Climate Adaptive Heat Action Plans for Vulnerable Poor

A case study of Bhubaneshwar city, Odisha

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Abstract

IPCC's Fifth Assessment Report (IPCC, 2014) indicates that the last 50 years have witnessed a hike in the frequency of hot days, nights and heatwaves globally. June and July in 2019 were the warmest months on records, globally. Future projections of temperature indicate a steady increase across the three periods (the 2030s, 2050s, 2080s), with anomalies reaching 4-5°C for high emission scenarios by 2080. Heat stress-induced deaths in 2100 are estimated to be about 85 per 100,000 globally (Climate Impact Lab 2019) and above 100 per 100,000 in lower-income groups. In addition to their profound impacts on health, heatwaves also pose significant economic and non-economic impacts affecting livelihoods and productivity.

Impacts of heat stress are more severe in urban areas due to Urban Heat Island (UHI) effect (CCA, 2016). UN predicts that the majority of the world's population will live in cities by 2050. Urban slums which are most vulnerable to heat stress are concentrated in cities. According to the Global Climate Risk Index 2020 (Germanwatch, 2020), countries in South Asia are among the most vulnerable globally to the impacts of climate change. India, ranked 5th in that list and having witnessed consecutive years of highest temperatures between 2015 and 2019, is highly susceptible to adverse impacts from extreme temperatures.

In order to help cities with adapt to heat stress, and attain the Sustainable Development Goal, **SDG 13** (Urgent action to combat Climate change and its impact), it is important to develop climate-adaptive heat stress action plans. The Climate adaptive heat stress plans will help strengthen the cities' resilience and adaptive capacity to Heat Stress (**SDG 13.1**) and will also prevent mortality (**SDG 11.5)** as well as reduce economic and non-economic impacts of heat stress (**SDG 11. 5.2**).

Climate Adaptive Heat Stress Action Plan (HSAP) identifies ward level heat hotspots, vulnerability assessment of the urban poor and provides a framework for implementation, coordination and evaluation of extreme heat response in Bhubaneswar (**SDG 11.B,** increasing the adaption and implementation of integrated policies and plans). Heat Stress Action Plan developed through this initiative supports Bhubaneswar city in prioritizing targeted action through understanding adaptive deficits and strategies to evolve adaptation strategies.

Keywords

Heat Stress, Heat Stress Action Plan (HSAP), Urban Heat Islands, Sustainable development goals, Bhubaneswar, Urban Poor

1. Introduction

The last 50 years have witnessed a hike in the frequency of hot days, nights and heat waves in the world (IPCC, 2014). Under the 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 heatwaves is 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 (the 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 heatwaves are becoming increasingly frequent globally due to climate change. Extreme temperatures are among the most dangerous natural hazards but rarely received adequate attention.

A Heat wave is a “silent disaster” and adversely affects the livelihood and productivity of people. 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). Cities being the engines of economic growth need to be climate resilient and should have appropriate mitigation and adaptive strategies at a place for combating the impact of heat waves on public health. To increase people’s resilience to heat stress and to reduce the adverse impacts on public health, it is important to have climate adaptive heat stress action plans at the city level. Indian Meteorological Department, IMD defines Heat wave conditions if 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. Refer to Figure 1 for heat alert criteria. 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 the normal average.

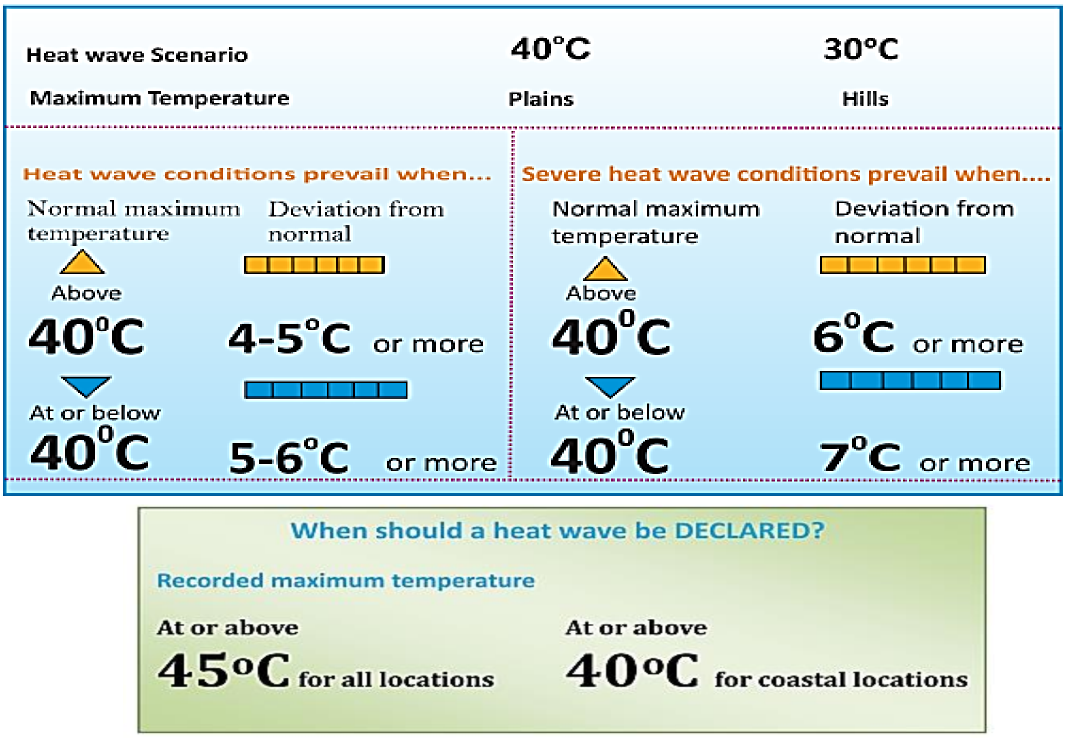


Figure 1: Heat Wave Alert Criteria, NIDM, 2016

Figure 2 indicates the rise in the annual mean land surface air temperatures anomalies over the period of 1901-2018, where the temperature has been increasing since 2001.

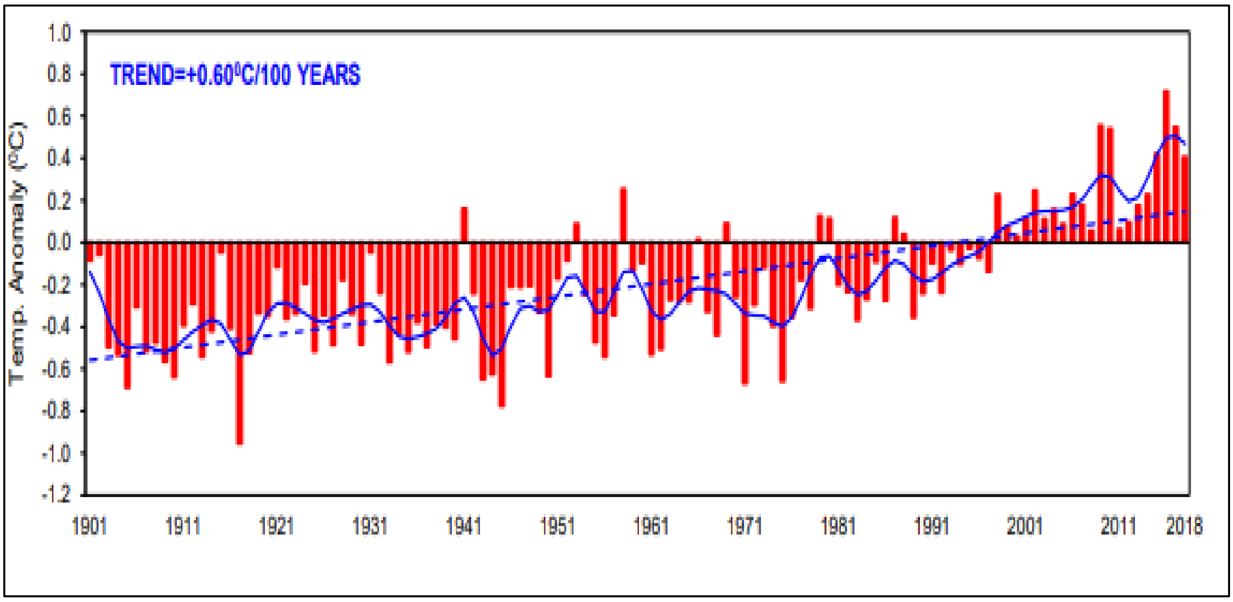


Figure 2: Annual mean land surface air temperatures anomalies 1901- 2018. IMD, 2019

Heatwaves related mortality is highest in Indian cities. Figure 3 indicates the regional distribution of the wave incidences across India and the corresponding heat stroke deaths recorded (2000-2014), which has killed 25,716 people from 1992 to 2016 in various states (*National Disaster Management Authority, 2016)*. Refer to Table 1 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 the current death rate (*Climate Impact Lab, 2019*). In 2010 May, the city of Ahmedabad had a major heat wave, registering 1,344 additional deaths in the city with an excess of 800 deaths recorded in the week of 20-27th May. This served as a wake-up call for intergovernmental agency action, preparedness, and community outreach for heat related awareness and mitigation actions.

Table 1: Heat Wave Mortality Records

Year	Death Record
2010	1274
2011	798
2012	1247
2013	1216
2014	1677
2015	2422
2016	1111
2017	220
2018	25
2019	94 (till 16.6.19)
	210 (30.6.19)-MHFW
NDMA, Ministry of Home Affairs, GoI, 2019	

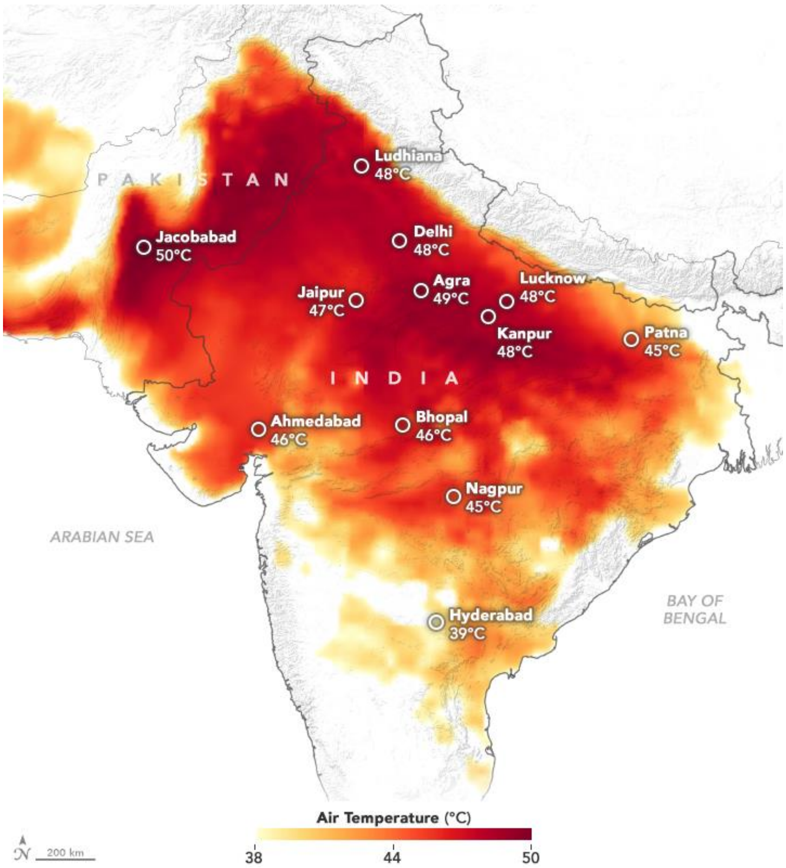


Figure 3: Heat Wave in India

Source: Goddard Earth Observing System(GEOS) mode,

Though the impact of a heatwave has been great 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. As per the guidelines, the heat action plans underline measures like a 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.

The impact of climate change on mortality from heat waves in urban areas of India is significant. Vulnerable population and city authorities lack the resources to adapt to heat waves. Existing Plans 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. Climate Adaptive Heat Action Plans needs to:

- 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.

Along with the identification of vulnerable groups, the particular city level thresholds need to be calculated. The threshold temperature for an increase in heat-related mortality depends on the local climate and is higher in warmer locations. Table 2 refers to the temperature thresholds for heat alerts issued by NDMA. There are no thresholds computed for India, and needs are specific to region, group (gender, age and other vulnerabilities) exposure, occupation.

Table 2: Heat Alerts for by NDMA

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]		

Several cities and states, such as Ahmedabad, Odisha, and Telangana have formulated action plans to address this issue. By 2018, 30 cities and 12 states across India had prepared Heat Action Plans (Figure 4).

The Action plans have been beneficial in checking the death rates in the cities, with a decrease in mortality rate recorded in cities of Ahmedabad, Orissa, Surat and other cities.

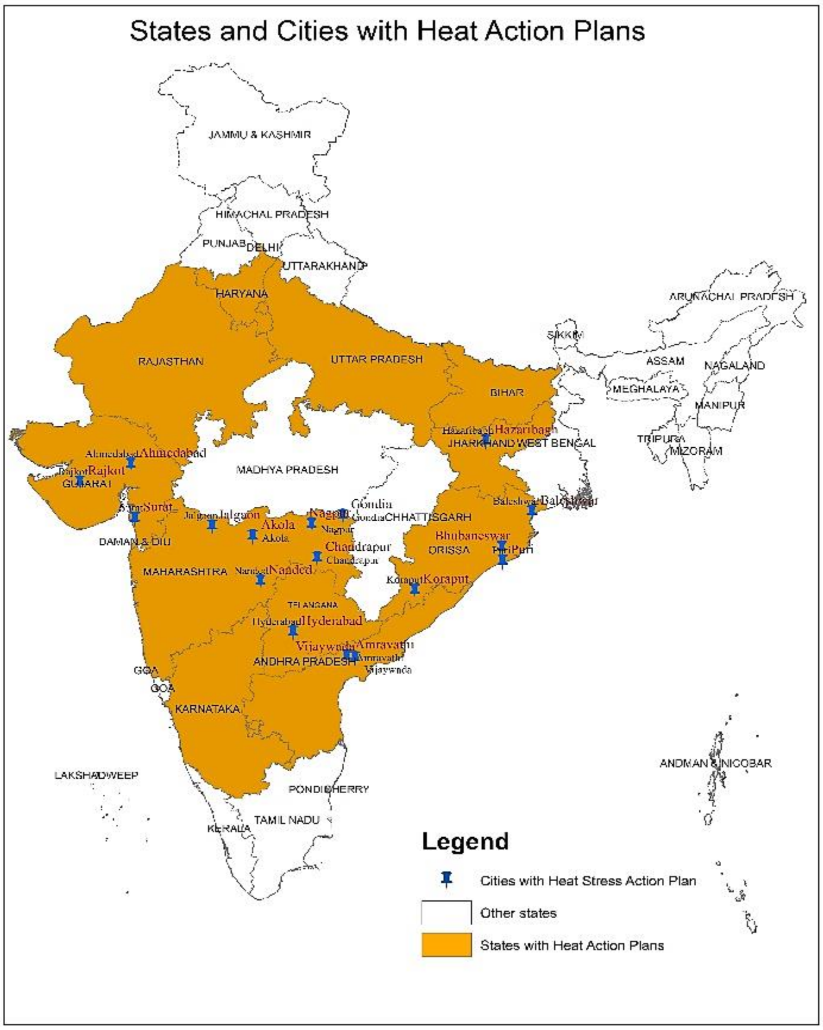


Figure 4: States and cities with Heat Action Plans, India

2. Bhubaneswar city, Odisha

Bhubaneswar city is the largest city and capital of Odisha and located on the east coast of the Indian peninsula. The city has a population of about 8,40,834 with a population density of 6,228 per sq. km (Census, 2011).

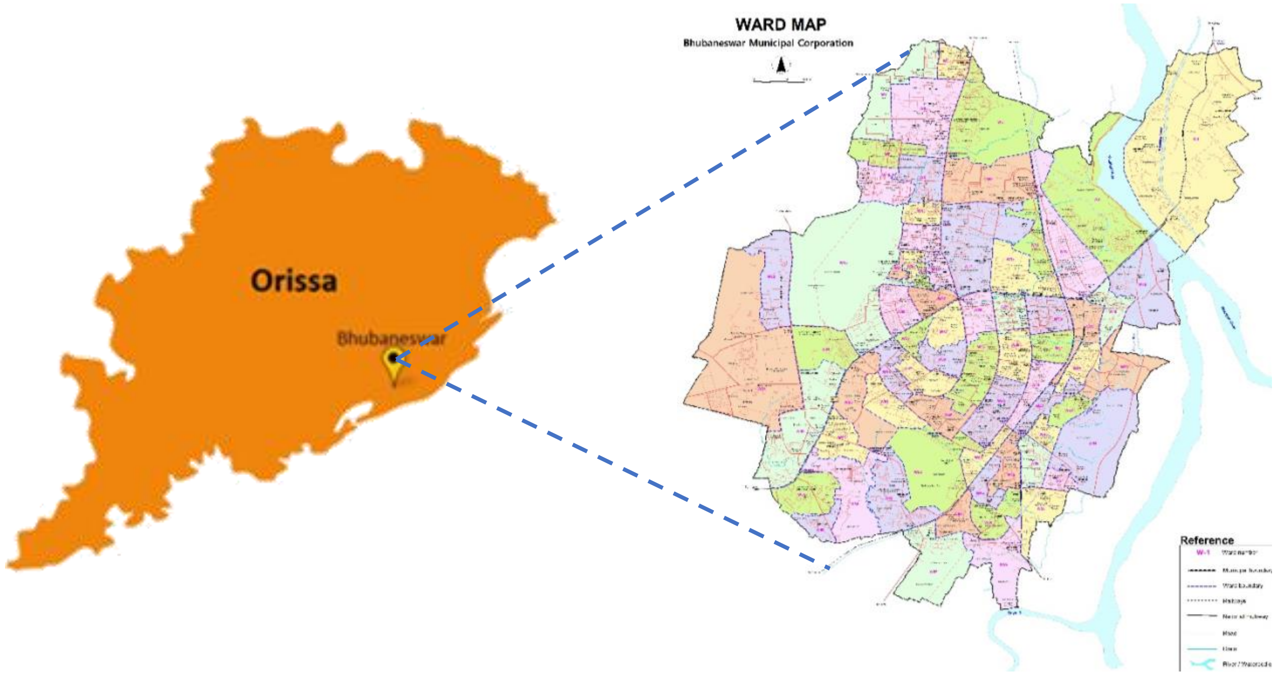


Figure 5: Bhubaneshwar City location Map

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 (HRVA, Bhubaneswar, 2014), with almost 116 authorized and 320 un-authorized slums, with 3.01 lakh population and 80,630 households (2014) (Bhubaneswar Municipal Corporation), with the majority of slums lying along the railway line, national highway and natural streams.

2.1 Need for Climate Adaptive action plan in Bhubaneswar

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 indicate 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 (Times of India, 2016). 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). Refer to figure 6. In 1998, Bhubaneswar experienced one of its worst heat waves with a death toll of 123 persons.

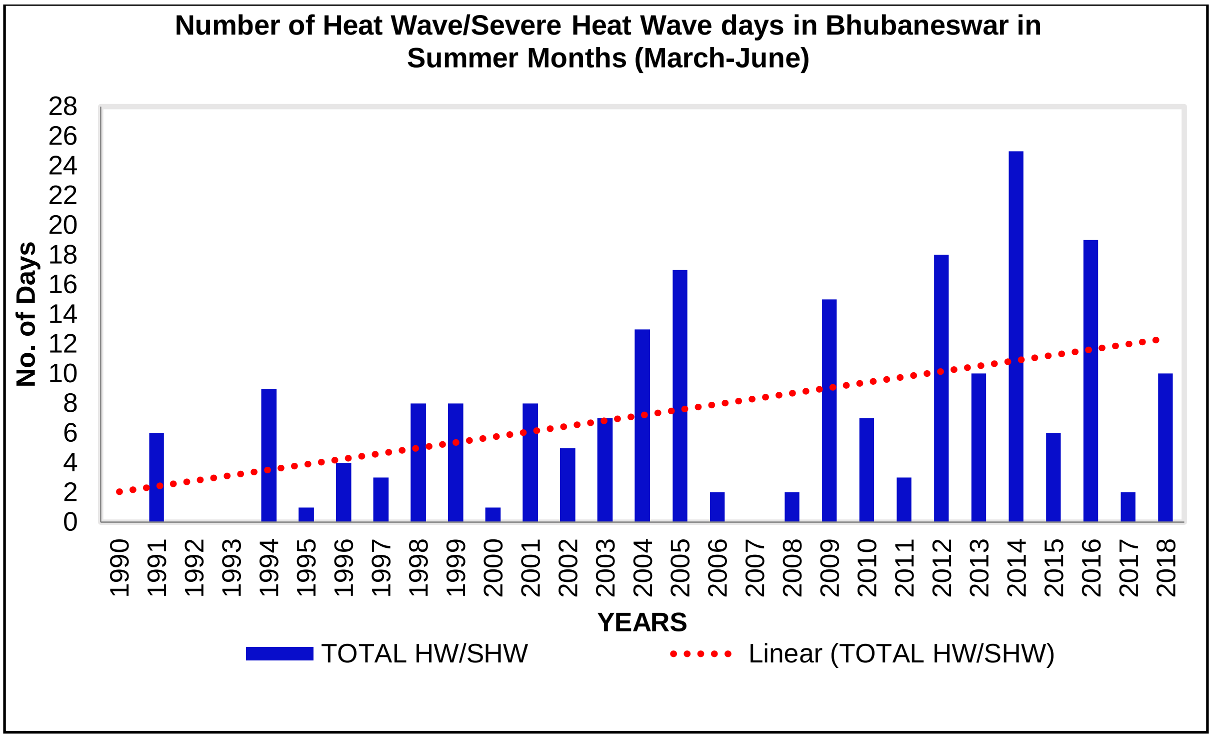


Figure 6: Trend in Heat Wave Days, Bhubaneswar,
Source: IMD

2.2 Climatology of Heat Waves in Bhubaneswar

Bhubaneswar has predominately a tropical climate. Bhubaneswar shows a moderating maritime influence of Bay of Bengal and has monsoon type of climate with little variations with around 86.5% of annual rainfall concentrating over a period of 5 months. The average annual rainfall of the area is 1542 mm. The city records an average annual Maximum temperature of 32°C and a minimum of 27 °C throughout the year.

Table 3:Climatology Records, Bhubaneswar City

Temperature	
Average annual Maximum Temp	32 °C
Average annual Minimum Temp	27 °C
Rainfall	
Average annual Rainfall	1,542 cm
Mean Annual Humidity	70%
Source: Bhubaneswar Municipal Corporation, Census of India, http://www.odisha.gov.in/	

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 was measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)].

The analysis of climatological parameters, viz, Tmax, Tmin and Relative Humidity, over a period of 11 years (2008-18) in Bhubaneswar presents an increasing trend in the 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, an 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.

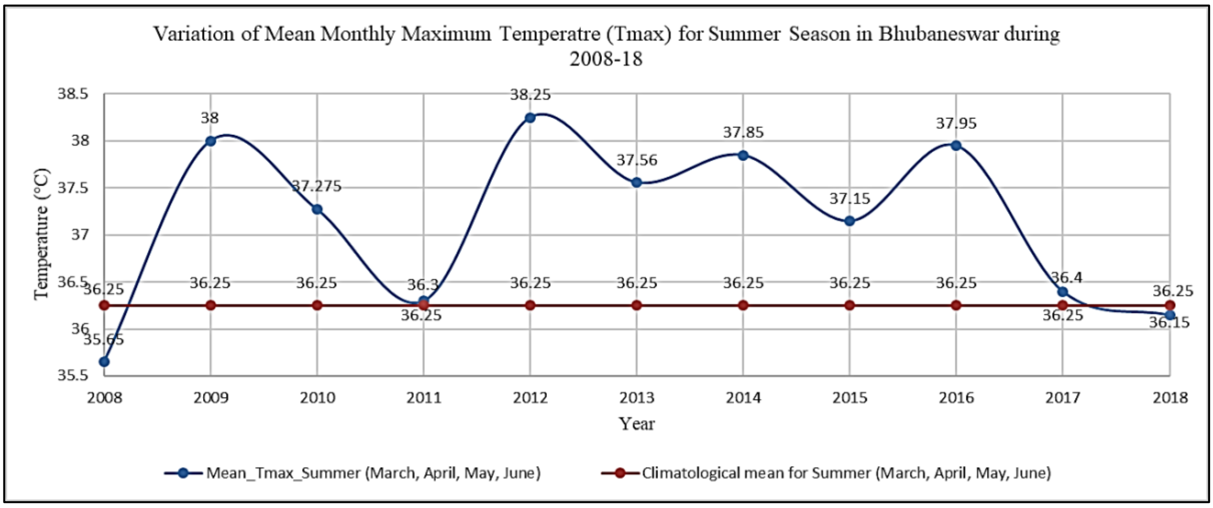


Figure 7: Variation of Tmax for summer season in Bhubaneswar (2008-2018)

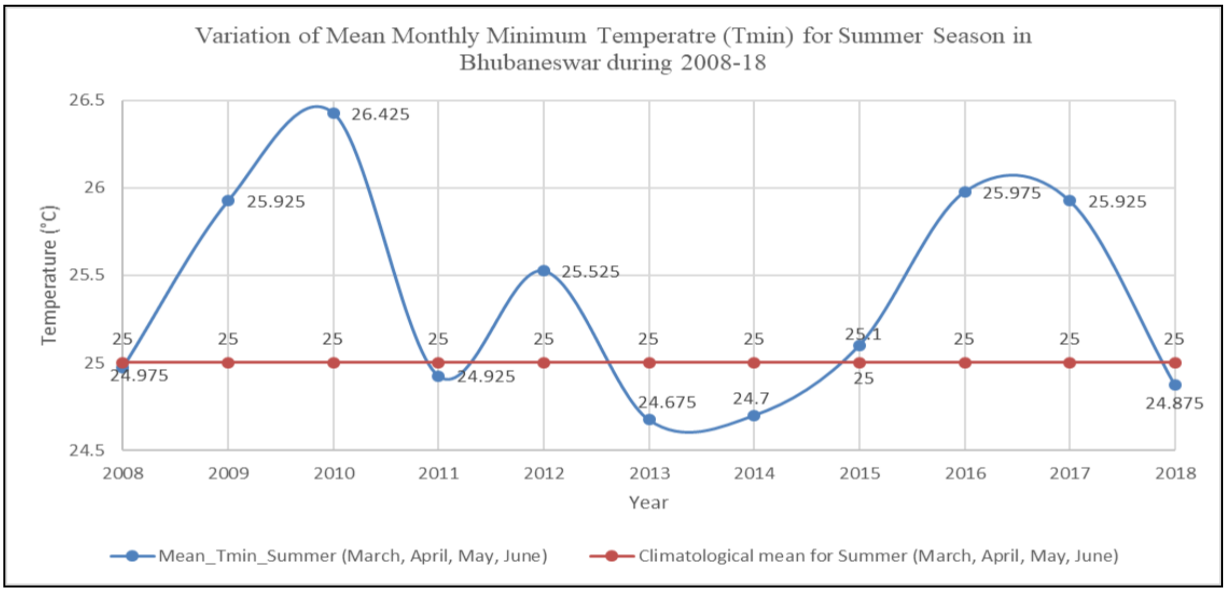


Figure 8: Variation of Tmin for summer season in Bhubaneswar (2008-2018)

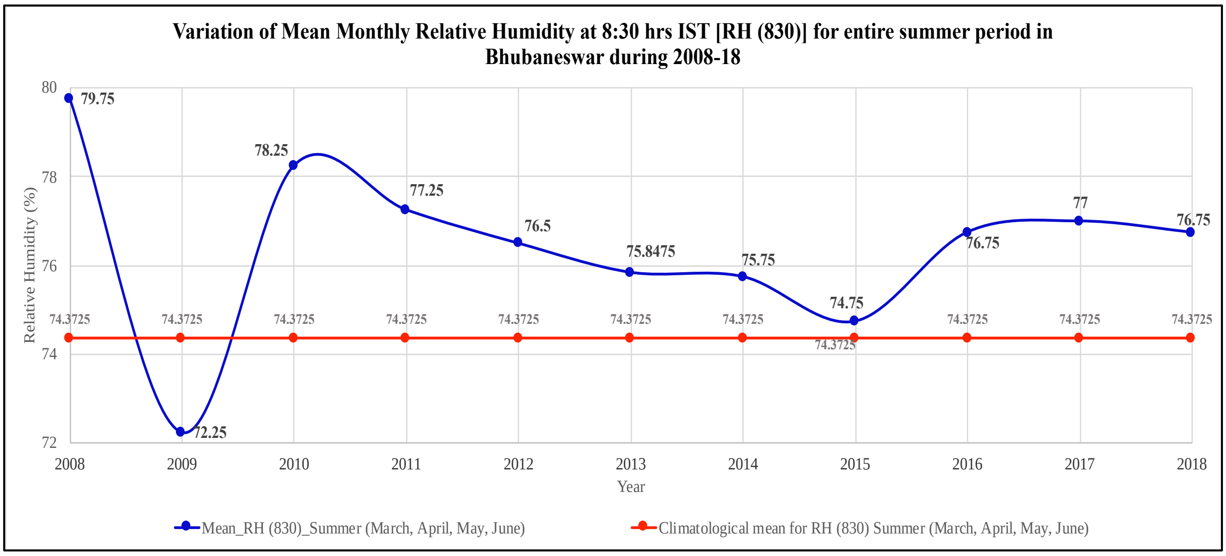


Figure 9: Variation of RH at 8:30 hrs. for summer in Bhubaneswar (2008-18)

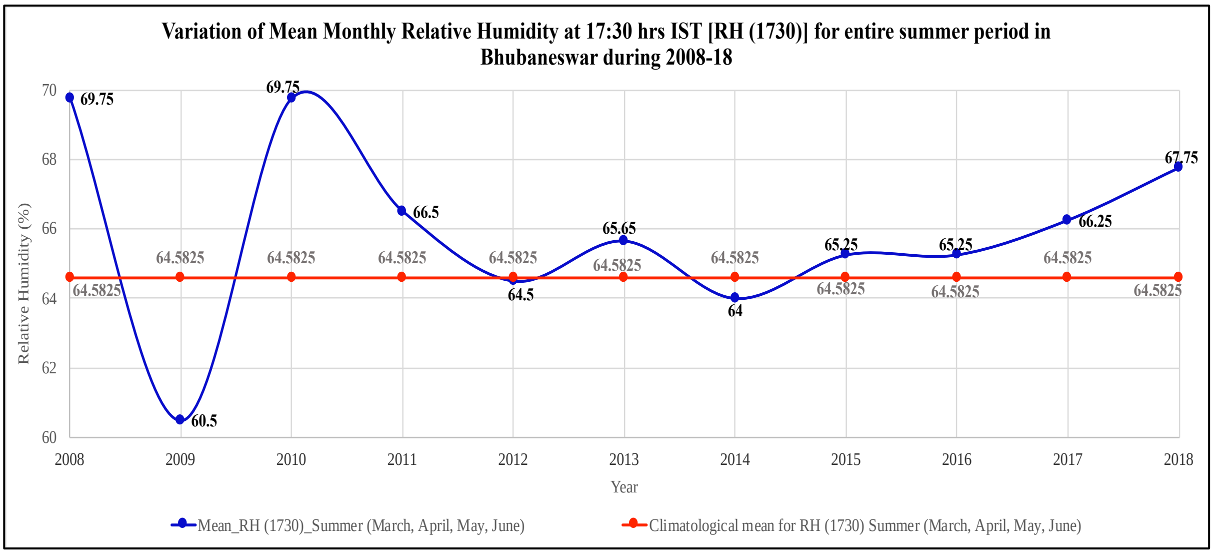


Figure 10: Variation of RH at 17.30 hrs., for the summer season In Bhubaneswar (2008-2018)

3. Spatial Variation and Mapping of Hotspots, Bhubaneswar

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.

Thermal hotspots maps were developed using Landsat 8 data. The Land Surface Temperature (LST) mapped was validated using ambient air temperature (AAT) recorded by 20 AWS (Automatic Weather Stations) installed by RMC and the IMD (Indian Meteorological Department) station. Landsat 8 provided a range of open-source data at a spatial resolution of 30 m and with 11 spectral bands, out of which two are thermal bands. The thermal bands, band 10 and band 11, are mostly employed for the purpose of LST retrieval; however, it has been observed that band 11 has more uncertainty than band 10 (Yu, Guo, & Zhaocong, 2014). Therefore, band 10 of Landsat 8 data was used for retrieval of LST. Data of May and June months of the years 2017 and 2018 were employed to map LST. For 2017, data of 04 May and 14 June were used, whereas, for 2018, data of 07 May and 08 June were used, as these dates provided images without any cloud cover. Hence clear images were derived on the particular dates. Shapefile of Rajkot municipal wards and slum distribution data was obtained by RMC. The methodology flow chart is shown in Fig 10.

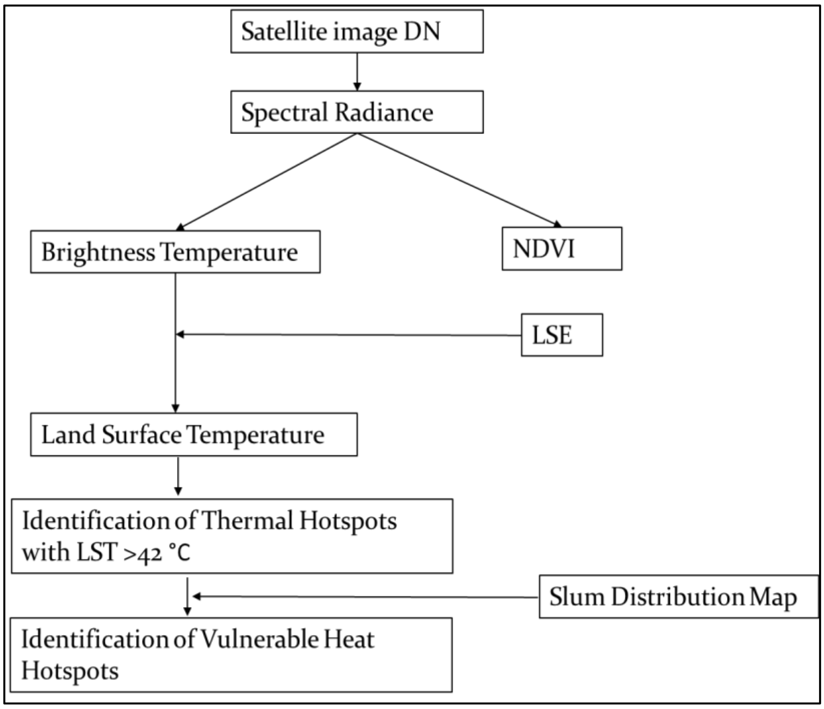


Figure 11:GIS Methodology for identification of vulnerable heat hotspots

The LST derived from satellite data (NDVI – Normalized Difference Vegetation Index and LSE –Land Surface Emissivity) was validated with ambient air temperature recorded by IMD station within the city. To mark the high temperature areas within Bhubaneswar city, thermal hotspot maps were prepared to map areas with a temperature higher than 40°C and were marked as thermal hot-spots.

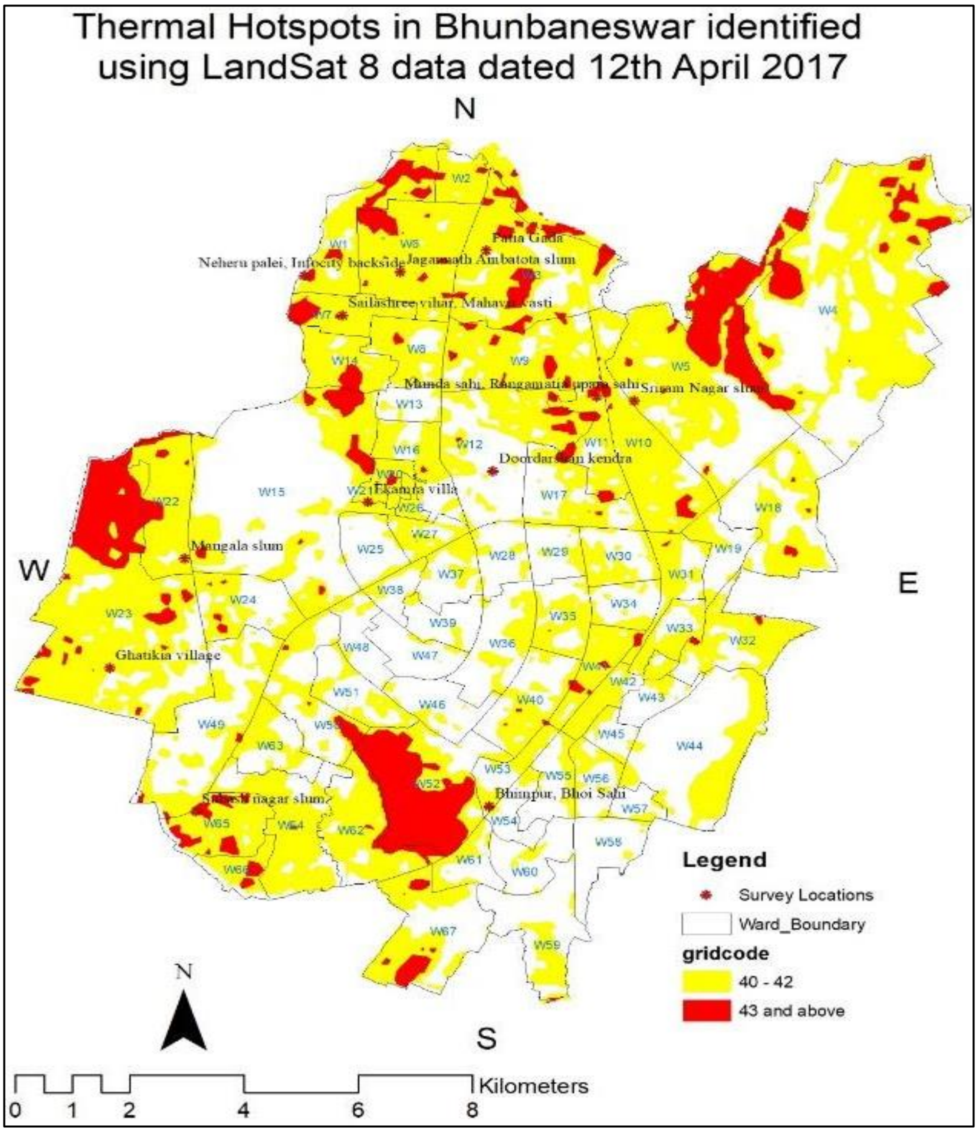


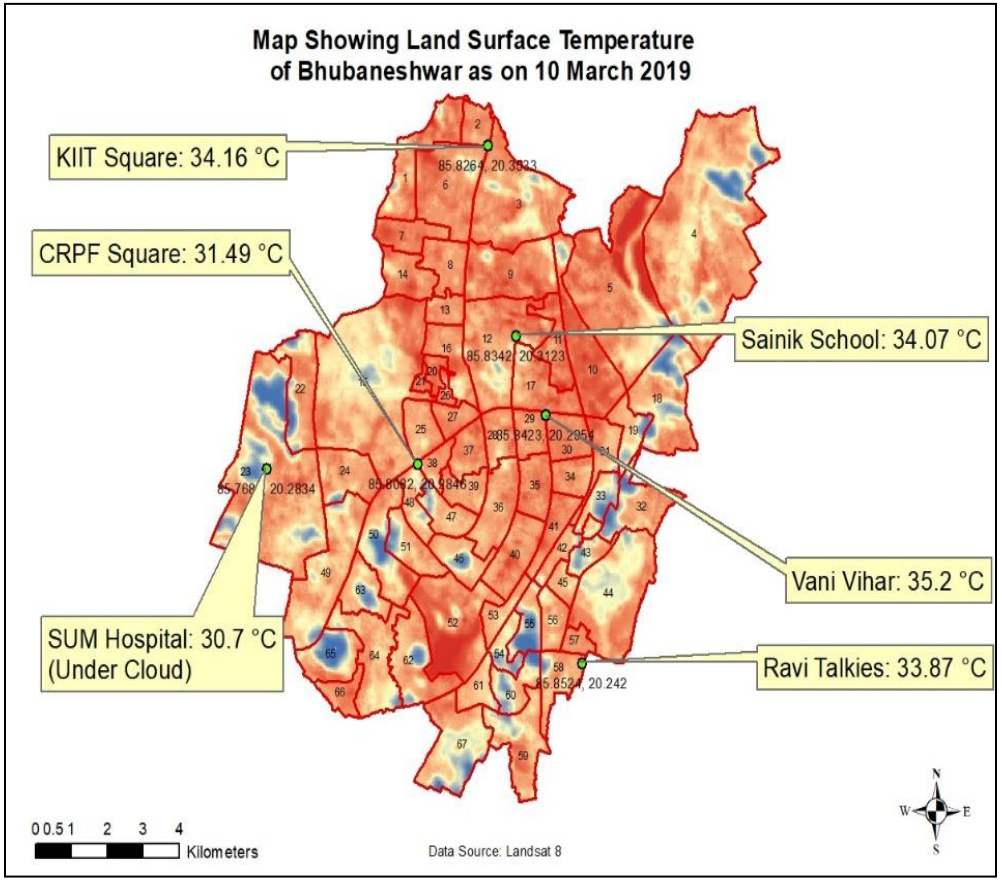
Figure 12: Thermal Hotspots, Bhubaneswar

3.1 Vulnerability mapping of Heat Stress, Bhubaneswar

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 Neheru 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.



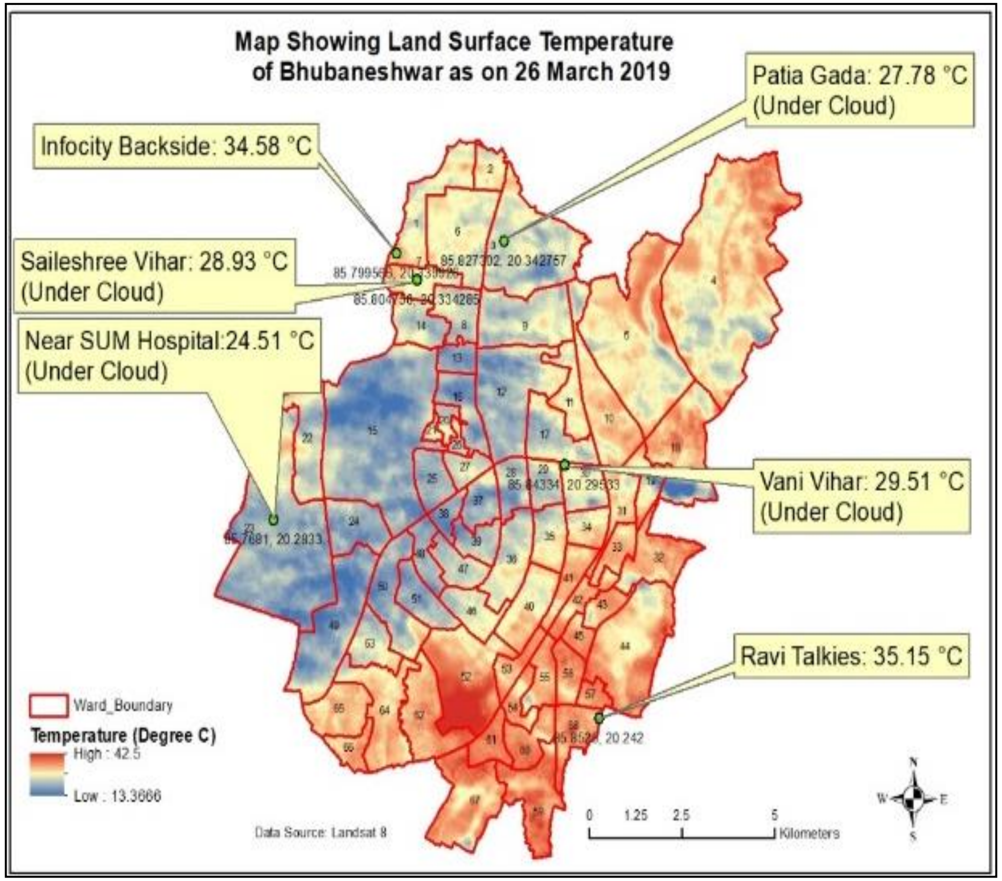


Figure 13: Map showing LST of Bhubaneswar as on 10 & 26 March 2019. The LST of surveyed locations has been highlighted separately

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 Rajkot 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.

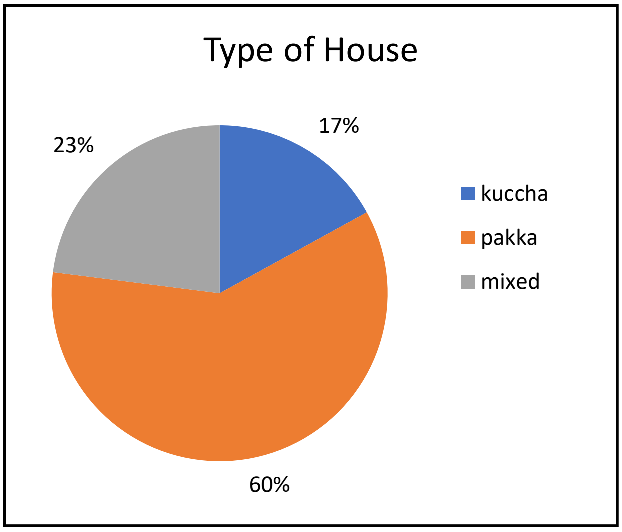
4. Survey Analysis

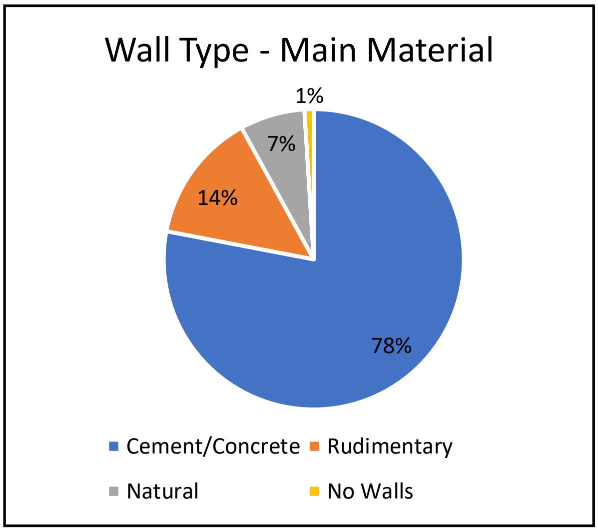
Household surveys were conducted to understand the present situation in the city in terms of housing structure and availability of basic amenities like water and sanitation and the impact it had on the lives of the vulnerable section in coping with heat stress in summers. The Heat Stress Action Plan for urban poor in Bhubaneswar was prepared based on the analysis to prioritize the adaptation strategies, the vulnerability maps and the analytical results of the household surveys.

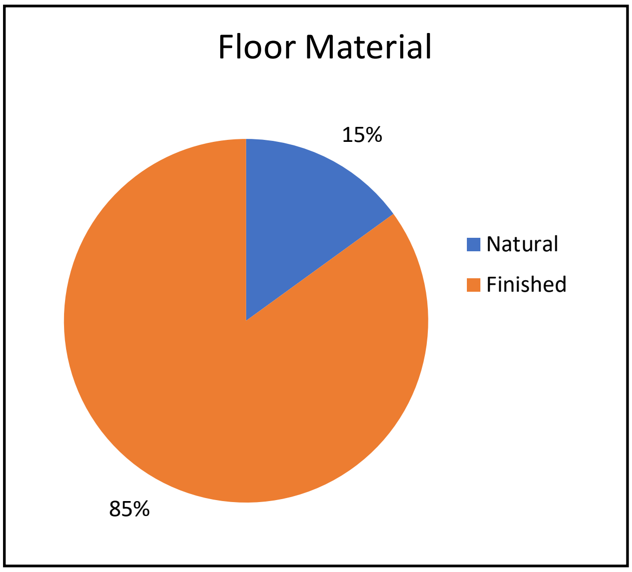
4.1 Housing Typology

The Household surveys conducted at the ward level indicated the majority (60%) of the houses surveyed were pukka in nature, which usually helps in providing the necessary protection from heat.

The most common material used for building the house was cement (85%) for the floor, cement (78%) for the walls and asbestos sheets (75%) for the roof. The wide use of hazardous materials like as asbestos sheets can aggravate vulnerability towards heat, therefore, there is a need for substituting the same with heat resistant properties.







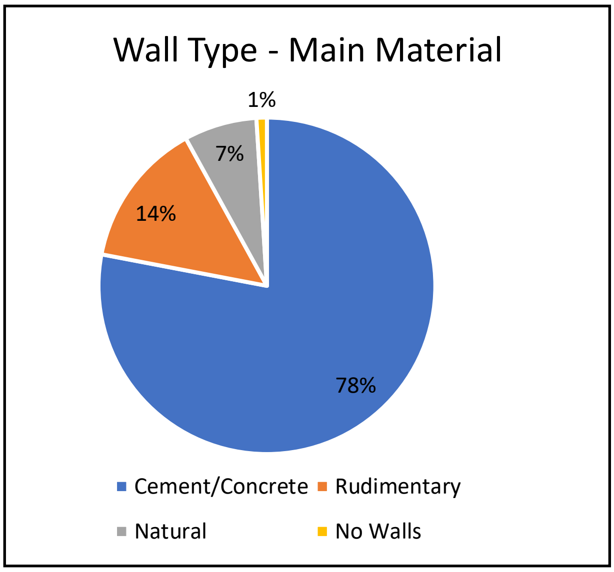
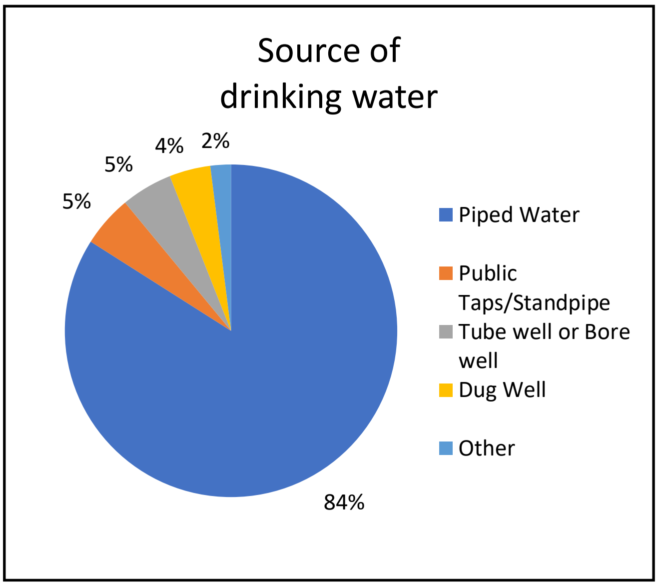


Figure 14: Housing Typology

Around 40% of the dwelling units have just 1 window followed by 34% having no window at all. A total of 74% of the household lives in a poorly ventilated and confined dwelling unit, resulting in one of the causes of heat related illness.

4.2 Portable Drinking water

The accessible sources of water in the city are piped water and public taps, Tube wells and wells. Out of the total, 84% of the sample households have access to a sustainable piped water supply. For the majority of households, 77%, the water source is located within the premise of respective households. Nearly 42% of the surveyed Households get water supply twice a day followed by 38% who have water supply 24*7



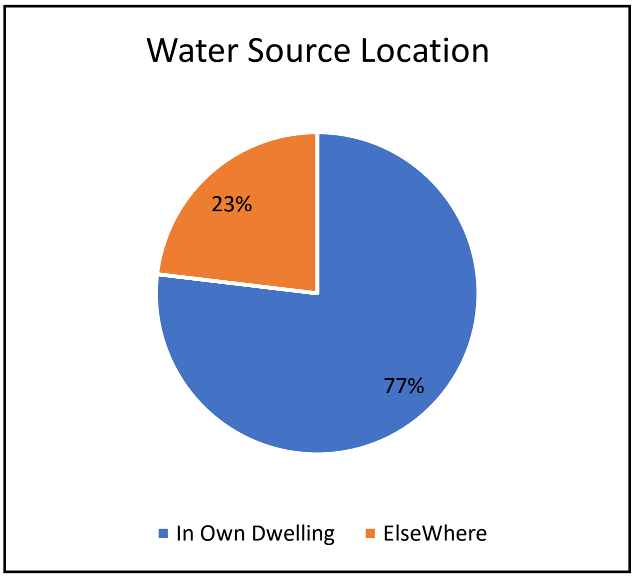


Figure 15: Drinking Water Facilities

4.3 Wage loss

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

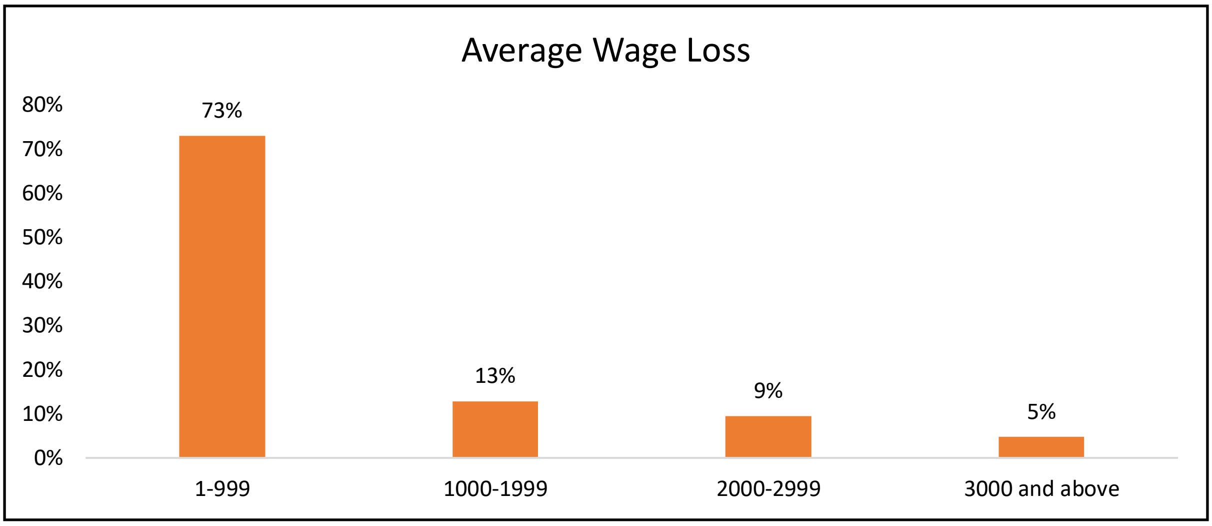


Figure 16: Average Wage Loss

The average wage loss in the city falls under the category INR 1 to 999 followed by INR 1000-1999. It is observed that the occupation with average wage loss in category 1 to 999 is majority casual workers.

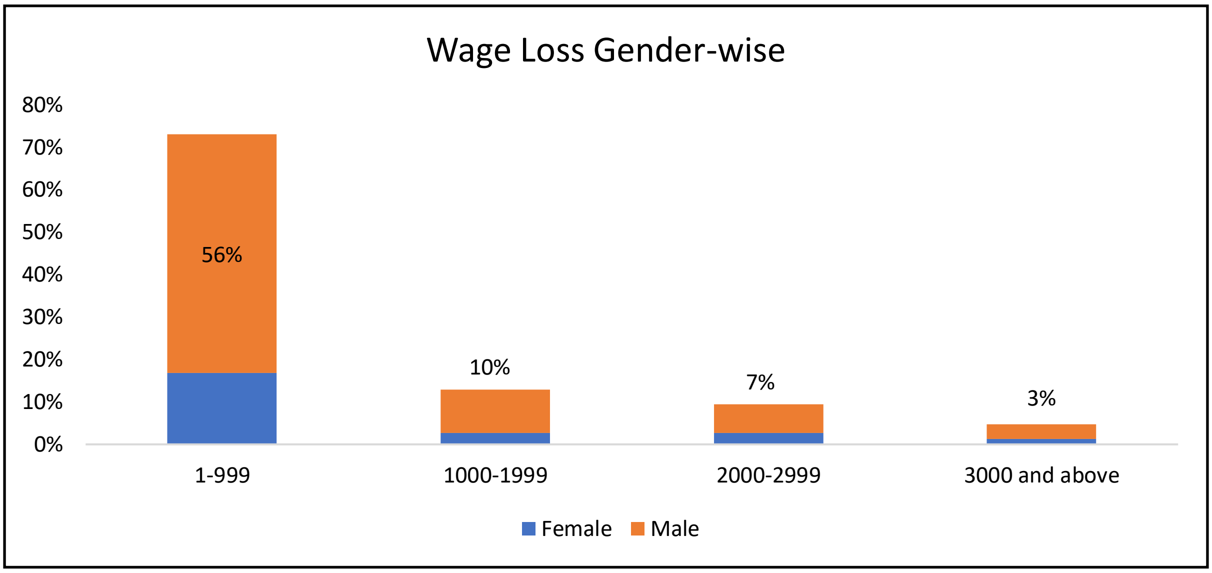


Figure 17: Wage Loss Gender-wise

It is observed that the majority of males (76% out of the total) experienced wage loss due to heat as compared to the women involved in work. Most females and males experience wage loss in the category INR 1 to 999. The average monthly wage loss in females in INR 600 while in males is INR 700. The genders are divided by the mentioned gap as workforce consists of more males as compared to females.

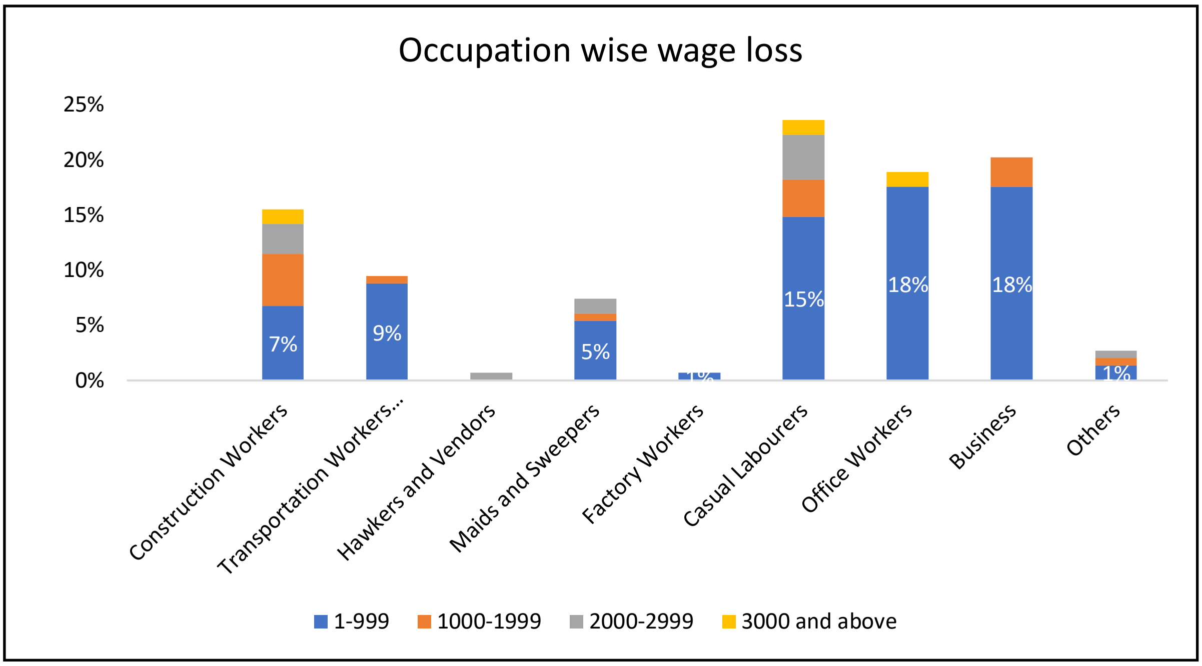


Figure 18: Wage Loss Occupation wise

The casual labourers are most affected by the high heat days. As the maximum wage loss is reported in the daily causal labourers (23%). This is due to the high share of involvement and a low share of income; they are followed by the business category. Hawkers and factory workers are least affected amongst the identified occupations

4.4 Productivity Loss

With the loss in wages, the productivity of the individuals is also highly affected. The majority (42%) of the working population had reported the loss in the working days by 1 to 5 days during the heat stress period followed by 10 to 15 days (41%) in a month. High percentage of productivity loss is observed amongst the working population making a total of 83%.

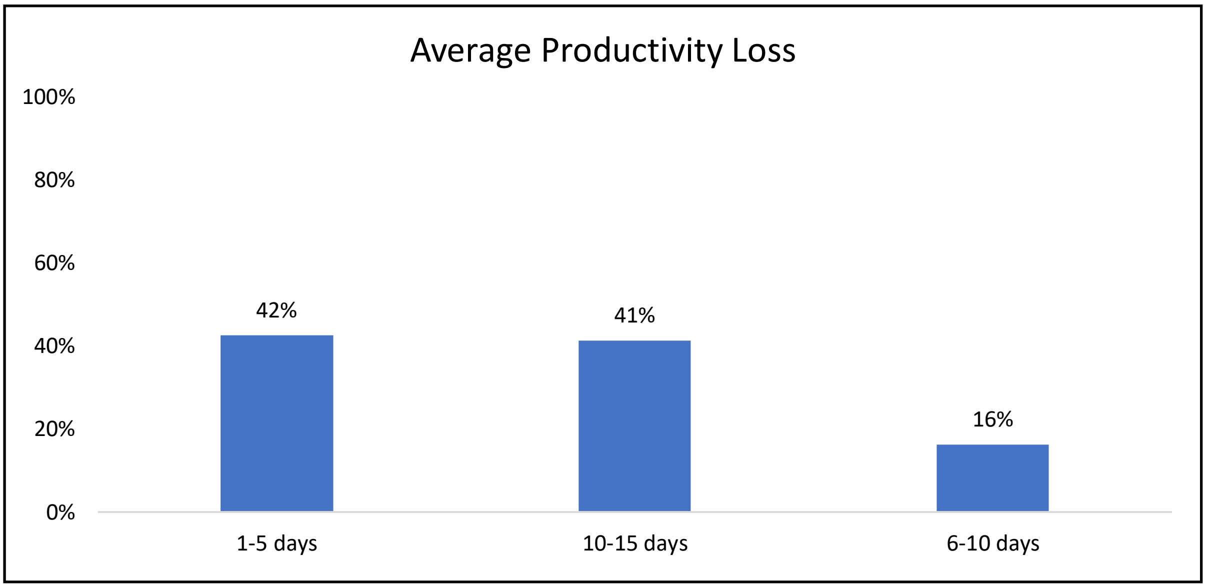


Figure 19: Average Productivity Loss

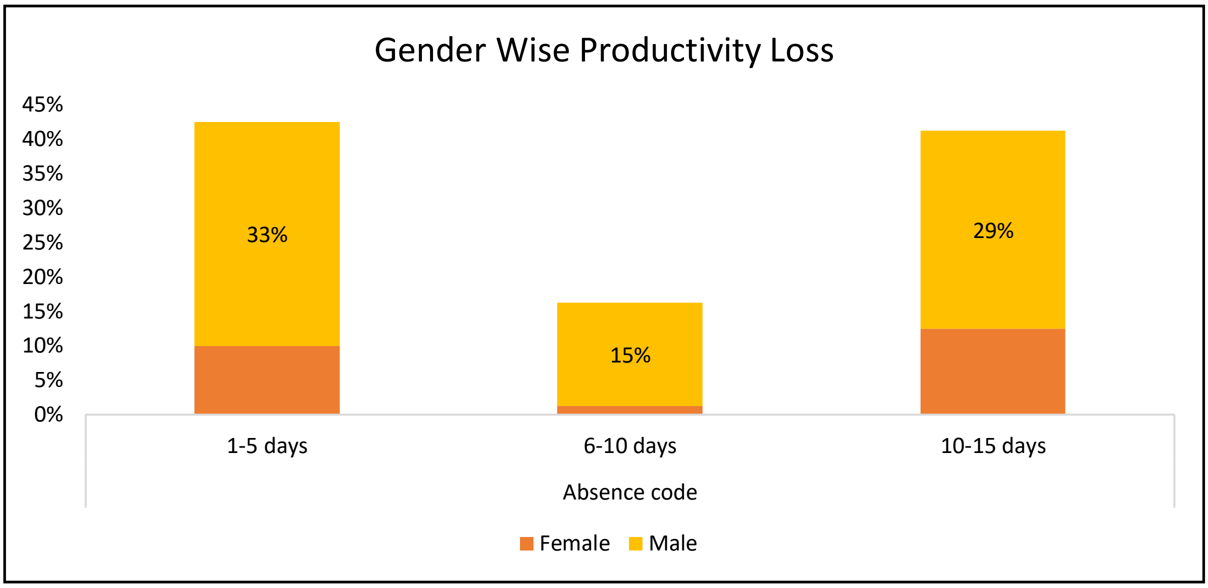


Figure 20: Productivity Loss Gender-wise

Similar to wage loss the males (76%) are at a greater loss as compared to females. The majority males and females experience productivity loss in 1 to 5 days. The average days lost due to high temperature for both males and females is 1 day per month

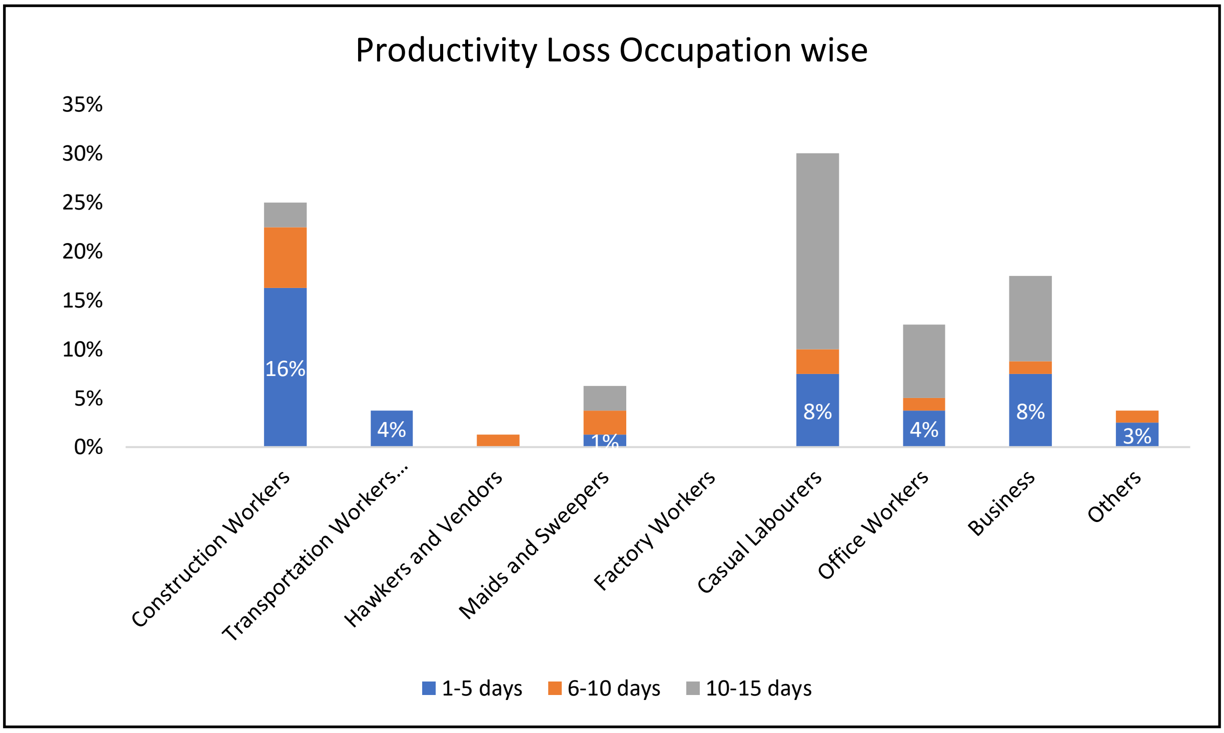
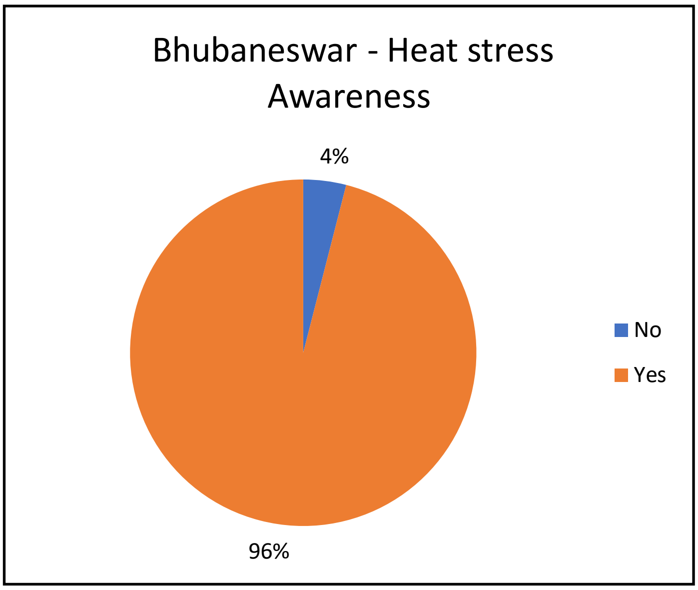


Figure 21: Productivity Loss Occupation -wise

The casual labourers and construction workers are most affected at the time of high-temperature days. As the maximum productivity loss is reported in the casual workers (31%) followed by the construction workers (25%). Prolonged working hours, not suitable working conditions and lack of sensitization are some of the reasons behind the loss. It is observed that factory workers and hawkers/vendors are least affected amongst the identified occupations.

4.5 Heat Stress Awareness

The majority, 95% of the surveyed population is aware of the term heat stress and its implication. Around 38% of the sample households are yet not aware of the medical facilities offering treatment for heat stress. There is a need for improved sensitization in the city. A majority (57%) of the sample population are aware of the adaptive mitigation strategies adopted by the government. Although 40% still suffer due to lack of awareness.



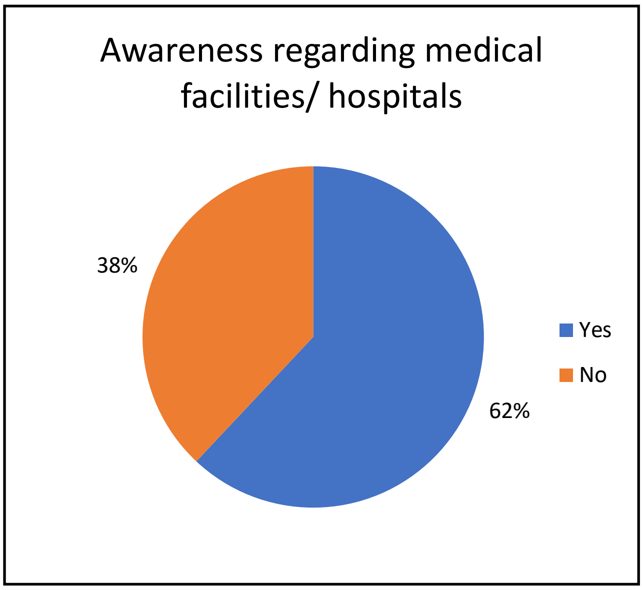


Figure 22: Heat Stress Awareness

5. Climate Adaptive Heat Action Plan, Bhubaneswar

The Climate Adaptive Heat Stress Action Plan has been developed to improve the management of heat-related risk in Rajkot 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 plan intends to identify impacts of extreme heat events on the health, work productivity and livelihoods of the vulnerable population within the city and mobilize communities and government agencies towards appropriate, innovative and affordable climate adaptation measures for improving health and livelihood resilience for the urban population, with consideration of the associated cost-effectiveness as well as gender-based implications. The plan also aims to improve the communities' resilience through capacity building of key stakeholders to facilitate the implementation of the Plan. The various components of the heat action plan for Rajkot city are indicated in Fig 23.

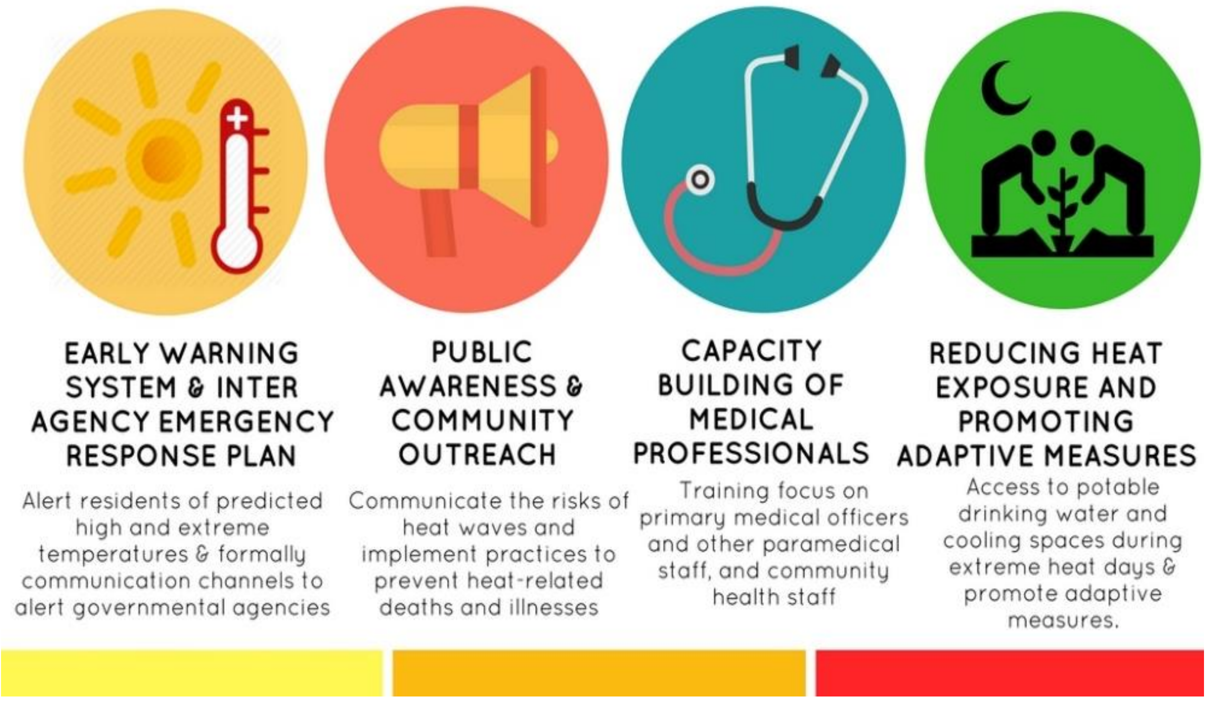


Figure 23: Heat Action Plan Components
Source: Indian Institute of Public Health, Gandhinagar

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 updating of the 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.

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

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.

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 the regional and community level for sensitization and awareness generation. Local culture and physical exposure of population need 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 the 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.

Capacity Building

Medical Stakeholders Training Assessment Need for Bhubaneswar was organized by IRADE with IIPH Bhubaneswar at Bhubaneswar. The Training was attended by more than 30 medical officers and was conducted with the aim to enhance capacities of Medical Officers for better management of heat-related illnesses and to develop Heat Stress Management Manual for Health care professionals for managing heat stress related illness in cities across India.

6. 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 Indian cities to efficiently prepare, mitigate and adapt to the heat stress induced by climate change.

The action plan recommended 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 Rajkot's medium-term development planning especially in prioritizing and integrating adaptive resilience within the agenda of climate-resilient smart cities.

7. SDGs and Heat Stress Management

In order to help cities with adapt to heat stress, and attain the Sustainable Development Goal, SDG 13 (Urgent action to combat Climate change and its impact), it is important to develop climate adaptive heat stress action plans. The Climate adaptive heat stress plans will help strengthen the cities' resilience and adaptive capacity to Heat Stress (SDG 13.1) and will also prevent mortality (SDG 11.5) as well as reduce economic and non-economic impacts of heat stress (SDG 11. 5.2).

Climate Adaptive Heat Stress Action Plan (HSAP) identifies ward level heat hotspots, vulnerability assessment of the urban poor and provides a framework for implementation, coordination and evaluation of extreme heat response in Bhubaneswar (SDG 11.B, increasing the adaption and implementation of integrated policies and plans). Heat Stress Action Plan developed through this initiative supports Bhubaneswar city in prioritizing targeted action through understanding adaptive deficits and strategies to evolve adaptation strategies.

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