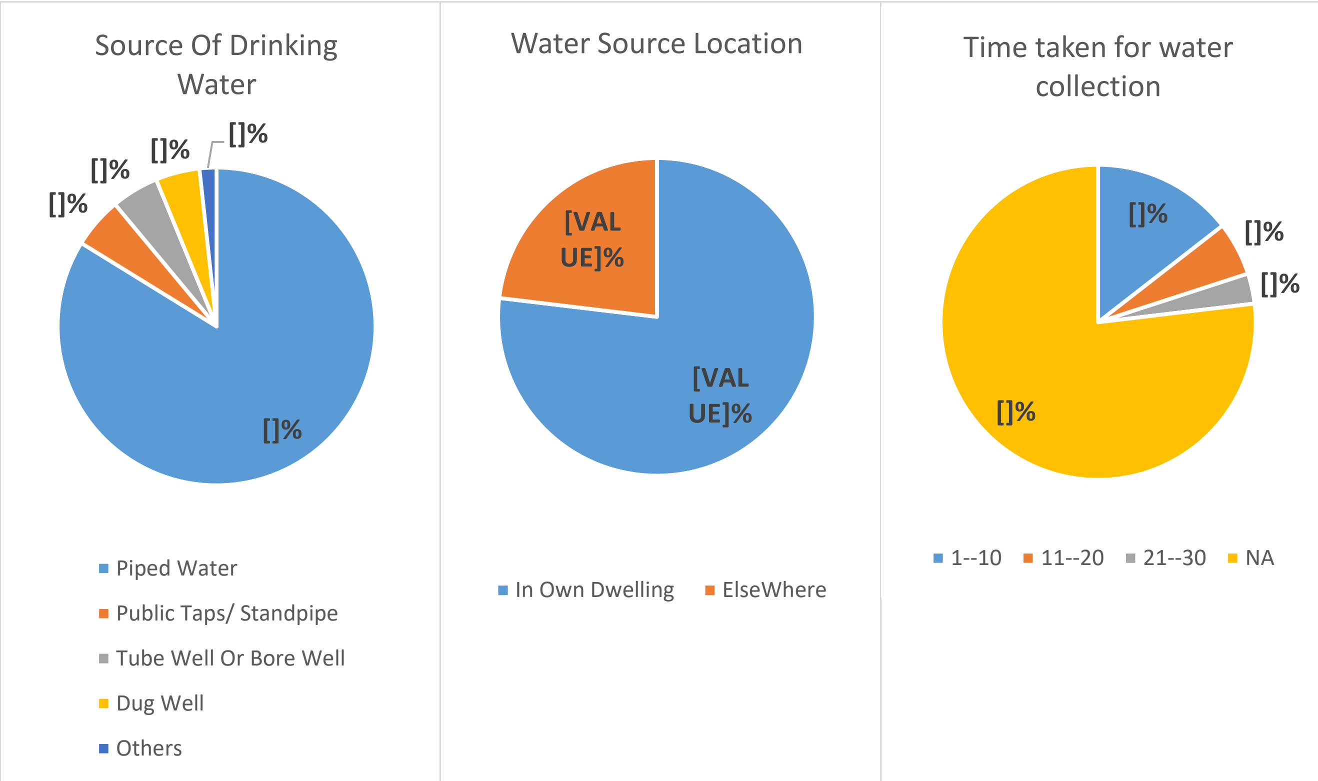


The sample survey shows that 73% of the households have access to either pit latrines or flush toilets.

54%, making the majority, do not use a shared facility for sanitation purposes.

Water:

Source of drinking water, Location of water Source and Approx. time for water collection from outside source:

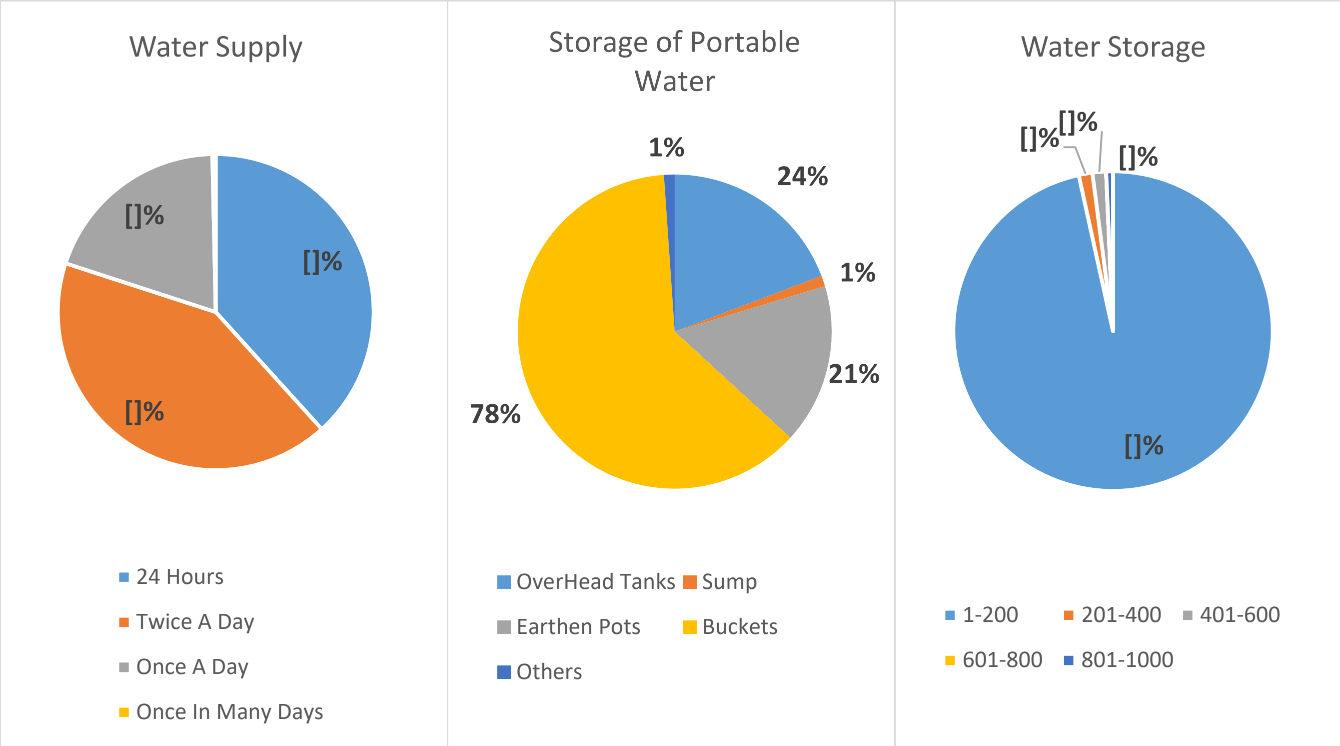


Out of the total, 84% of the sample households have access to piped water supply.

The water source is located within the premise for 77% of the sample households. For the rest 23% water source is located elsewhere.

For the 14% (majority) of the households water is available in the vicinity for 23% of those who do not have water source located within the premise.

Water Supply, Storage for potable water and Total water storage (liters):



Out of the total 42% of the sample households get water supply twice a day.

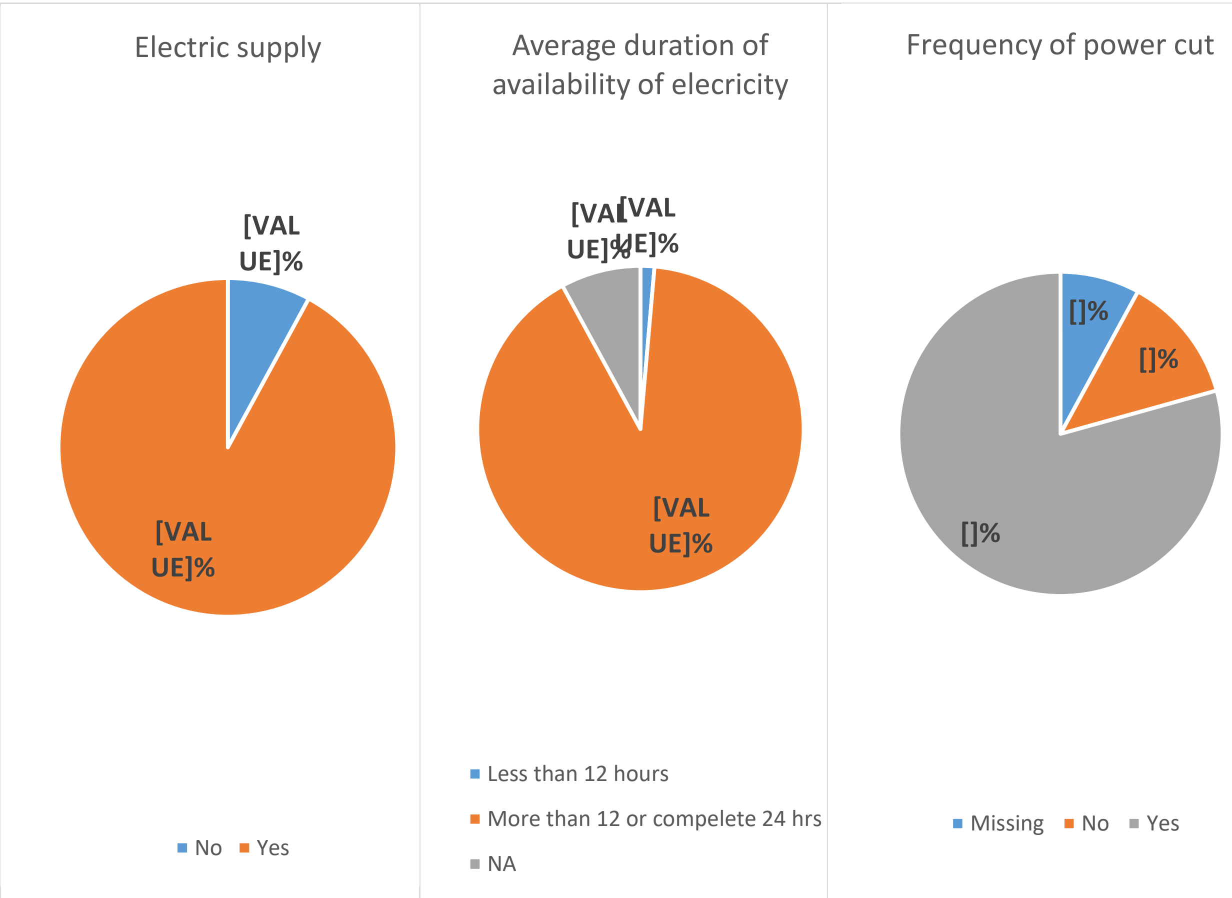
Buckets (78%) are most commonly used for storage of potable water.

As, big as a Bucket is used for storage. This in combination with the water supply twice a day to maximum sample households.

The majority water storage (in liters) for 97% of the HH ranges from 1 to 200 liters. This is too low as per the standards of service level benchmark.

Electricity:

Electric supply, Duration of Supply and Frequency of Power cut in summers:



92%, a fairly good supply of electricity to the sample households. Therefore, it is not a disrupting factor.

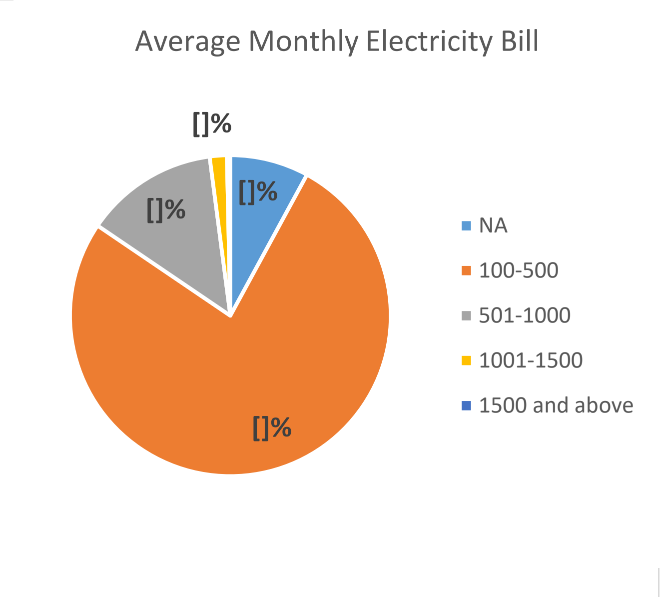
The average duration of availability of electricity for 91% of the sample households is for the duration of more than 12 hours or complete 24 hours.

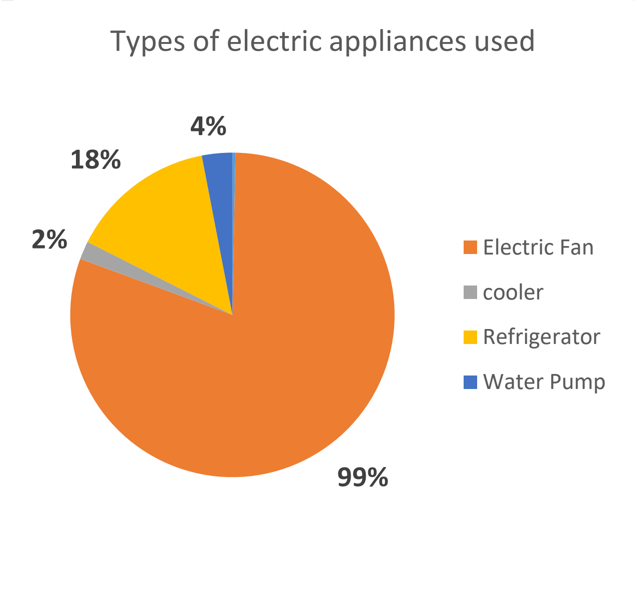
Although it is found that at the time of summers, 79% of the sample househo9lds claim that they have power cut issues.

Types of electric appliances used and Electricity Bill:

Most of the sample households have electric fan (99%), refrigerator (18%) and water Pump.

The average (77%) electricity bill in the sample survey is observed to be ranging from Rs. 100 to Rs. 500.

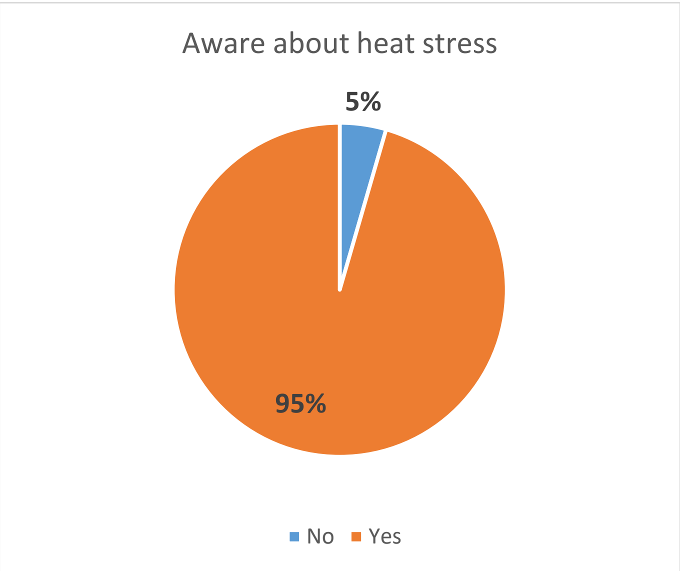




Heat stress awareness and Adaptive measures

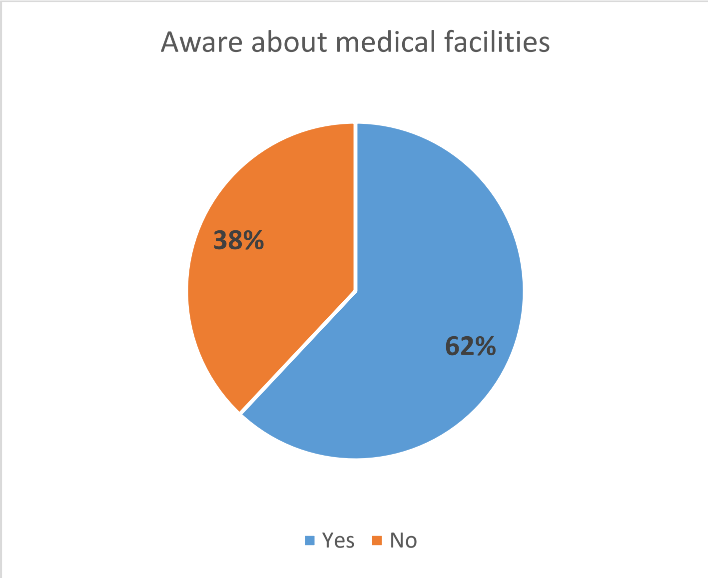
Awareness:

Aware of the term "Heat Stress"



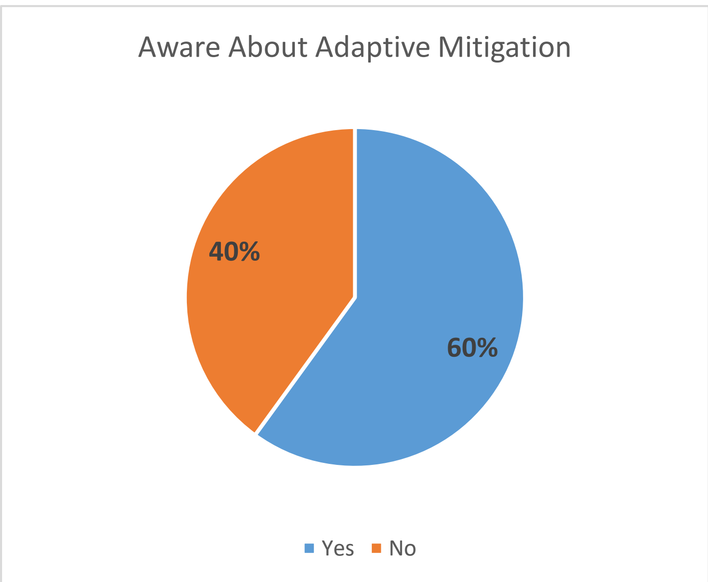
About 95% of the sample population is aware of the term heat stress.

Aware about Medical facilities offering treatment for heat stress



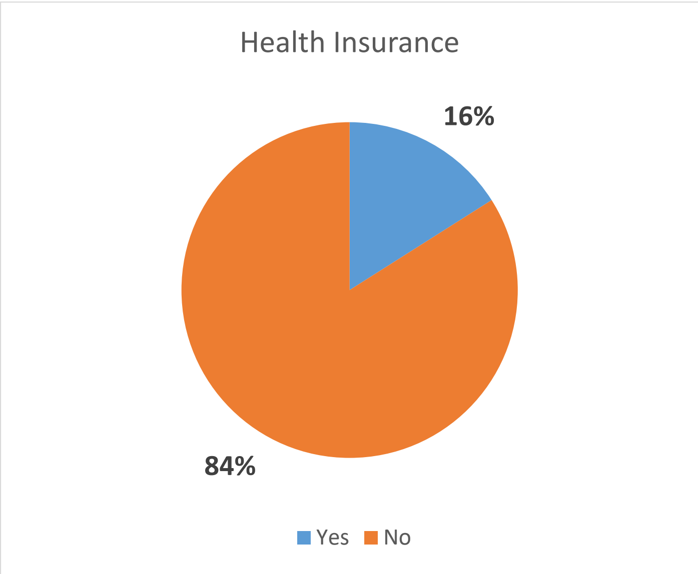
About 38% of the sample households are not aware of the medical facilities offering treatment for heat stress.

Aware about adaptive mitigation strategies adopted by ULB



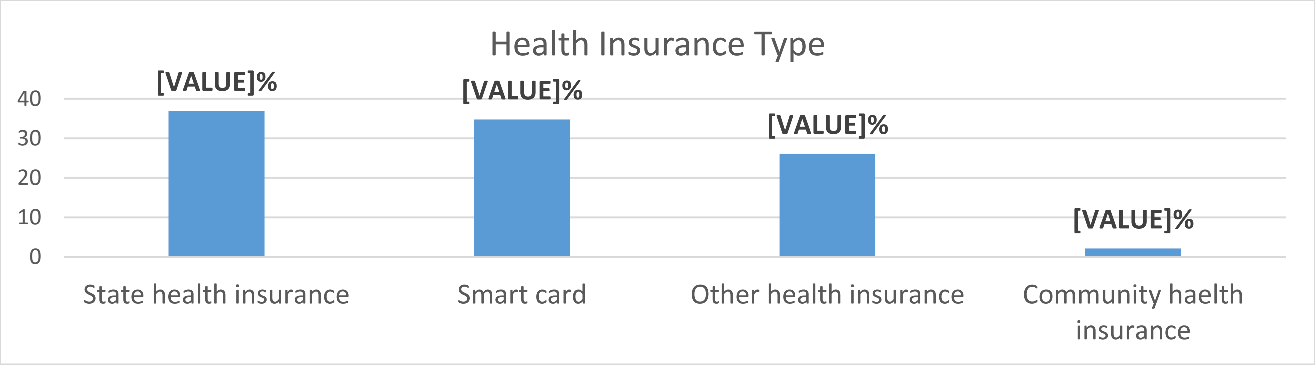
Majority (60%) of the sample population are aware of the adaptive mitigation strategies adopted by the government.

Health insurance



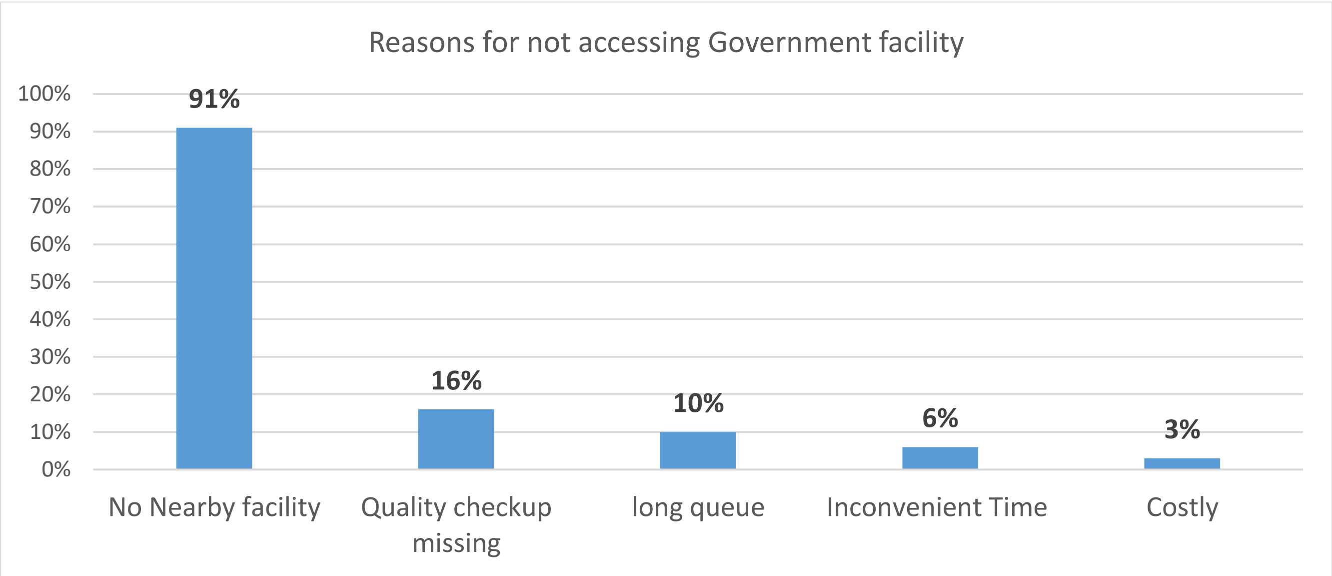
Most (83%) of the people from sample survey do not have access to the health insurance.

Source of health insurance



Out of the 16% of the sample survey population which have access to the health insurance. 37% have state health insurance, 35% have smart cards and 2% have community health insurance.

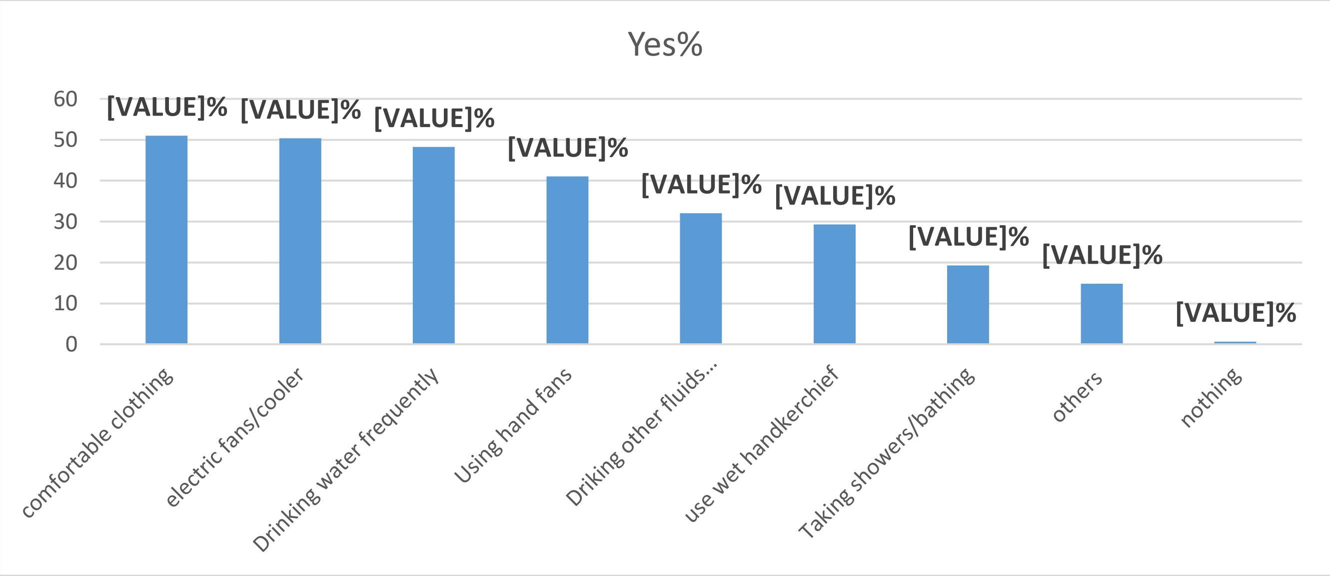
__Government facility not accessed due to__



Non Availability of the government facilities is the most (91%) prominent reason for not accessing the same. The other reasons are lack of quality checkup (16%), long queue (10%) and inconvenient timings (6%).

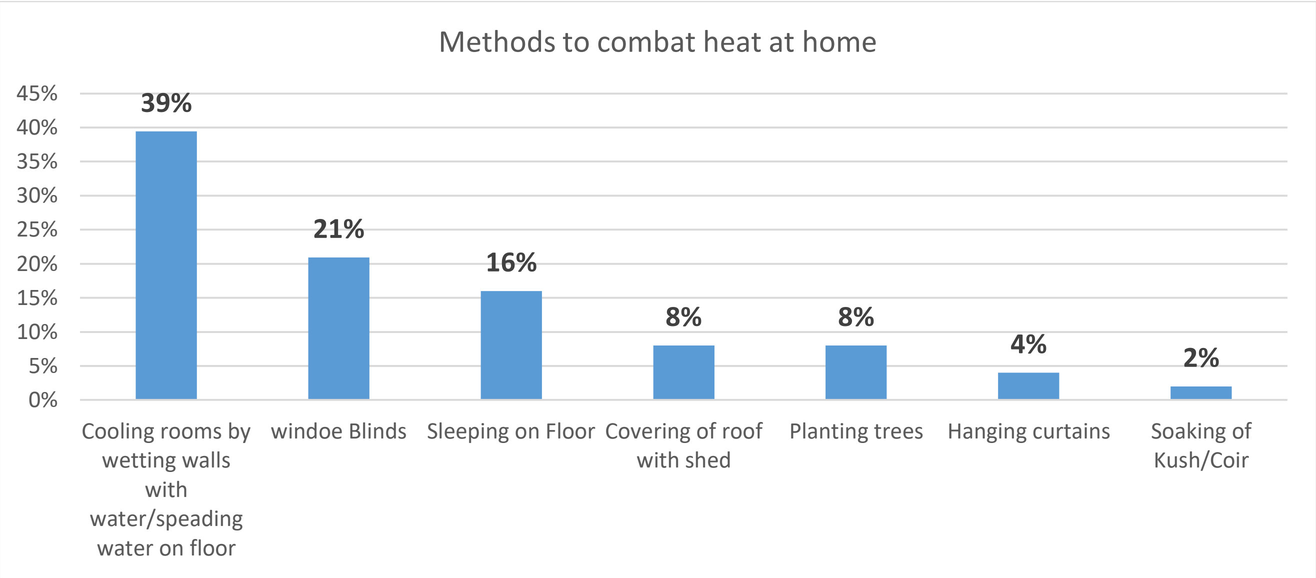
Adaptation:

Coping of heat related discomfort at work



The most convenient way to cope heat related discomfort are comfortable clothing (51%), usage of electric fans/coolers (50%), drinking water frequently (48%) and drinking other fluids (32%).

Initiatives at HH level to combat heat

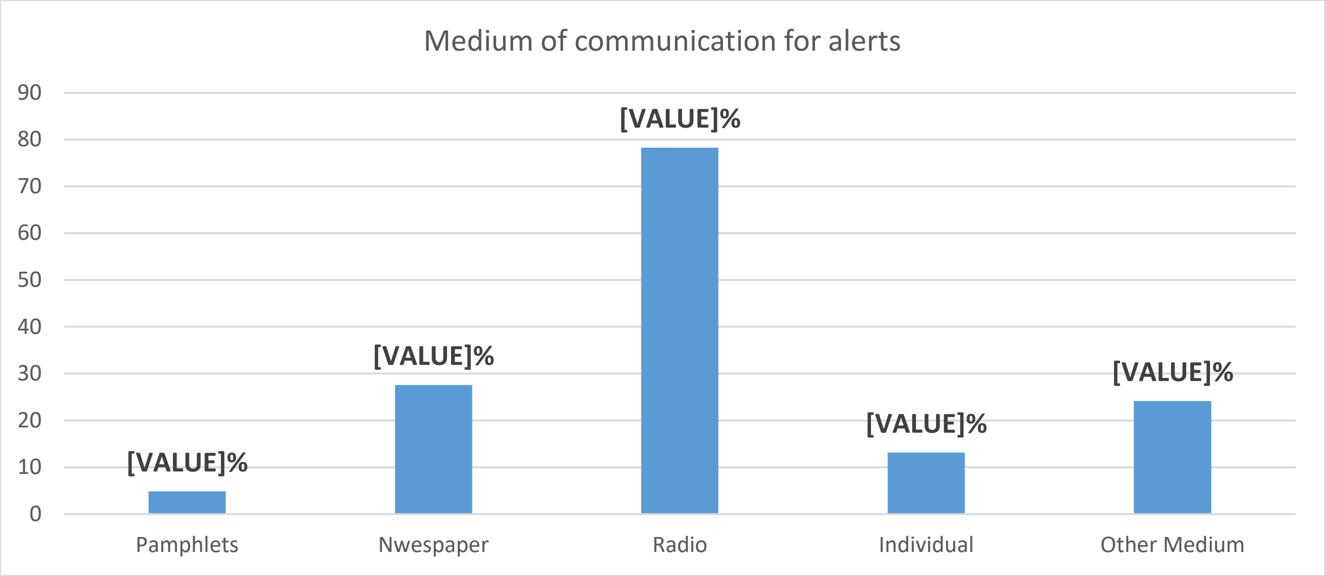


The most preferred methods to combat heat at household level are – cooling the roof by wetting the walls (39%), usage of window blinds (21%) and sleeping on floor (16%).

Preferred communication strategies:

Medium of communication for alerts

As per the majority (78%) responses for radio, it is the most preferred medium for communication alerts. This is followed by newspaper (28%) and individual (13%).



Fortnight Survey

Indicator of Heat stress:

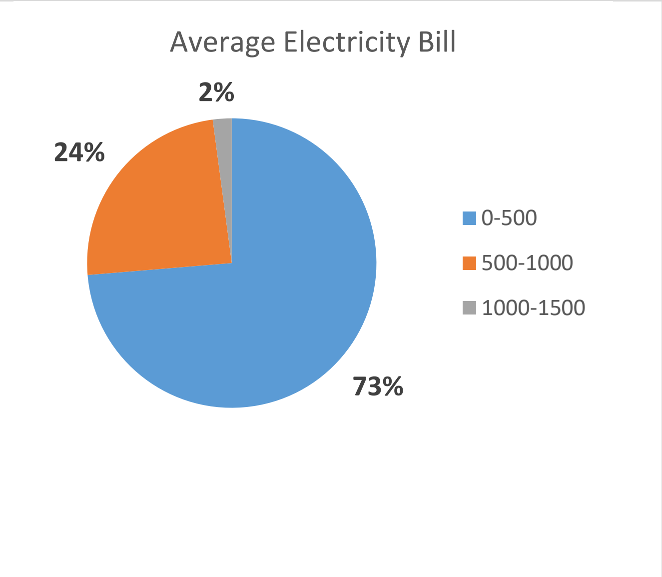
Temperature difference in work or school environment:

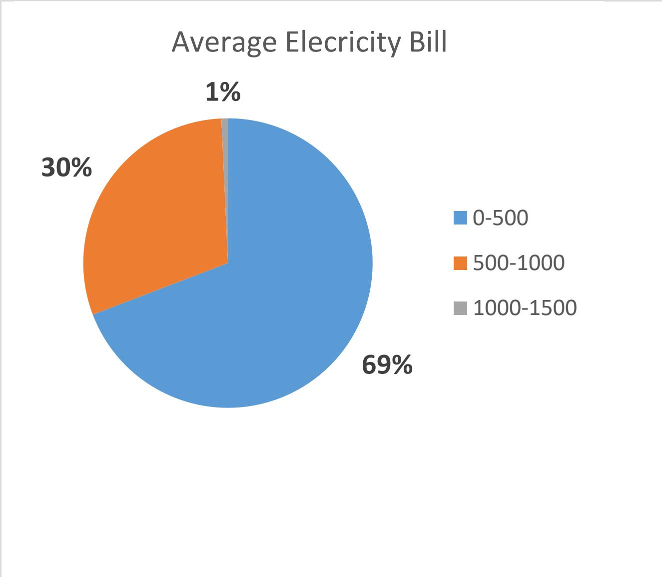
100% sample households have responded that they did experience a temperature difference in work or school environment in the last fifteen days.

Uncomfortable signs at the time of cooking

All (100%) the people responsible for cooking have reported that they have experienced uncomfortable signs at the time of cooking in last fifteen days.

Electricity bills in last 15 days:

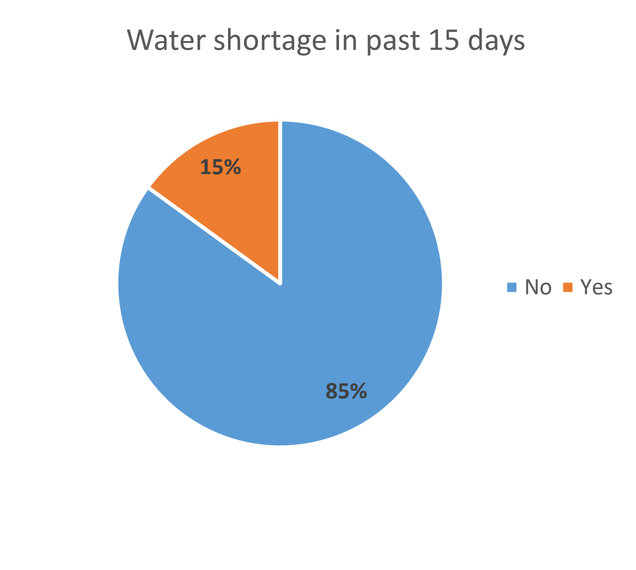


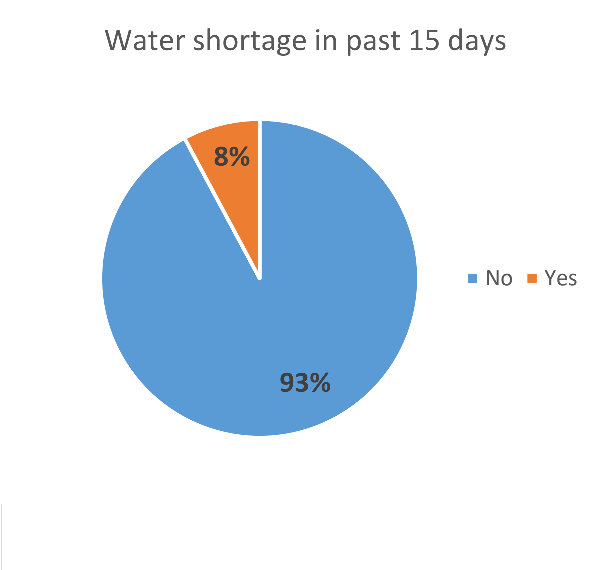


The average electricity bill for the sample survey ranges from Rs. 100 to Rs. 500.

This trend has remained same in summers; from the survey it can be seen that majority of the population surveyed pay their respective bills upto 500 Rs.

Water shortage in last 15 days





The survey done for two consecutive fortnights in a month during summer depicts that the percentage of respondents reporting water shortage reduced from 15% to 8%.

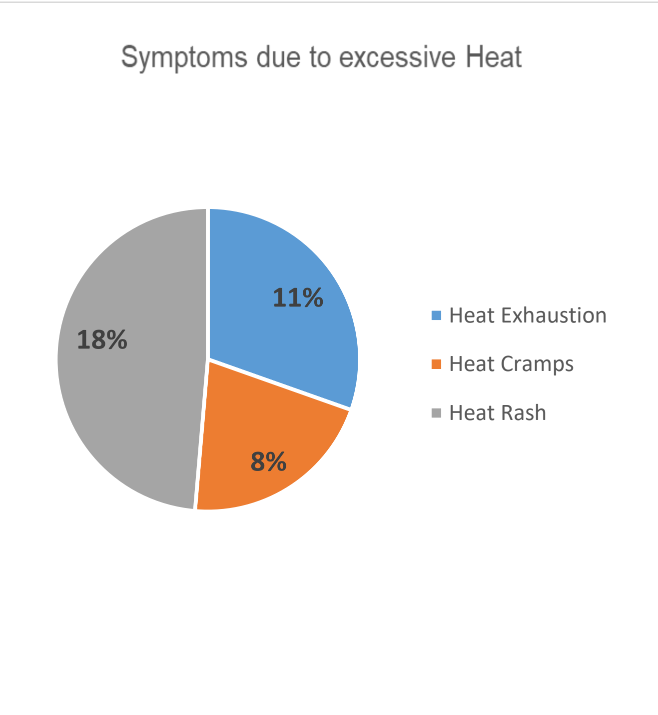
Electronic device bought in last 15 days

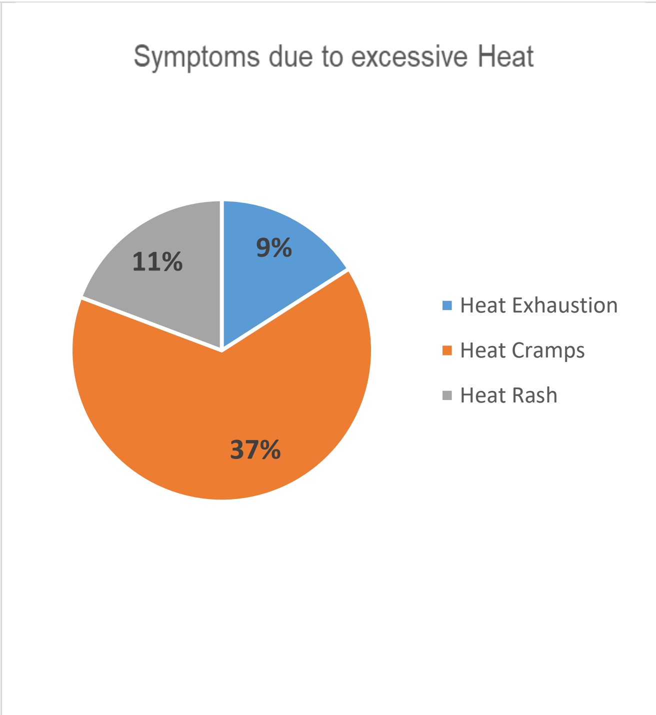
The survey shows that in summers with a gap of fifteen days, fan was bought most to combat heat.

Death due to heat in last 15 days

No deaths were reported in the duration of two consecutive fortnight survey.

Symptoms due to heat stress in last 15 days.

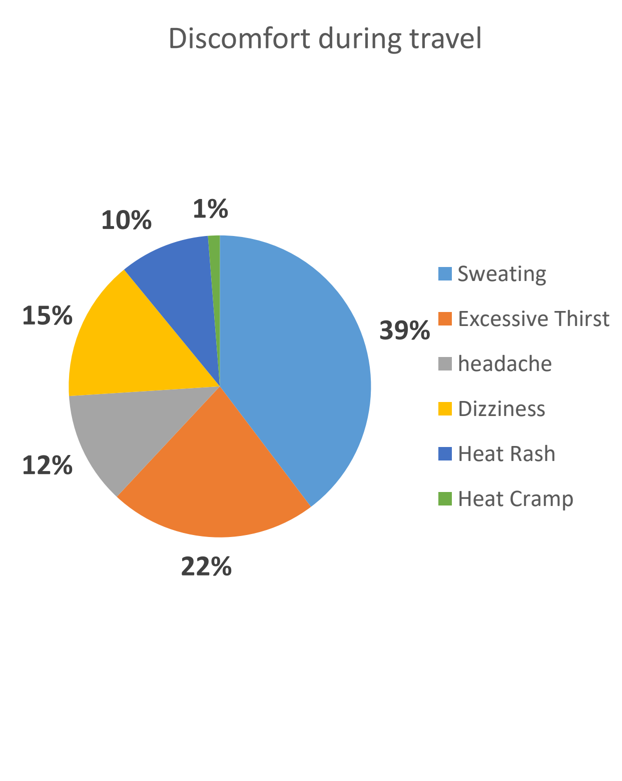


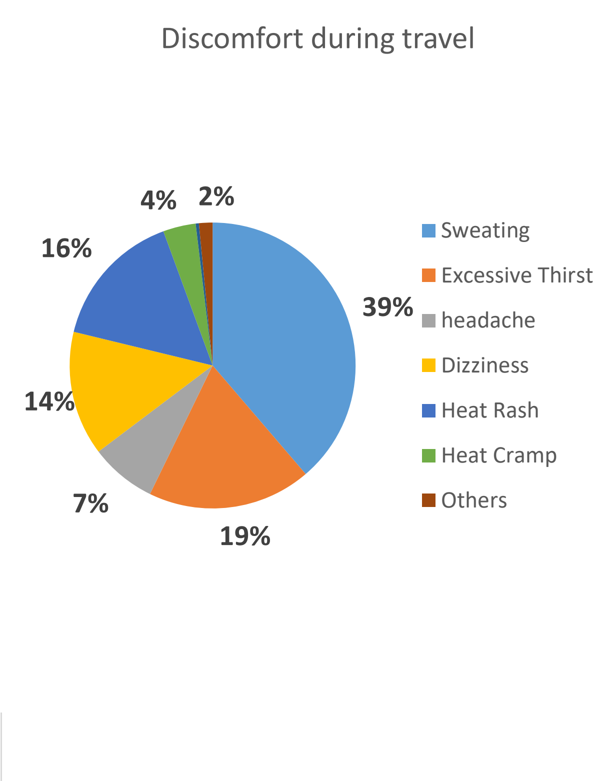


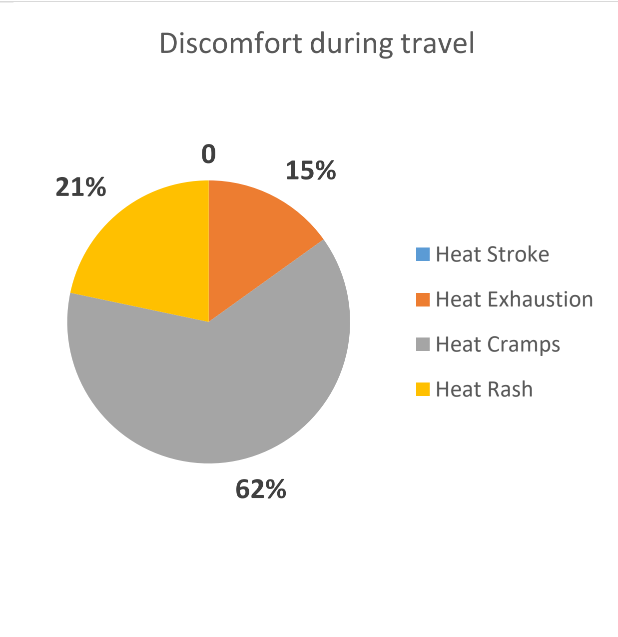
In the course of 15 days it can be seen that:

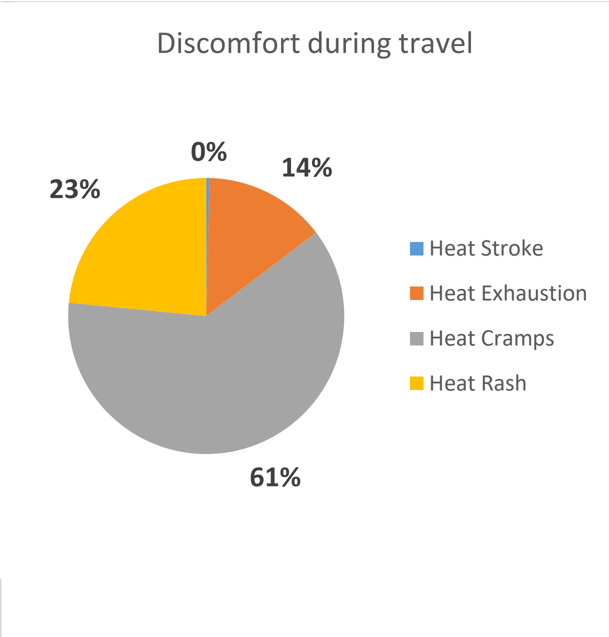
1st stage heat rash reduced from 18% to 11%. 2nd stage heat cramps, the people suffering from it have increased enormously from 8% to 37%. The sample population suffering from 3rd stage heat exhaustion was 11% which reduced to 9%

Problems faced while travelling to workplace or school









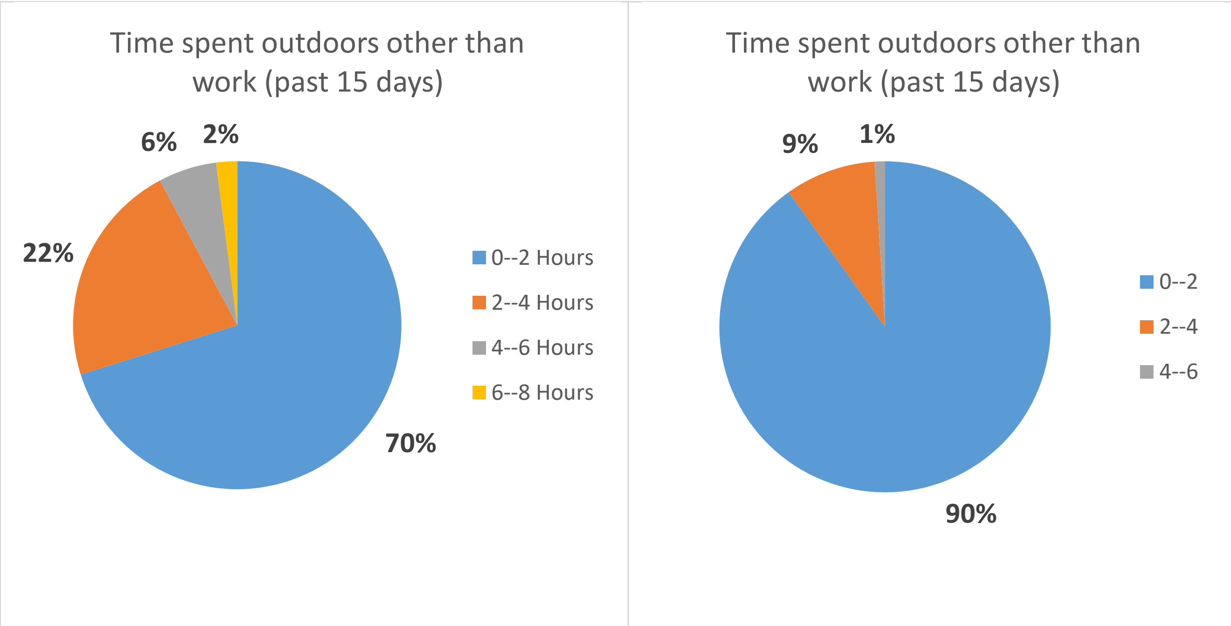
It is found from the survey that:

The percentage of sample population suffering from all the four stages of heat stress including heat rash, heat cramps and heat exhaustion during travel have remained similar in the span of 15 days.

Problems faced while sleeping in house

It was observed from the sample survey that during summers all face a problem while sleeping in house.

Number of hours spent outside except for work:

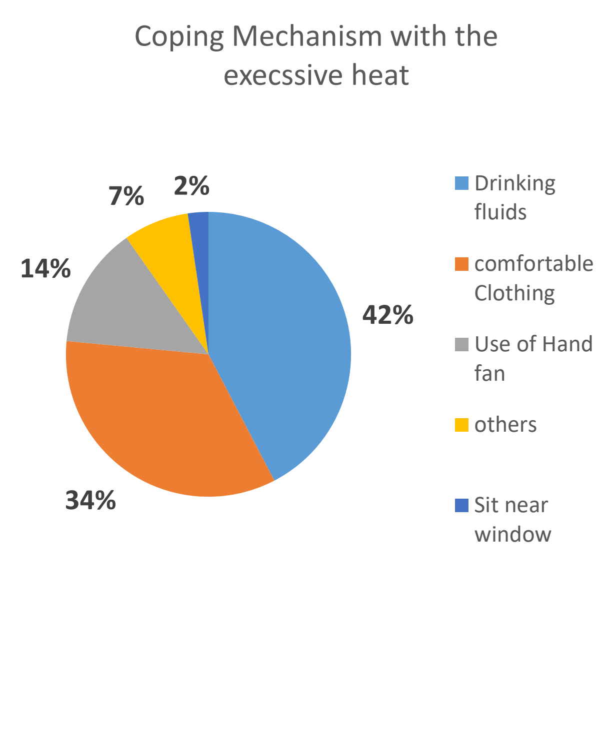


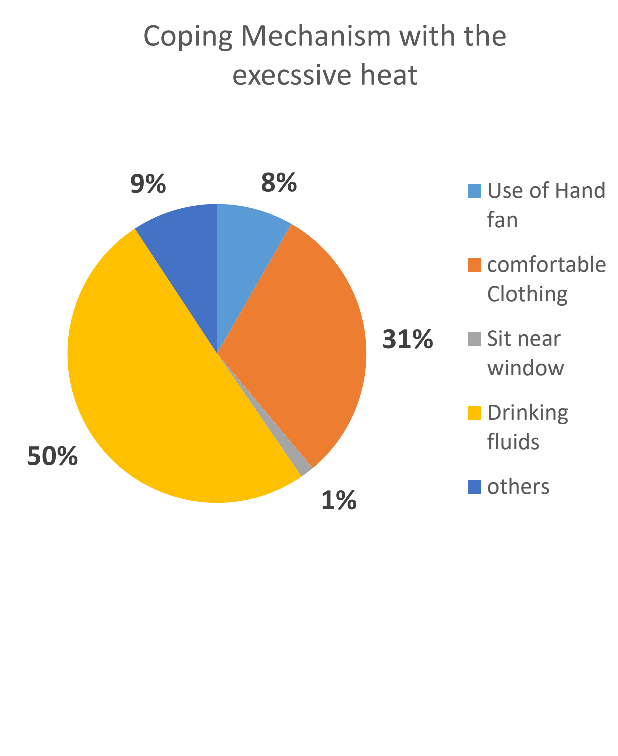
Majority of the population spent 0 to 4 hours outside except for work.

It is observed from the sample survey that population outside for the duration of 0 to 2 hours have increased from 70% to 90%. For rest, the share of population spending time outside for longer durations have reduced.

Ways to combat Heat stress:

Ways adopted to combat heat in last 15 days

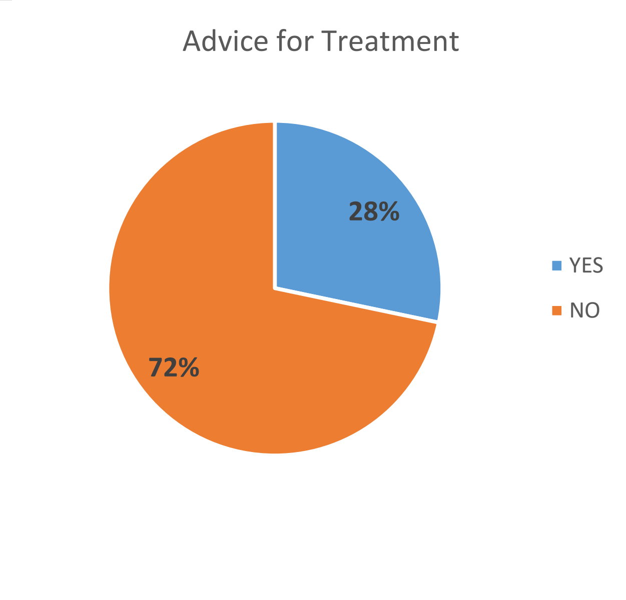


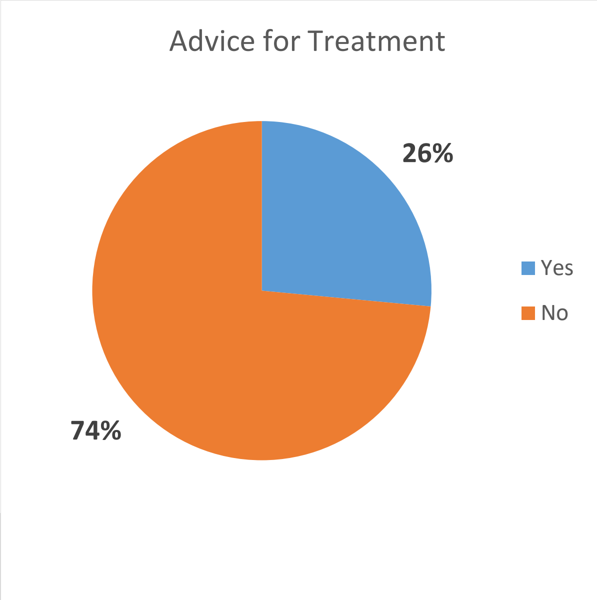


The most common coping mechanism adopted to combat heat in summers include drinking fluids, wearing comfortable clothing and use of hand fans.

The percentage of survey population choosing all three mentioned mechanisms to combat heat remained similar in the period of 15 days.

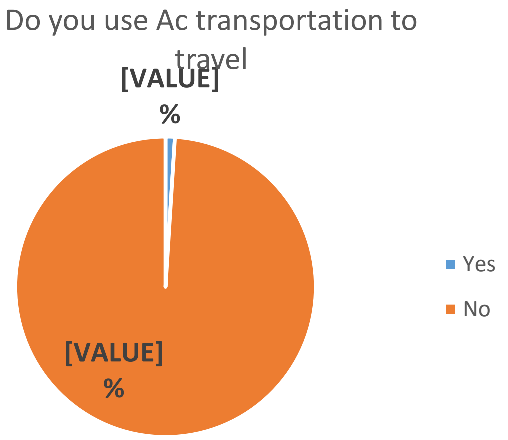
Treatment of the member suffering with heat related Illness:





The percentage of sample population seeking advice for the members suffering with heat related illness have reduced from 28% to 26% in the last 15 days.

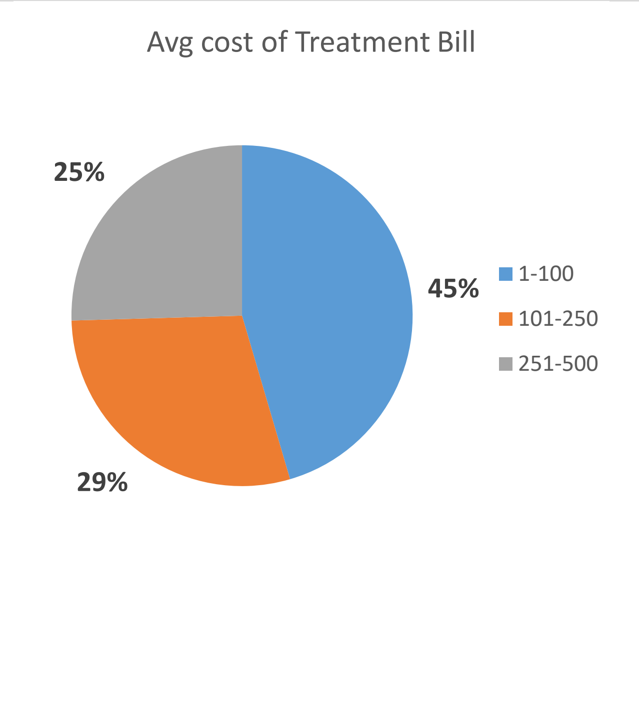
AC transport used for travelling

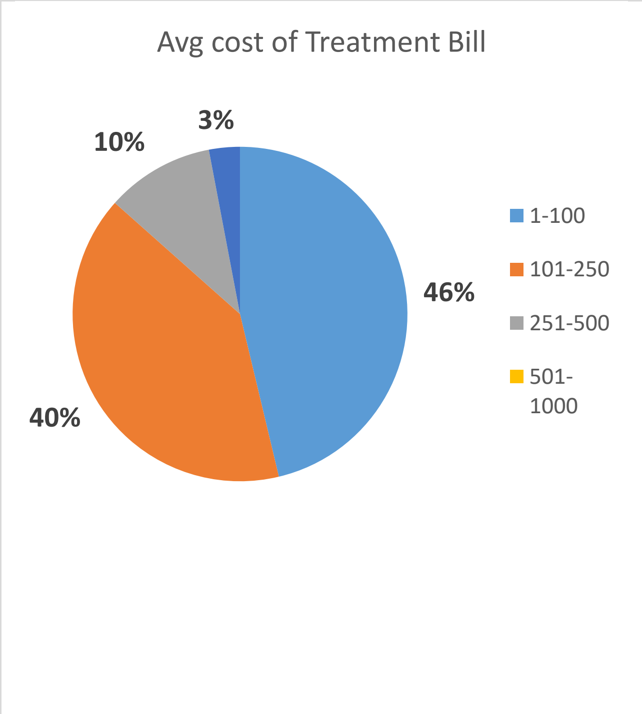


In the duration of 15 days it is observed from the survey that the 1% of the sample survey travelling using an AC transport has gone down to 0%.

Expenditure to combat heat:

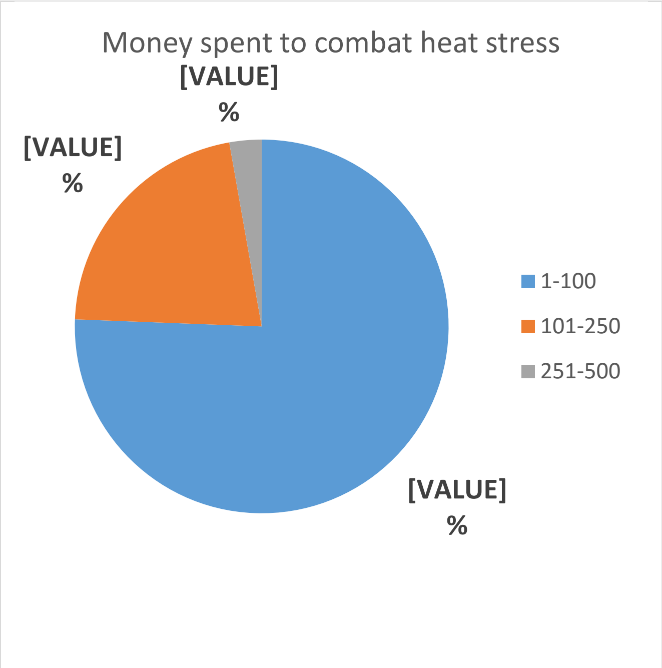
Money spent in health treatment

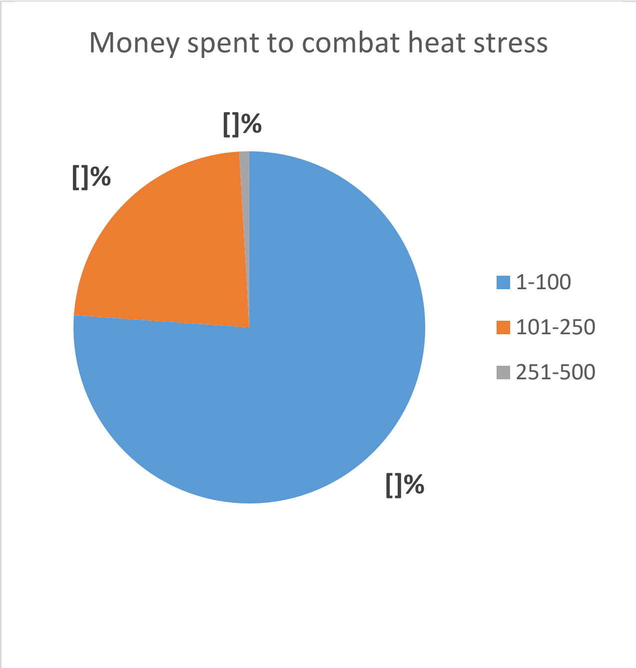




The sample survey delineates that most of the people spent 0 to 100 Rs in health treatments due to heat. It is seen that percentage of people spending 0 to 100 Rs have remained similar, from 45% to 46% in summers in the course of 15 days. Whereas those spending 101- 250 Rs have increased from 29% to 40%.

Money spent on food and clothes due to heat

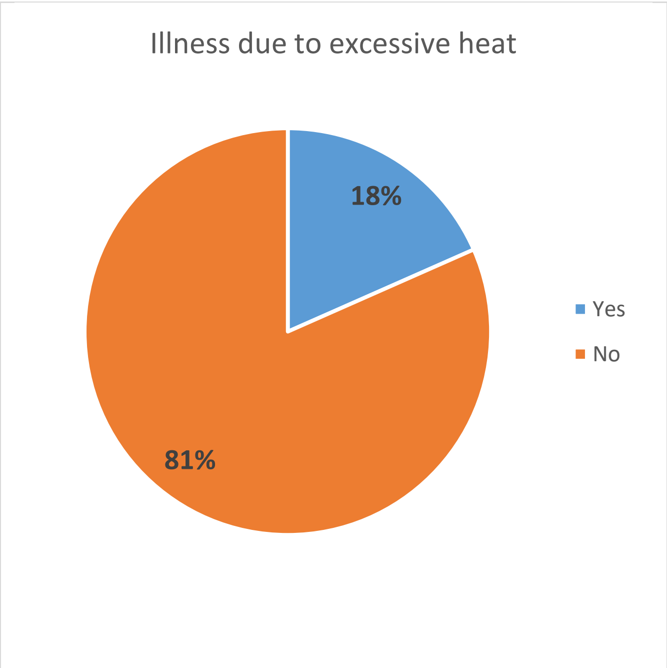


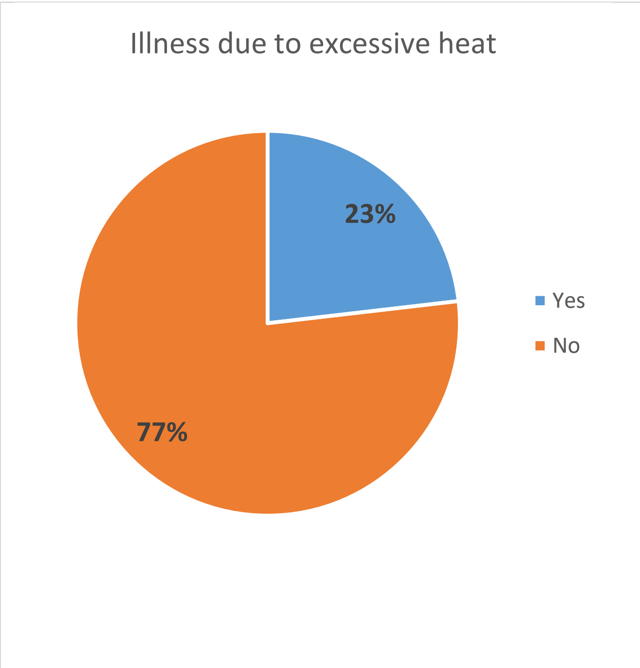


Most of the people spent Rs.1 to 100 to combat heat stress. The percentage of sample population spending the same increased from 75% to 76% with a difference of 1% in summers.

Impact on Livelihood and Productivity:

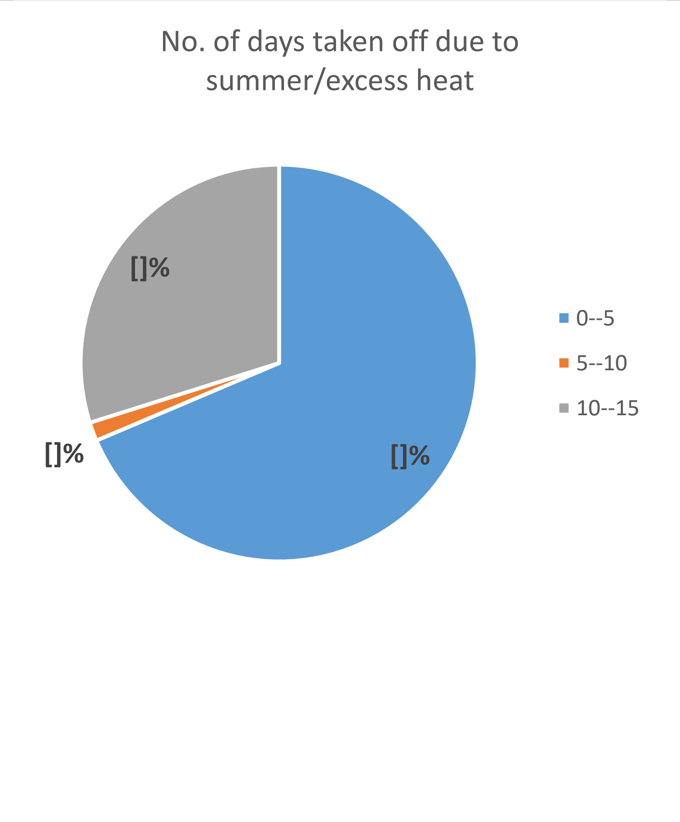
Anyone got sick in last 15days due to excessive heat

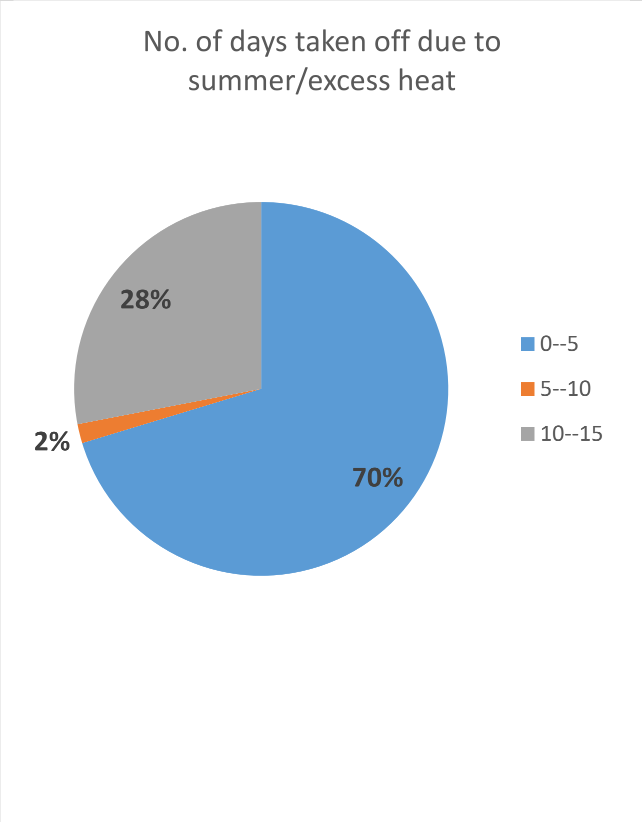




From 18% to 23% the sample population who got sick in last 15 days due to excessive heat increased to 5%.

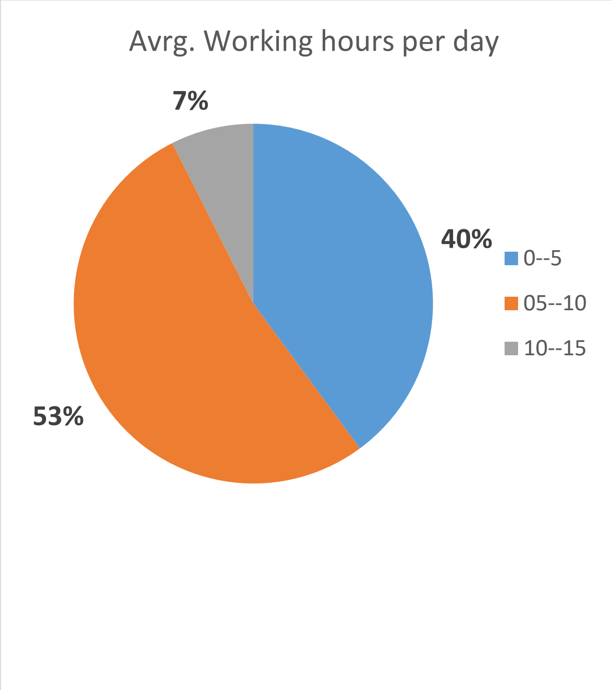
Due to excessive heat no of leaves from workplace or school

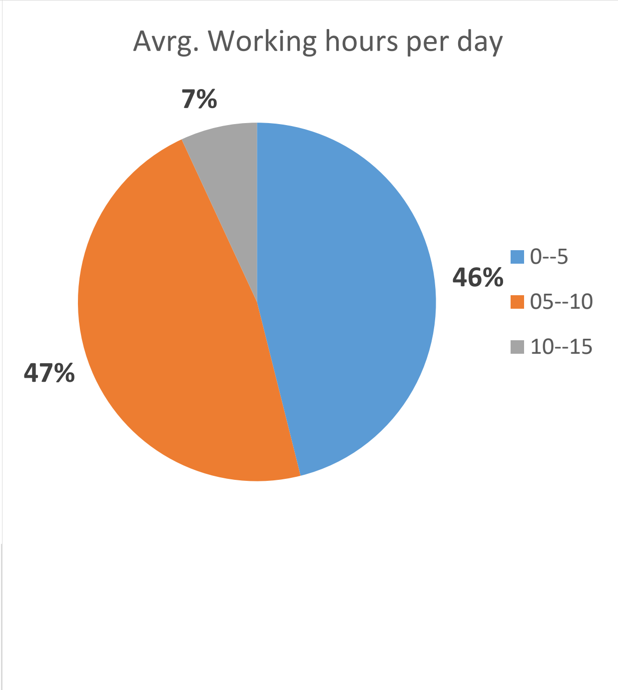




The percentage of sample population on leave due to excess heat for the duration of 0 to 5 days' have increased from 68% to 70 % with a difference of 2% in past 15 days during summers.

Duration of working hours in last 15 days

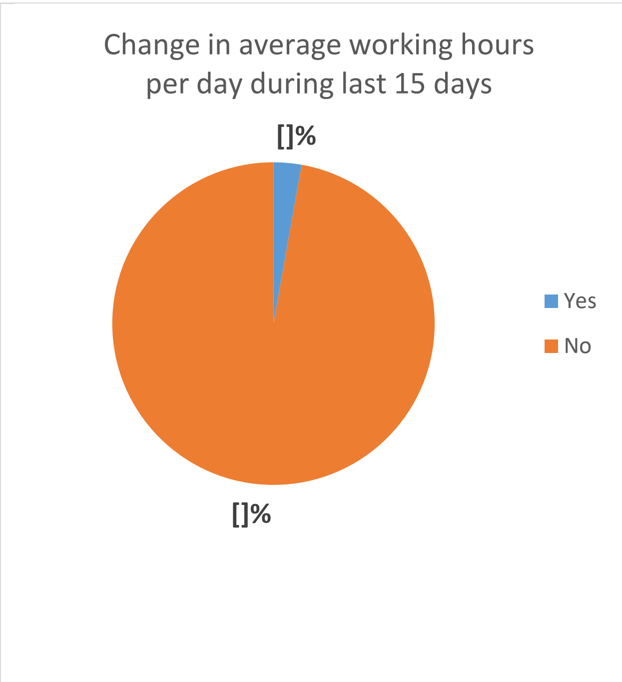


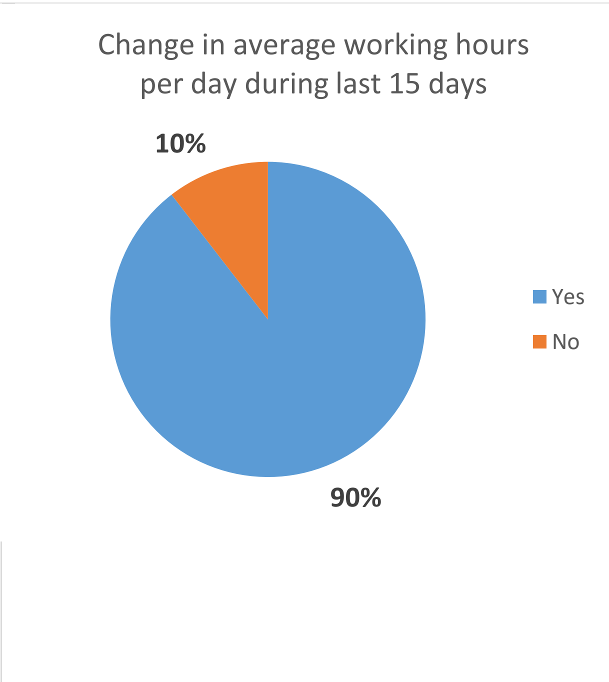


Majority of the population duration of working ranges from 5 to 10 hours followed by the range of 0 to 5 hours.

The sample survey depicts that in 15 days, the sample population working for 5 to 10 hours reduced from 53% to 47% while it increased from 40% to 46% for the duration of 0 to 5 hours.

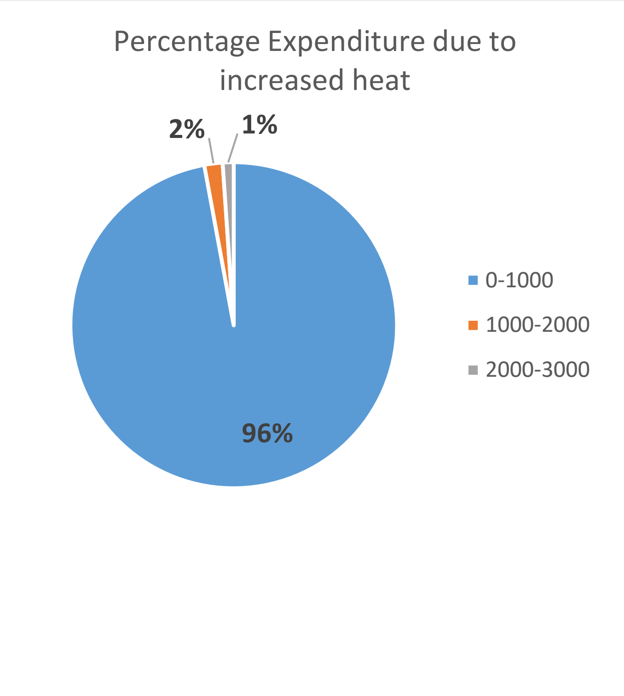
Shift in work timings

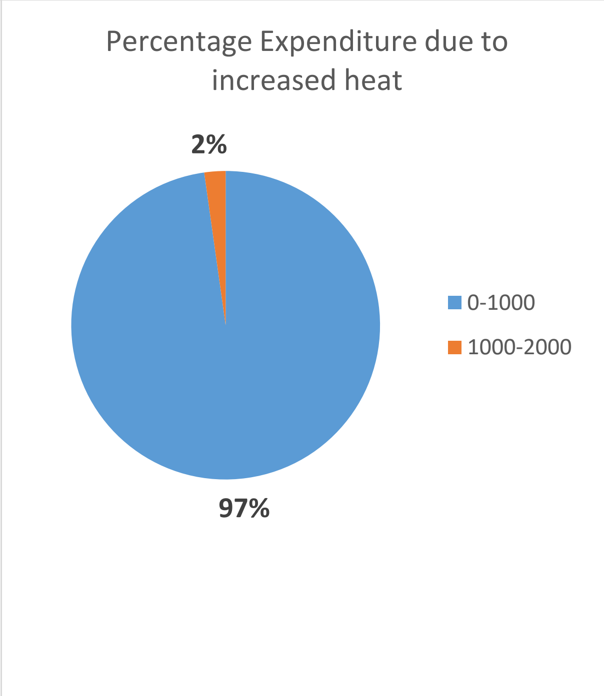




In the course of 15 days from just 3% people experiencing shift in the work timing due to heat increased to 10%.

Wage loss in last 15 days





The sample survey shows that in the duration of 15 days the loss of wages due to heat experienced by the people was seen most on the income category of Rs. 0 to Rs. 1000.

It can be seen that the percentage of population suffering from the loss in wages have remained similar, from 96% it grew to 97%.