Climate Adaptive Heat Action Plans

to

Manage Heat Stress

Case Study: Rajkot City, Gujarat

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"Climate Adaptive Heat Action Plans to Manage Heat Stress. Case Study: Rajkot City, Gujarat"

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Disclaimer

Abstract

Heat wave events are rising across the globe and India is no exception.Heat waves cause highest number of deaths compared to deaths caused by any other natural hazard in Indian cities.It is critical for the cities to adapt to the rising heat stress given cities have high concentration of vulnerable urban poor. Increase in heat stress due to climate change is affecting the health, livelihoods and productivity of the vulnerable population in Rajkot city. Integrated Research & Action for Development (IRADe) with support from International Development Research Centre, Canada (IDRC) and in collaboration with Indian Institute of Public Health (IIPH), Gandhinagar and Rajkot Municipal Corporation (RMC), did action research and developed Climate Adaptive Heat Stress Action Plan (HSAP) for Rajkot city. HSAP identifies ward level heat hotspots, vulnerability assessment of the urban poor and provides framework for implementation, coordination and evaluation of extreme heat response in Rajkot. This paper provides insights about the research approach and analysis to evolve Heat Action Plan at ward level for the city of Rajkot. The Heat Stress Action Plan developed through this initiative supports Rajkot city in prioritizing targeted action through understanding adaptive deficits and strategies to evolve adaptation strategies.

Keywords: Heat Stress Action Plans, Heat Hotspots, Heatwaves, Vulnerability Mapping, Climate Adaptation, Climate Change.

1. Introduction

The last 50 years have witnessed a hike in the frequency of hot days, nights and heatwaves in the world (IPCC, 2014).Higher daily peak temperatures of longer duration and more intense heatwaves are becoming increasingly frequent globally due to climate change. The duration of heatwaves is expected to increase 92 to 200-fold under 1.5 and 2ºC 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. India has experienced a number of heatwave incidences, since 2006, and average temperature during 2018 was significantly above normal (above +0.41ºC). The year 2019 was the seventh warmest year on record since nation-wide meteorological records commenced in 1901. June and July 2019 have been the hottest months recorded globally, with National Oceanic and Atmospheric Administration (NOAA) confirming June 2019 being hottest on records, + 0.95ºC above normal average temperature.

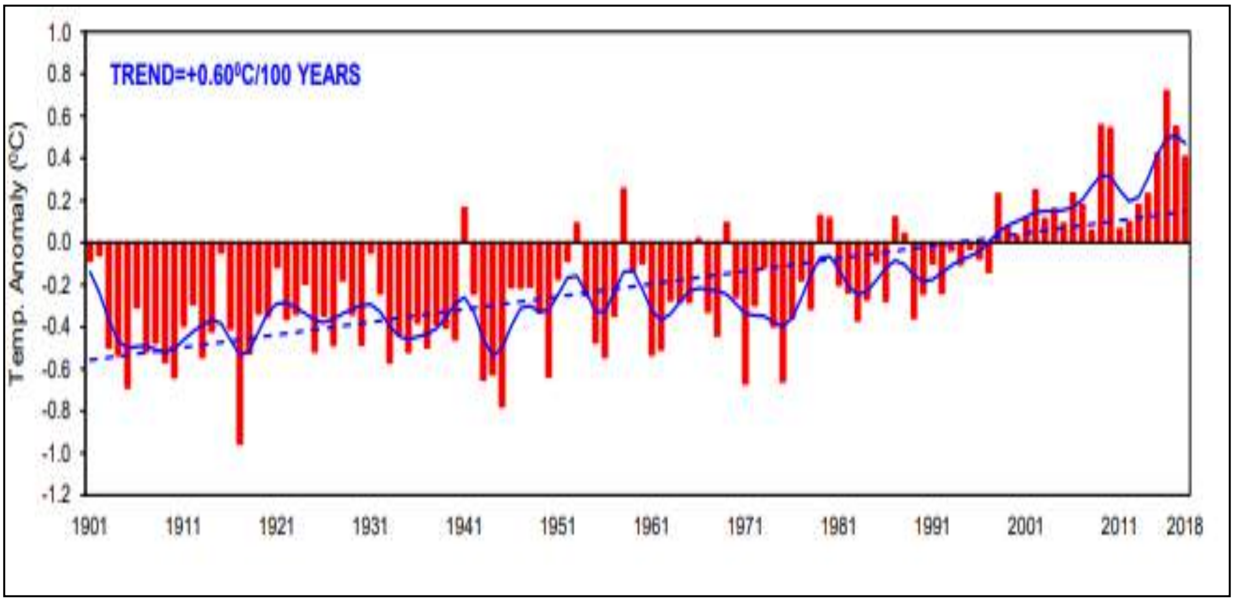


Figure 1: Annual mean land surface air temperatures anomalies 1901- 2018.IMD, 2019

Fig.1 indicates the rise in the annual mean land surface air temperatures anomalies in India between 1901 and 2018. It shows a very sharp temperature increase since 2001.Under the 2^0C warming scenario, the frequency of heatwaves in India is projected to increase by 30 times the current frequency by the end of the century.

Heatwaves cause the highest number of deaths compared to deaths caused by any other natural hazard in Indian cities. Extreme temperatures are one of the most dangerous natural hazards but rarely received adequate attention. The Heatwave is a "silent disaster" and adversely affects the health, 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). Vulnerable population and city authorities lack the resources to adapt to heatwaves. Heatwaves caused over 24,223 deaths recorded over the period of 1992-2015.

Table 1: Heat Wave Mortality Records

Year	Death Record
2010	1274
2011	798
2012	1247
2013	1216
2014	1677
2015	2040
2016	1111
2017	384
2018	25
2019	226
2020	4
NDMA	

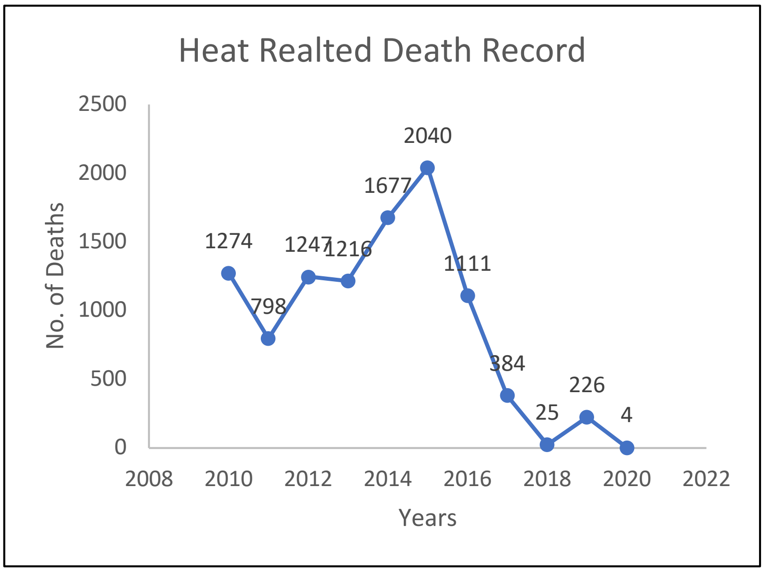


Figure 1: Heat Related Mortality (2010-20)

Fig.2 indicates the regional distribution of the wave incidences across India and the corresponding heatstroke deaths recorded (2000-2014), which 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 (2020-2019).The baseline death rate due to heat-induced climate change in the early 2000s in India was 550 per 100,000 of the population. India is projected to see a 10% increase in death rates due to climate change (Climate Impact Lab, 2019). In 2010 May, the city of Ahmedabad had high frequency and severity of heatwaves, registering 1,344 additional deaths in the city with an excess of 800 deaths recorded in the week of 20th-27th May. This served as a wake-up call for the city authorities for intergovernmental agency action, preparedness, and community outreach for heat-related awareness and adaptation actions.

Guidelines for Heatwave Action Plans: National Disaster Management Authority (NDMA) noticed the severity of the impact of heatwaves and worked towards heat risk reduction and formulated the 'Guidelines for Preparation of Action Plan – Prevention and Management of Heat-Wave' in 2016, to help the states take a pro-active approach to manage the heat stress. These guidelines have been revised in the year 2017 and in 2019 incorporating new experiences, lessons learnt by state stakeholders, long term mitigation measures and future course of action to mitigate heat stress impact(NDMA, 2019).As per the guidelines, the Heat Action Plans underline measures like the 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.

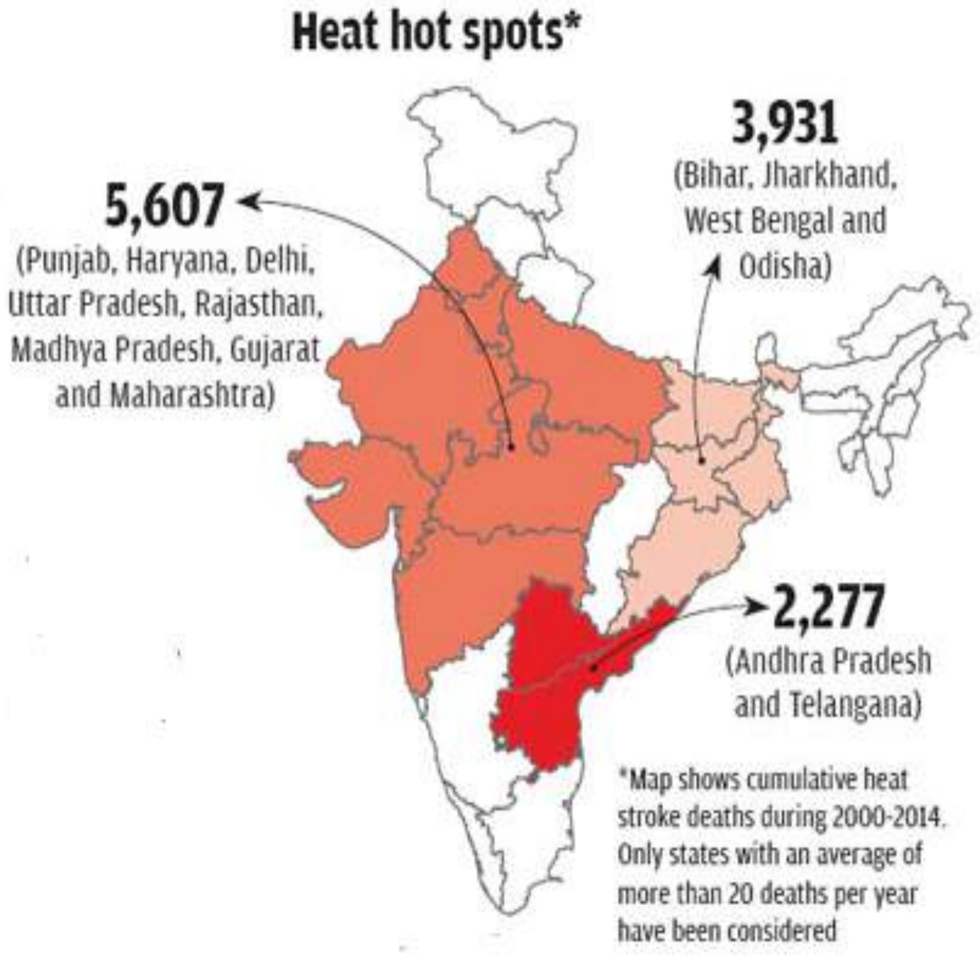


Figure 2: Regional Heat Hot Spots – 2000-2014
Source: National Crime Records Bureau, Ministry of Home Affairs and Ministry of Statistics and Programme Implementation, GoI, 2014

1.1Heat Stress Thresholds

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 for Rajkot city. However, there are no thresholds computed for Indian cities specific to region, group (gender, age and other vulnerabilities) exposure, occupation.

1.2 Heat Alert Criteria

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]		

Table 2: Heat Alerts Categories (Source: NDMA)

Indian Meteorological Department, IMD defines Heatwave 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.

1.3Heatwave Action Plans

Cities being the engines of economic growth need to be climate resilient and should have appropriate mitigation and adaptive strategies at a place to combat the impact of heatwaves 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.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.

For Ahmedabad, mortality has come down 20-25% with the implementation of the Heat Action Plan, Ahmedabad, 2010 (IIPH-G – the Hindu, 2017), (Langa, 2017). Mortality related to heatwave has decreased in Telangana from 489 deaths (2015) to 108 deaths (2017) (Telangana Heat Wave Action Plan, 2018).In Andhra Pradesh, the death toll of 2017 shows a fall to 87, after the implementation of the Andhra Pradesh Heat Action Plan, 2016.In the past two years, the numbers dying from heat-related illnesses has fallen sharply in Surat, from 2,040 in 2015 to a little over 200 in 2017, according to government data. The number of people known to have fallen ill because of extreme temperatures has come down from almost 40,000 cases in 2017 to a little over 1,000 in 2018(Heat and Health Action Plan- Surat, 2016). But existing Plans are generic and do not address action required at regions, wards, vulnerable groups, climatological and spatial variation of the cityscapes inplanning appropriate adaption and mitigation actions.Along with the identification of vulnerable groups, the particular city level thresholds needs to be calculated as well in order to develop a comprehensive Heat Action Plan.

2. Study Area: Rajkot, Gujarat

Rajkot is the largest city in the Saurashtra region of Western India. It is fourth-largest city in the state of Gujarat with a population of 1.39 Million (2011 census of India). The city is spread across an area of 170 sq.km with 18 wards and population density of 12, 275 Persons per Sq. Km. The city population growth rate had shown a significant rise from 1991-2001 (79.12%). Rajkot is urbanizing fast and the population is projected to cross 2.4 million by 2030 (UN Population Report, 2018).

The city has emerged as a major **Industrial Hub** in Saurashtra region with more than **43000 industrial units** This has lead to rapid urbanization, triggering a pull-effect form the adjacent urban and rural areas. This has also resulted in the increase in the slum pockets and scattered settlements across the city from **118 slums in 2012** (SFPoA, Rajkot, 2012) to **145 slums as of 2017** (Gujarat Government Gazette, 2017). The city is characterized by a semi-arid climate. May is the hottest month of the year with an average maximum temperature of 40.5 °C. Heatwaves are a major climate hazard which affects the city. It has been noted that the frequency of heatwaves in Rajkot has increased substantially during the decade of 2001-10, as compared to earlier decades (Ray, Chincholikar, & Mohanty, 2013). The decadal frequency of moderate heatwave days oscillated from 2 days during 1971-80 to 33 days during 2001-10. This is a substantial rise and with climate change, the heat events are bound to rise and also increase the number of heat extreme events. The years subsequent to 2010, have been hotter than before. Therefore, the risk associated with human life due to heat stress in the city cannot be underestimated. Refer to Figure 5 for the heatwave condition in Saurashtra and Rajkot.

3. Need for Climate Adaptive Action Plan in Rajkot

The trend of heatwave occurrence in the Rajkot city indicates a gradual increase in the heatwave days in the past decade (IMD), with severe heat days ranging from 2 to 13 days in the summer months (March – June). If we look into the number of heatwave days in Rajkot over the past decade (2011- 2017), there has been a sharp increase from 2 days to over 12 days (Refer to Fig.3). The Disease Surveillance System and Death Record System of the city do not record heatwave/heat stress deaths. However, due to the rise in temperature in the last few years in the city of Rajkot the cases related to heat stress has been increasing during summer months (Refer to Fig.4).

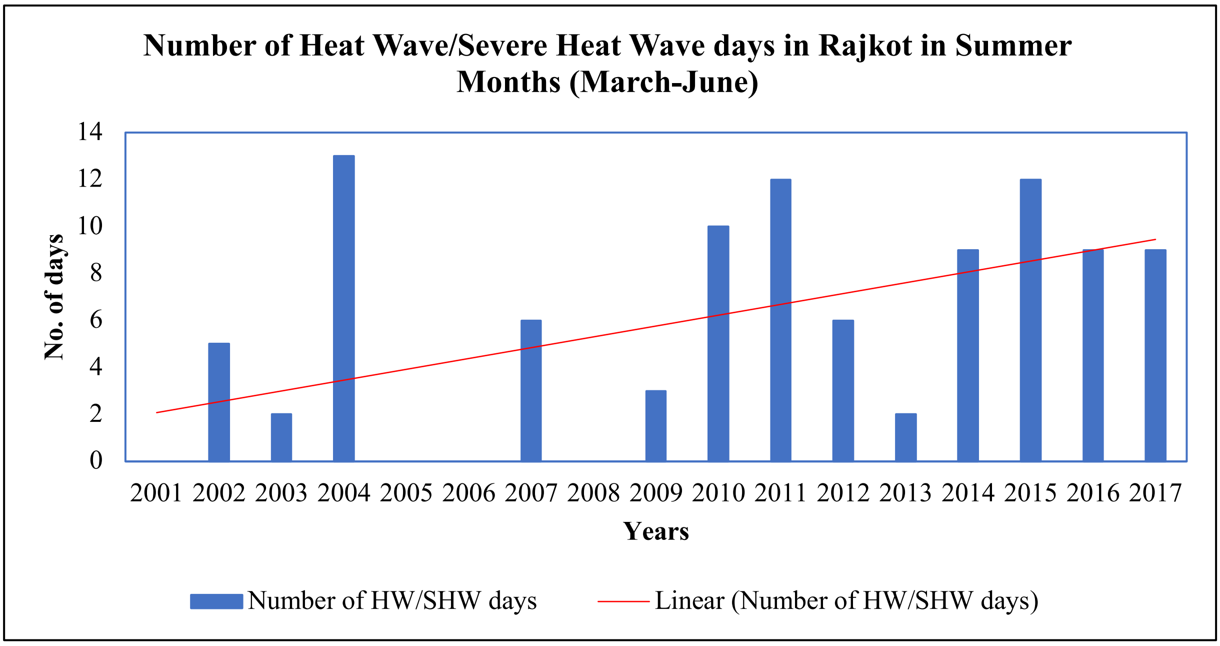


Figure 3: Trend in Heat Wave Days, Rajkot, Source: IMD

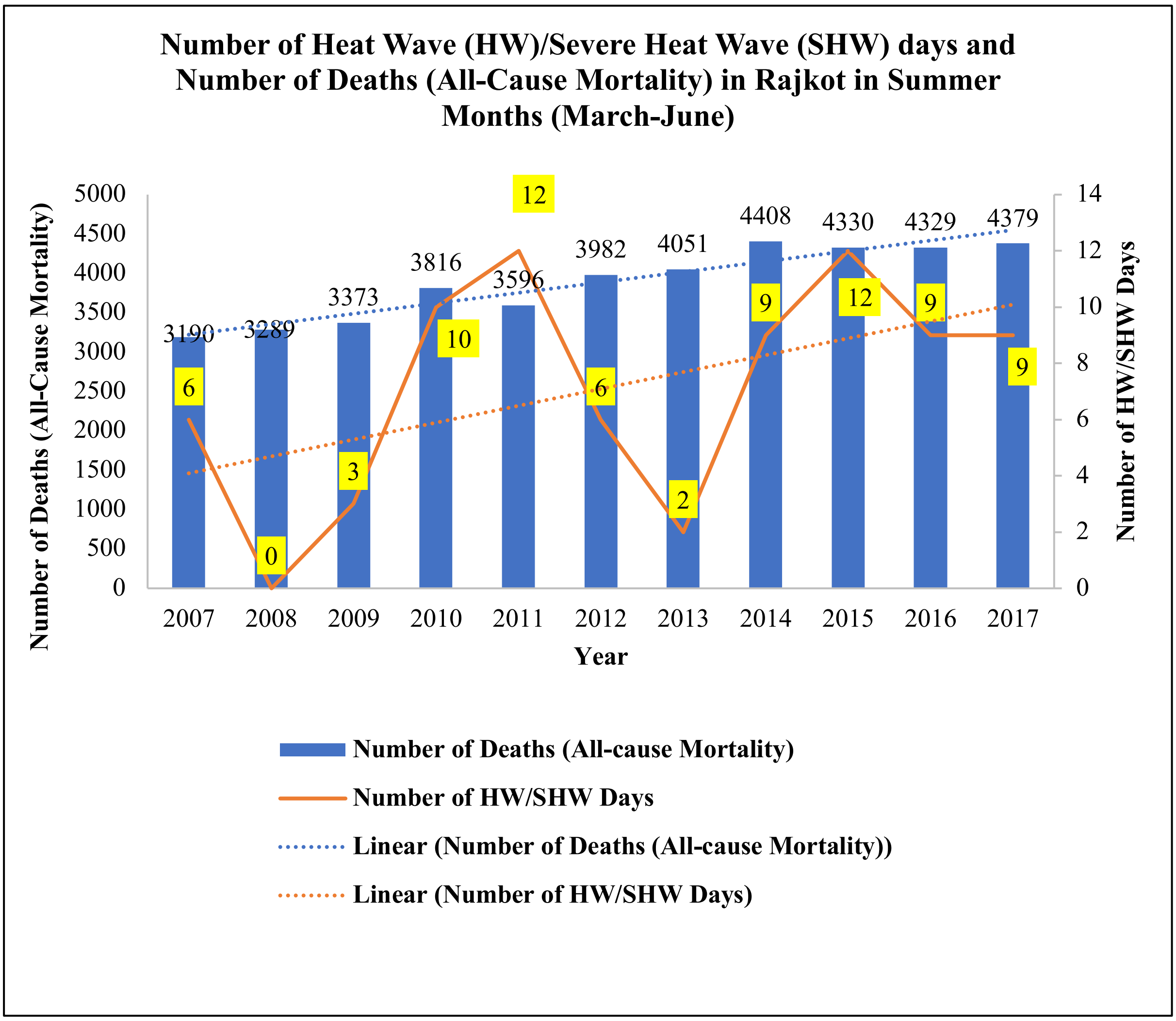


Figure 4: Co-relation between Heat Wave Days and Mortality Rate (2007- 2017)
Source: IMD & Heath Dept. Rajkot Municipal Corporation

3.1Climate observations of Heat Waves in Rajkot

In order to analyse the changing climate patterns in Rajkot, IRADe conducted a study of Rajkot climatology for the summer season (March, April, May and June) from years 2001 to 2017. The study revealed a significant increase in the city's temperature and decline in its humidity levels — indicating that the city is getting drier and hotter over time. Based on data from Indian Meteorological Department (IMD) for temperature and the regional IMD centre, Rajkot, for relative humidity, IRADe analysed the city's temperature data from 2001 to 2017 to determine its trends in maximum temperature (Tmax) and minimum temperature (Tmin) for the summer months ((March, April, May, and June) and compared it against the city's long-term climatological mean Tmax and Tmin (mean of 1905 to 2000) for the corresponding months to determine the deviation in the city's temperature trends. Similarly, it analysed trends in the morning (08:30) and evening (17:30) relative humidity for the summer months (March, April, May, and June) from 2004-2017 against the long-term climatological mean relative humidity. Refer to Figure 5i, 5ii, 6i and 6ii for variation of Tmax, Tmin and RH at 8:30 hrs and 17.30 hrs, for the entire summer season in Rajkot.

Month 2001-2017)	Tmax (° C)	Average Mean Tmax (° C)	Deviation from Mean Tmax (° C)	Tmin (° C)	Average Mean Tmin (° C)	Deviation from Mean Tmin (° C)
March	+35.2	+37.92	+1.09	+18	+22.65	+1.7
April	+38.6		+1.2	+21.7		+1.6
May	+40.3		+0.84	+24.8		+0.7
June	+37.6		+0.36	+26.1		+1.2
Tmax- Maximum Temperature, Tmin – Minimum Temperature, Source: IMD						

Table 4: Mean monthly Temperature value and Deviation, Rajkot, 2001-18

The average monthly Tmax value in Rajkot has increased for all the summer months, though the increase is relatively more in March and April. This in addition to the significant deviation in May, indicates shorter winters and prolonged summers for the city. The average deviation for the entire summer period over the decade is 1.095°C, with mean temperatures recorded above 38°C. There is a visible shift in the baseline Tmax values, indicating increasingly hotter summer daytime temperatures.

In terms of the Tmin value, the average deviation for the entire summer season over the 17-year period was 1.43 °C, with maximum deviation in seasonal Tminvalueobserved in 2009 (2.46 °C). Refer to Table 3. A Significant deviation in Tmin resulted in higher daily mean temperatures during summer, increasing the frequency of hot days.

The average deviation for RH (morning) and RH (evening) over the 14-year study period was -0.23% and -0.17% respectively, which is negligible. This suggests average morning humidity remained stable over the entire summer season during the 14-year duration. However, the last four summers (2014-17) were, in particular, drier in the morning, recording the RH values consistently below the climatological mean. Refer to table 4.

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	+69	+73.705	+1.33	+21.33	+30.66	-1.27
April	+71.33		+1.12	+21		-0.48
May	+75.16		+0.42	+30.16		-1.40
June	+79.33		+0.29	+50.16		+2.46
RH – Relative Humidity **Source: IMD**						

Table 5: Mean monthly Relative Humidity value and Deviation, Rajkot

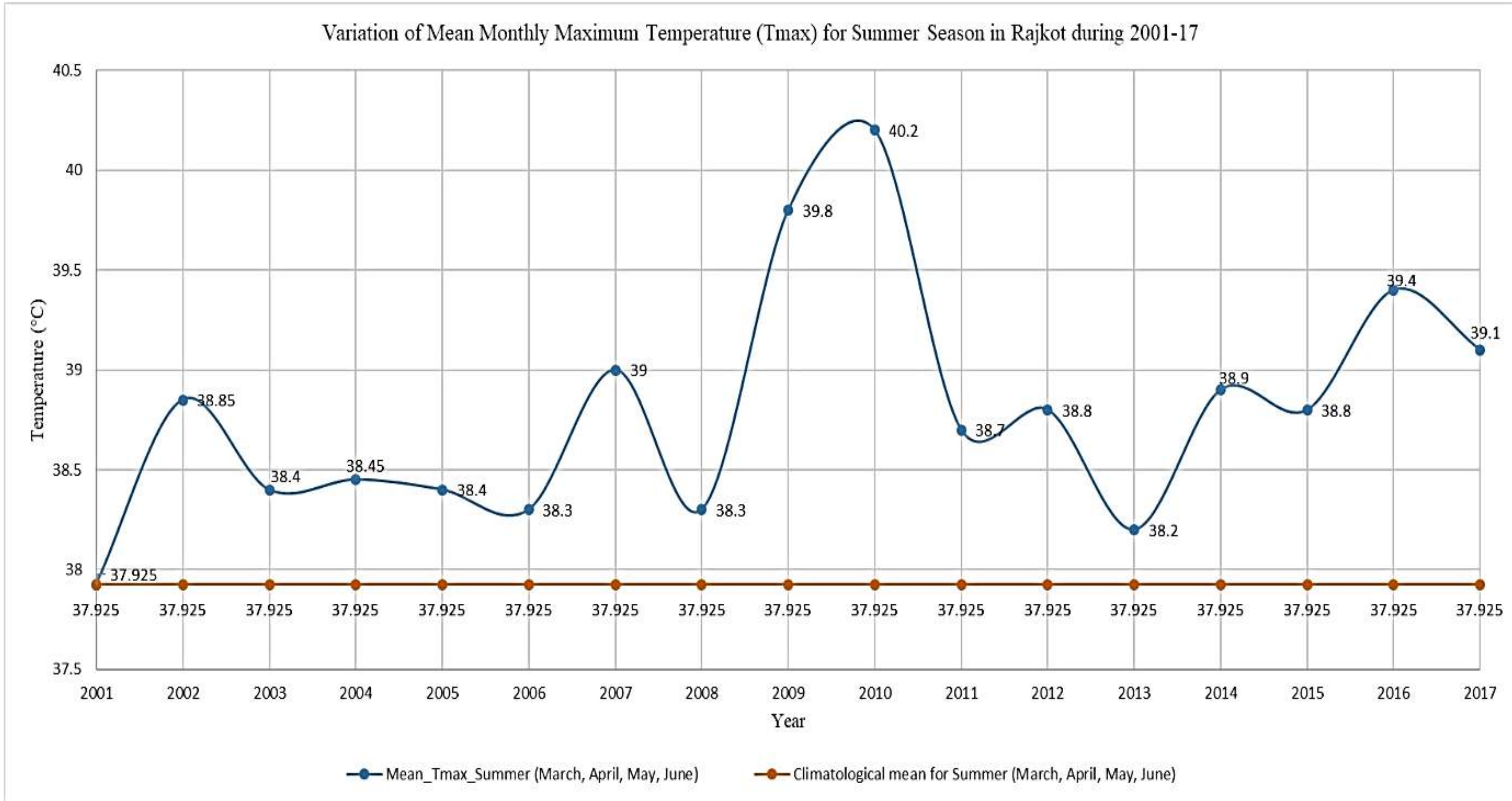


Figure 5i: Variation of Tmax for summer season in Rajkot during 2001-17

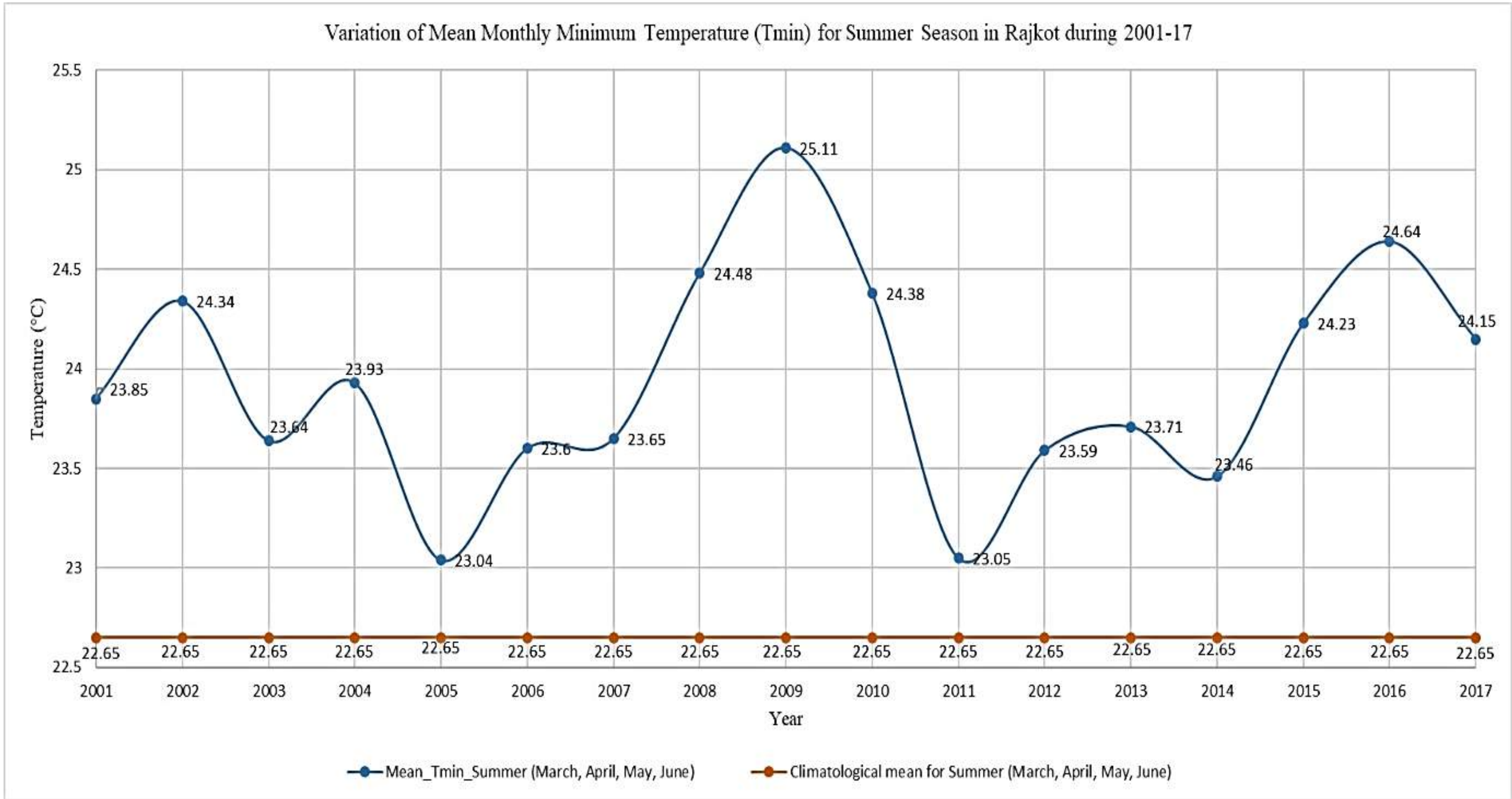


Figure 5ii: Variation of Tmin for summer season in Rajkot during 2001-17

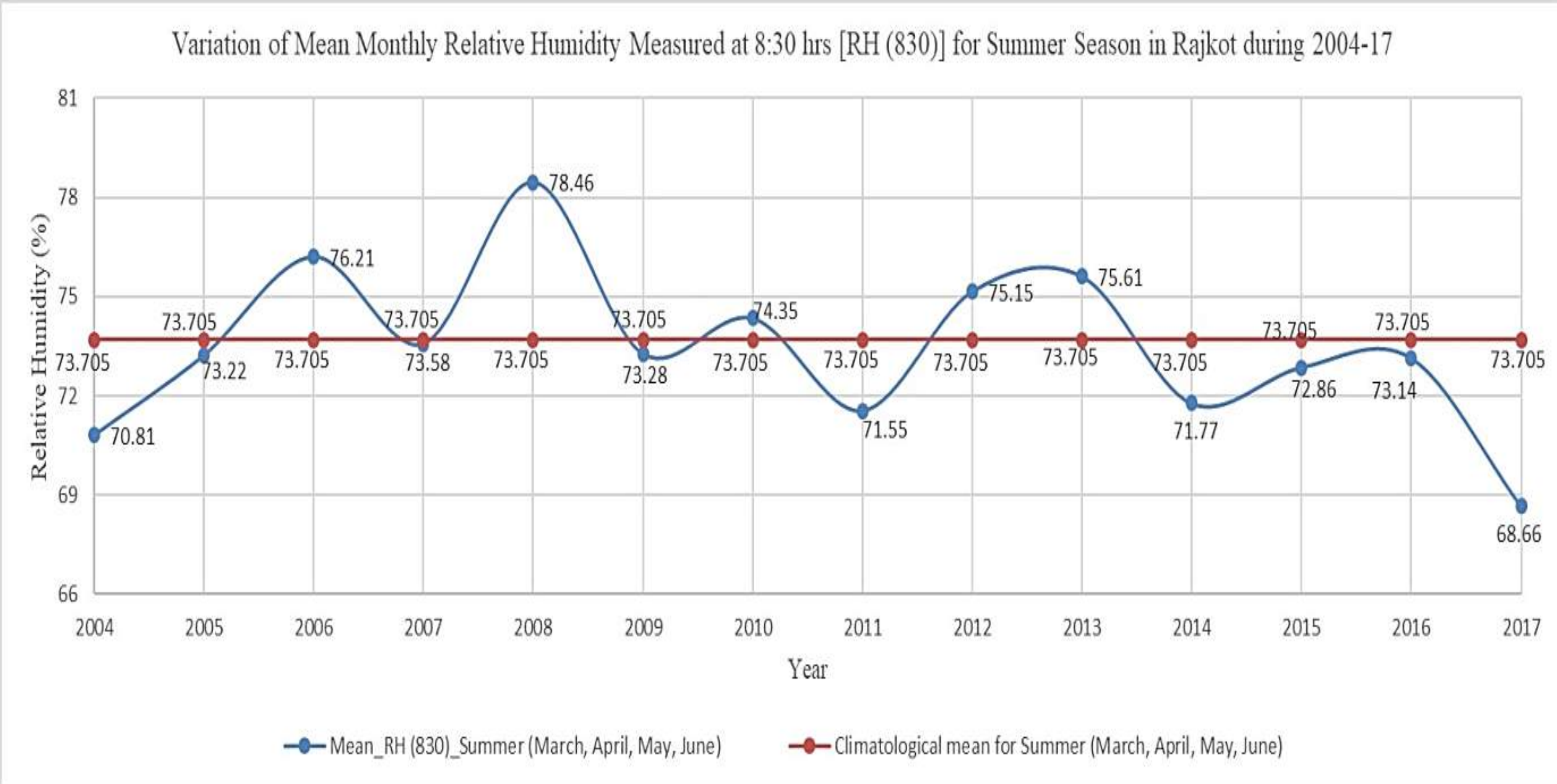


Figure 6i: Variation of RH at 8:30 hrs for the entire summer season in Rajkot during 2001-17

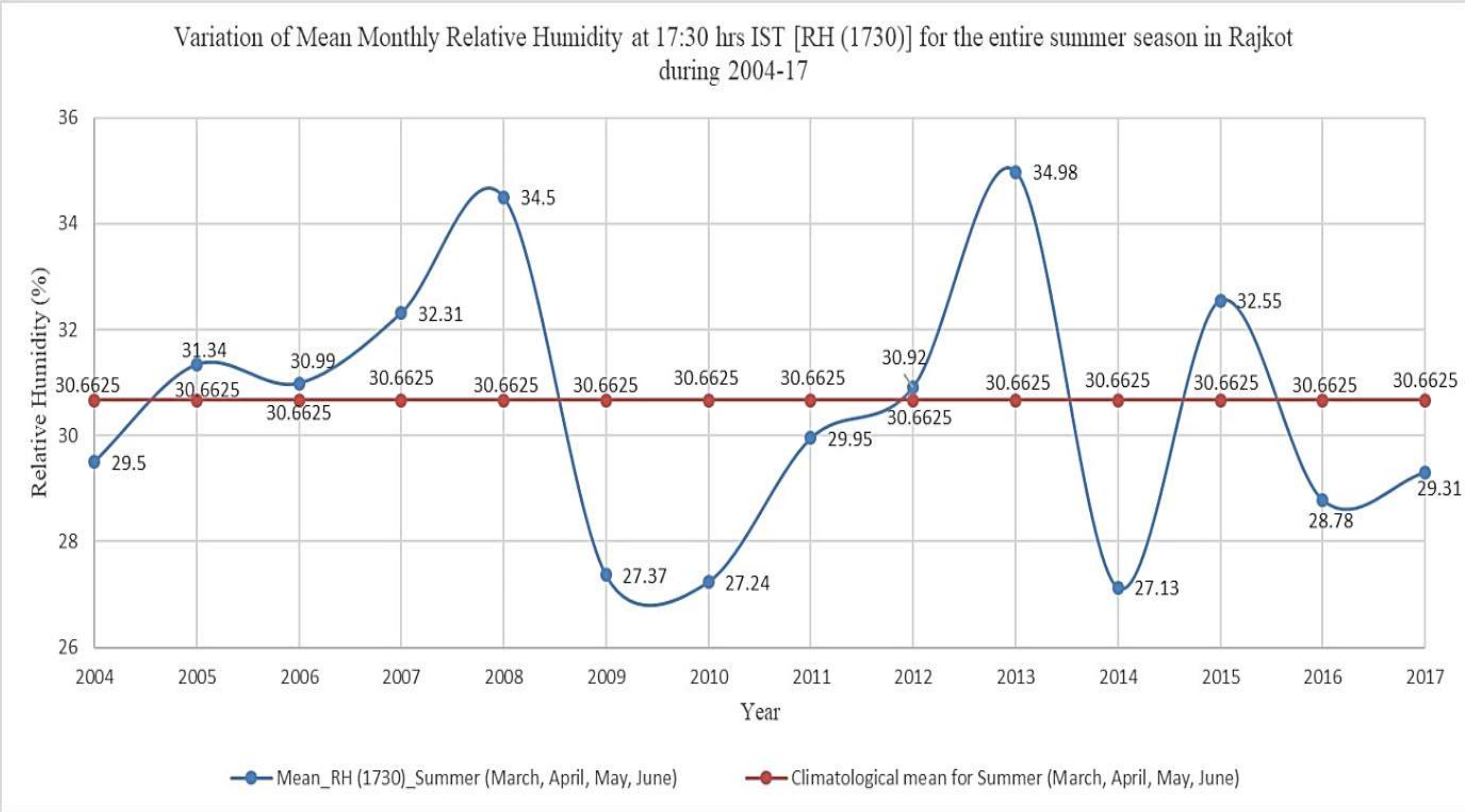


Figure 6ii: Variation of RH at 17.30 hrs, for the entire summer season in Rajkot during 2001-17

4. Spatial Variation and Mapping of Hotspots, Rajkot

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 Indian Meteorological Department (IMD) 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.7.

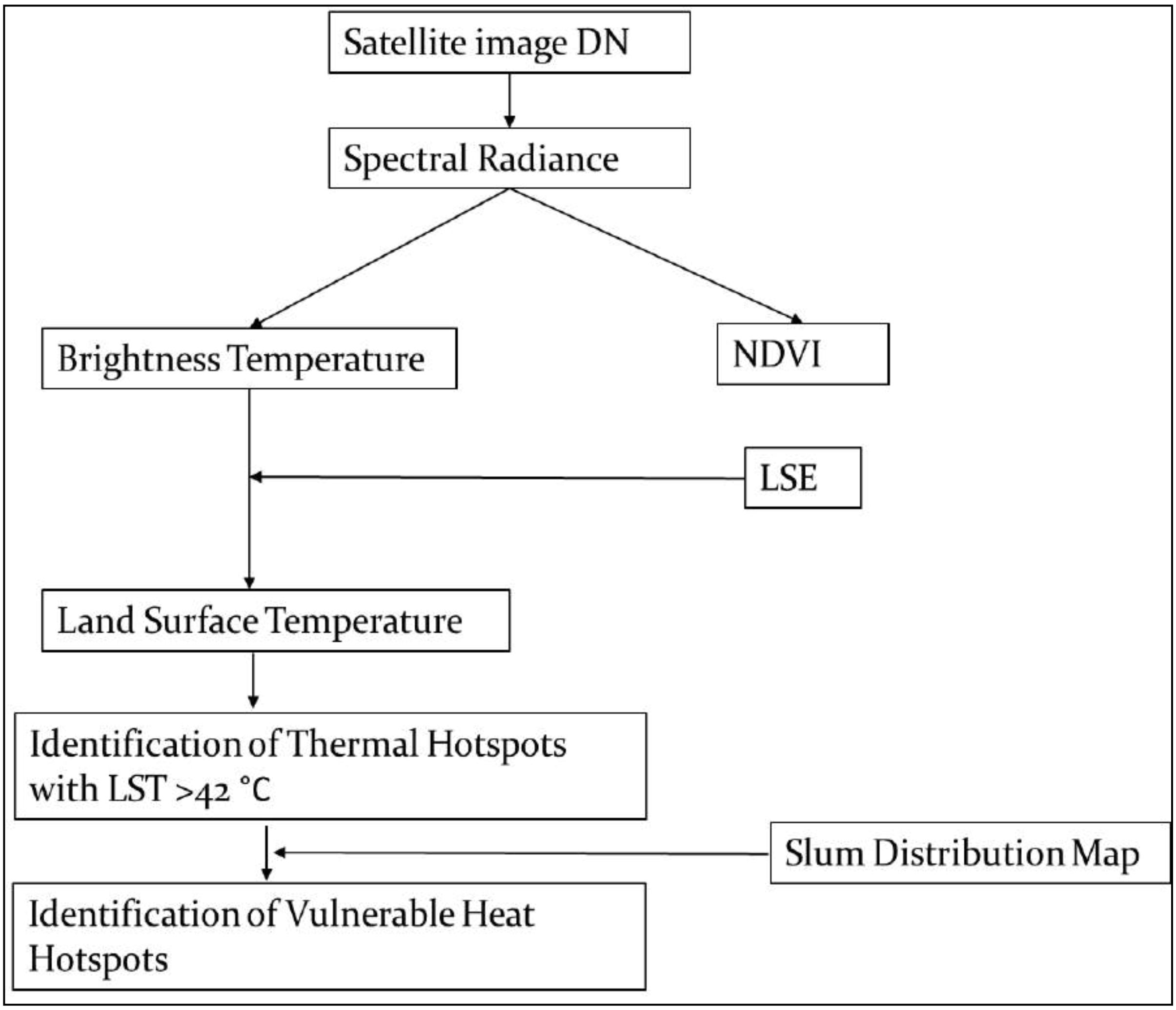


Figure 7: GIS Methodology for identification of vulnerable heat hotspots

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 as well as the data received from 20 AWS stations installed within the city by Rajkot Municipal Corporation (RMC).

To mark the high temperature areas within Rajkot city, thermal hotspot maps were prepared to map areas with temperature higher than 42ºC, and were marked as thermal hot-spots. Landsat 8 data of May and June months of 2017 and 2018 were employed to map Land Surface Temperature (LST). Refer fig. 8i, 8ii, 9i and 9ii.

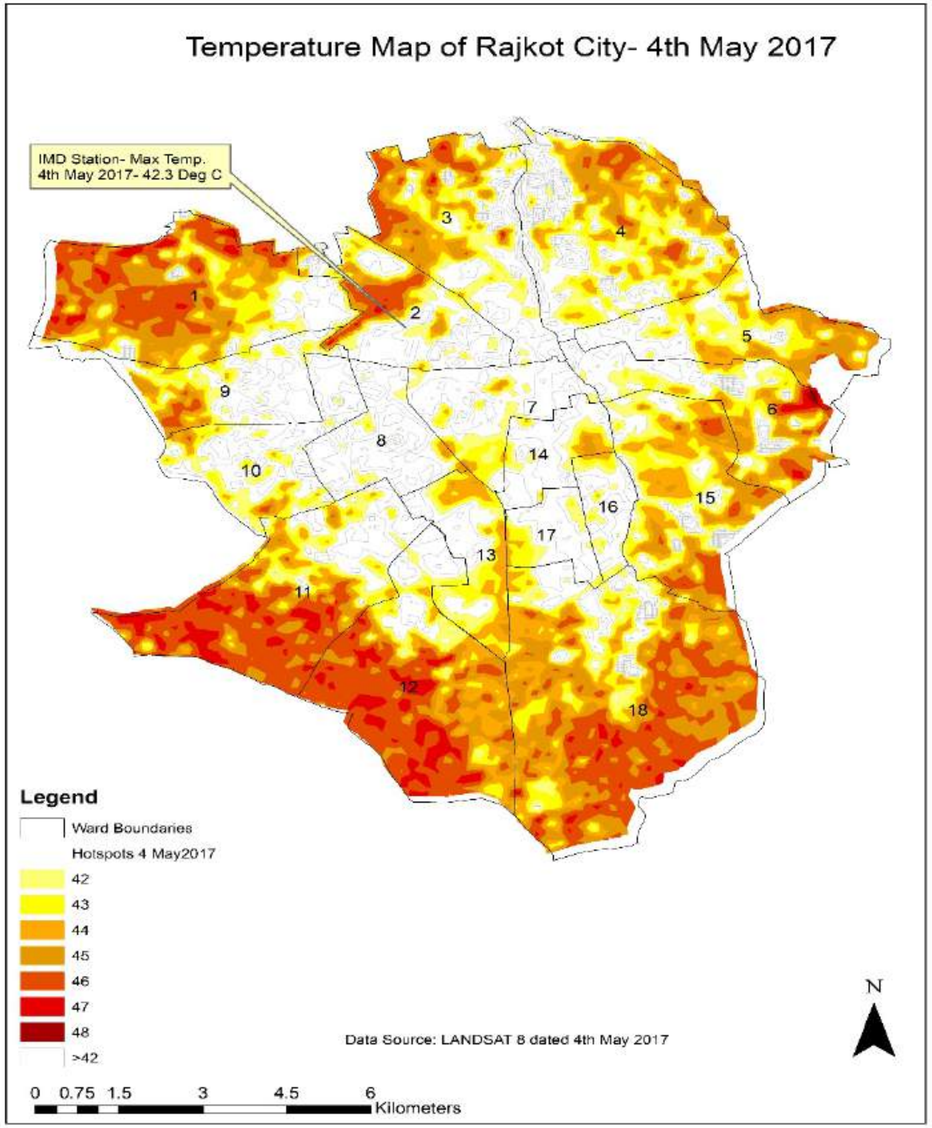


Figure 8i: Thermal LST distribution in Rajkot on, 04 May, 2017

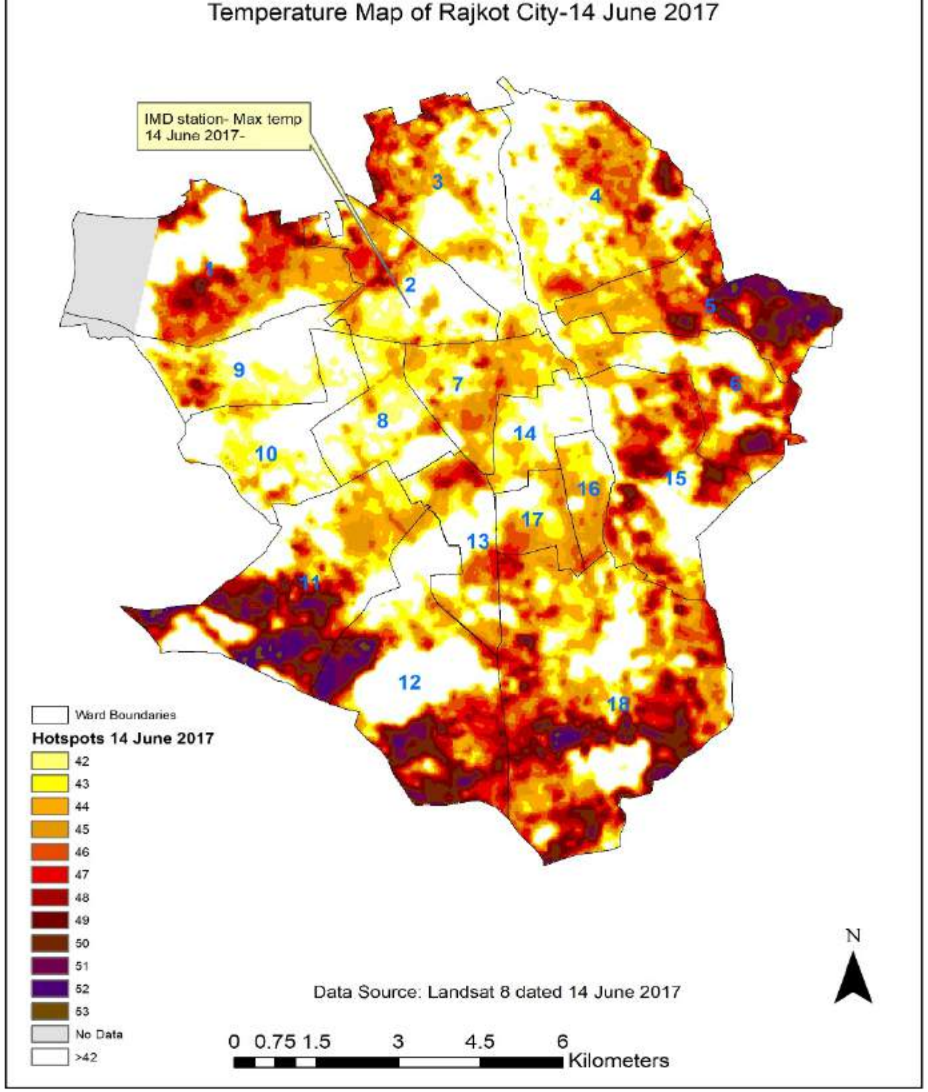


Figure 8ii: Thermal LST distribution in Rajkot on, 14 June, 2017

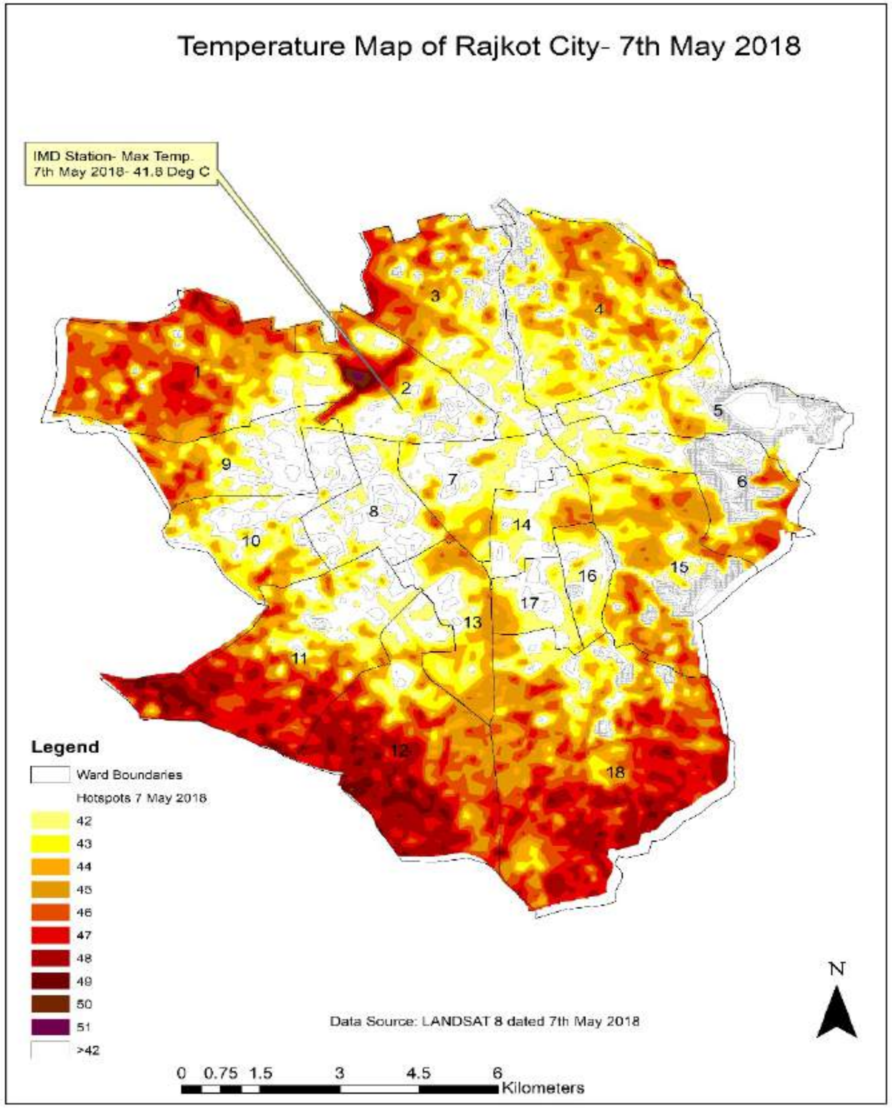


Figure 9i: Thermal LST distribution in Rajkot on, 07 May, 2018

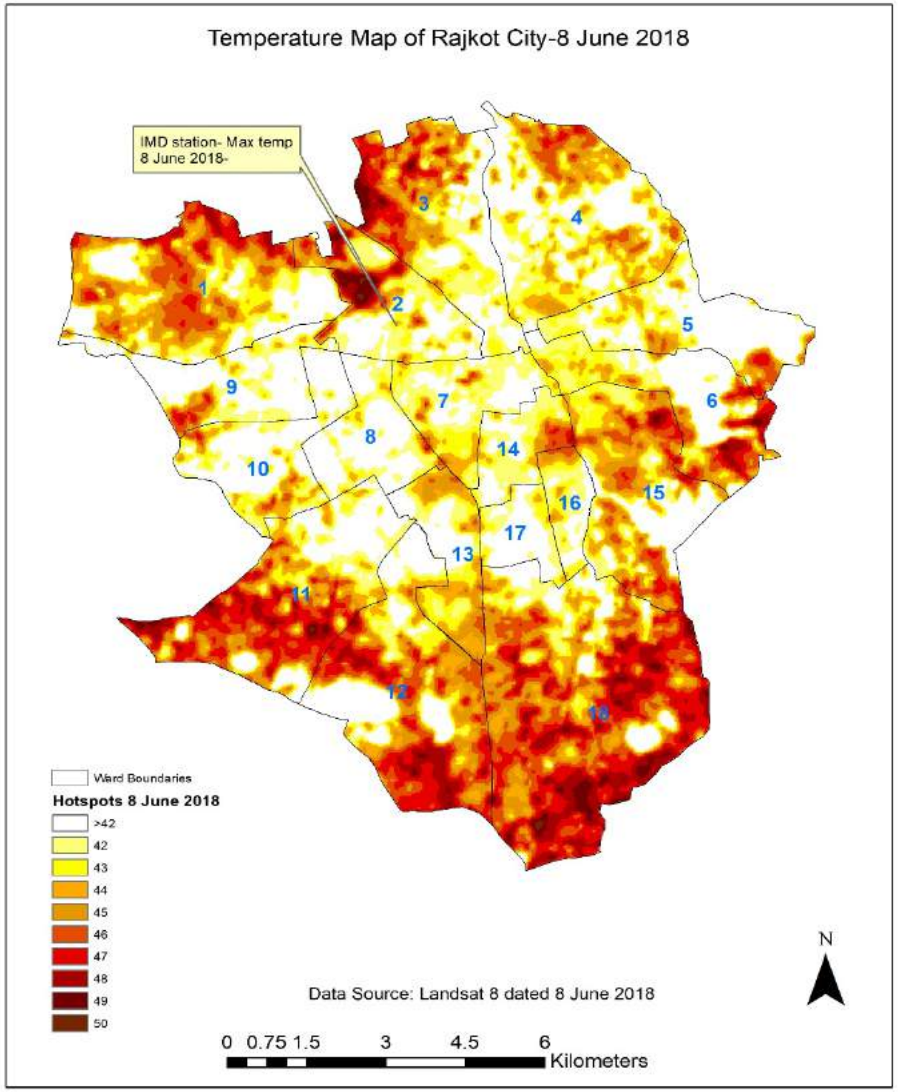


Figure 9ii: Thermal LST distribution in Rajkot on, 08 June, 2018

5. Vulnerable mapping of Heat Stress, Rajkot

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 Rajkot was mapped using GIS (Geographic Information System), and slum distribution map was overlaid on LST maps to identify vulnerable thermal hotspots. Satellite images of Rajkot 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 Rajkot city include: Ambedkar Nagar, Rashulpura, Bajrangnagar, Rajyadhar, Shitaldhar, Jay Bhim Nagar, Bharat Nagar 1, Pradyuman Park and Laludiwonkdi. Refer Fig. 10.

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 stress. Pregnant women are also susceptible to increasing ambient temperatures and heatwaves 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.

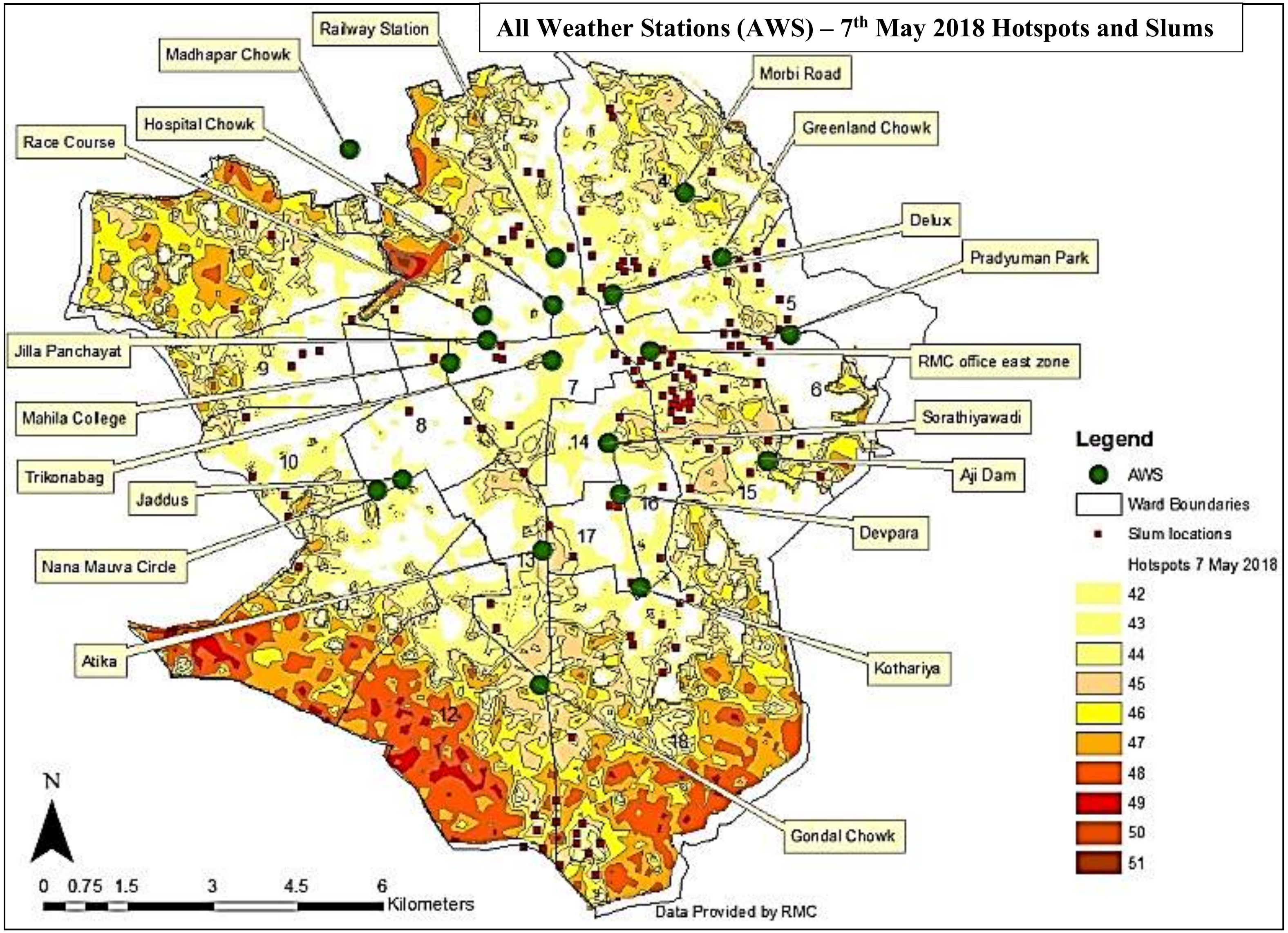


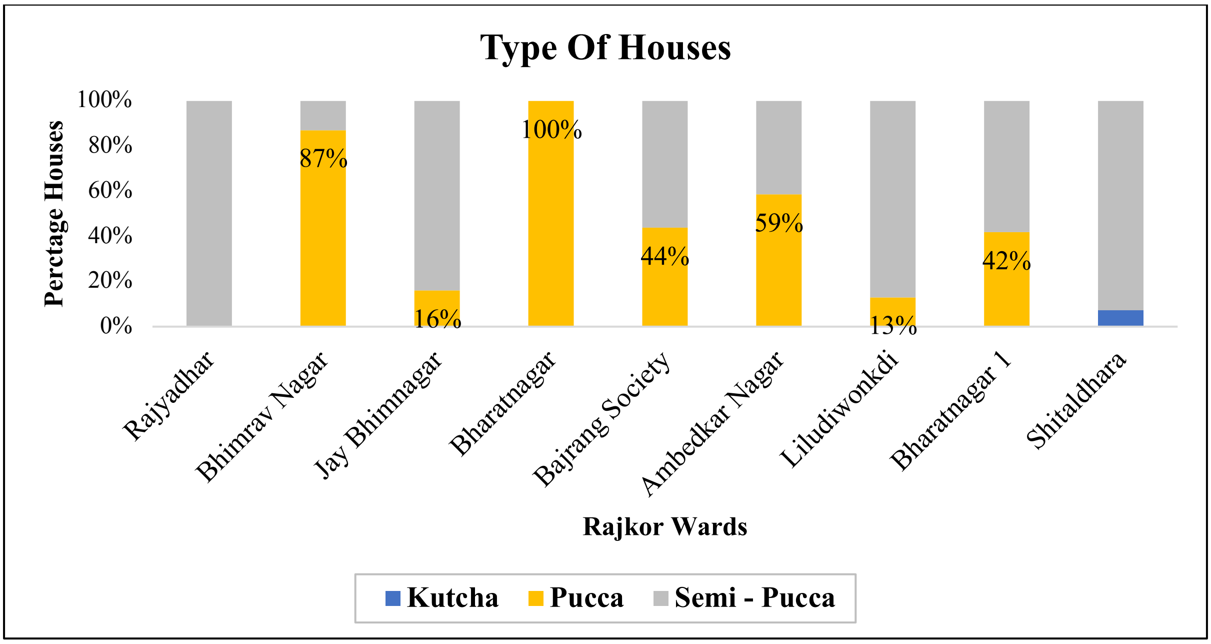
Figure 10: Vulnerability Mapping-Thermal Hotspots and Slum, Rajkot

6. Vulnerability Assessment and impacts of Heat Stress on Vulnerable Poor

After identifying the 9 hotspots in Rajkot city, household surveys were conducted to assess the housing infrastructure including the size of housing units, ventilation, cooking area, water supply, sanitation, and access to clean fuel, electricity as well as their awareness of the health complications from heat stress, and access to medical facilities and the health impacts of high temperature or heatwaves among the residents. The existing state of heat exhaustion and heat stress among the identified wards was assessed to understand the vulnerability. All these factors influence the community's resilience and preparedness for high temperature or heatwaves.

6.1 Type of Housing

Majority of the houses in the city are Pucca and Semi Pucca, the only ward which has the presence of Kutcha houses is Shitaldhara, which indicates that indoor temperatures usually remain higher than outside, especially in roof-top stories. Refer to Fig. 11.



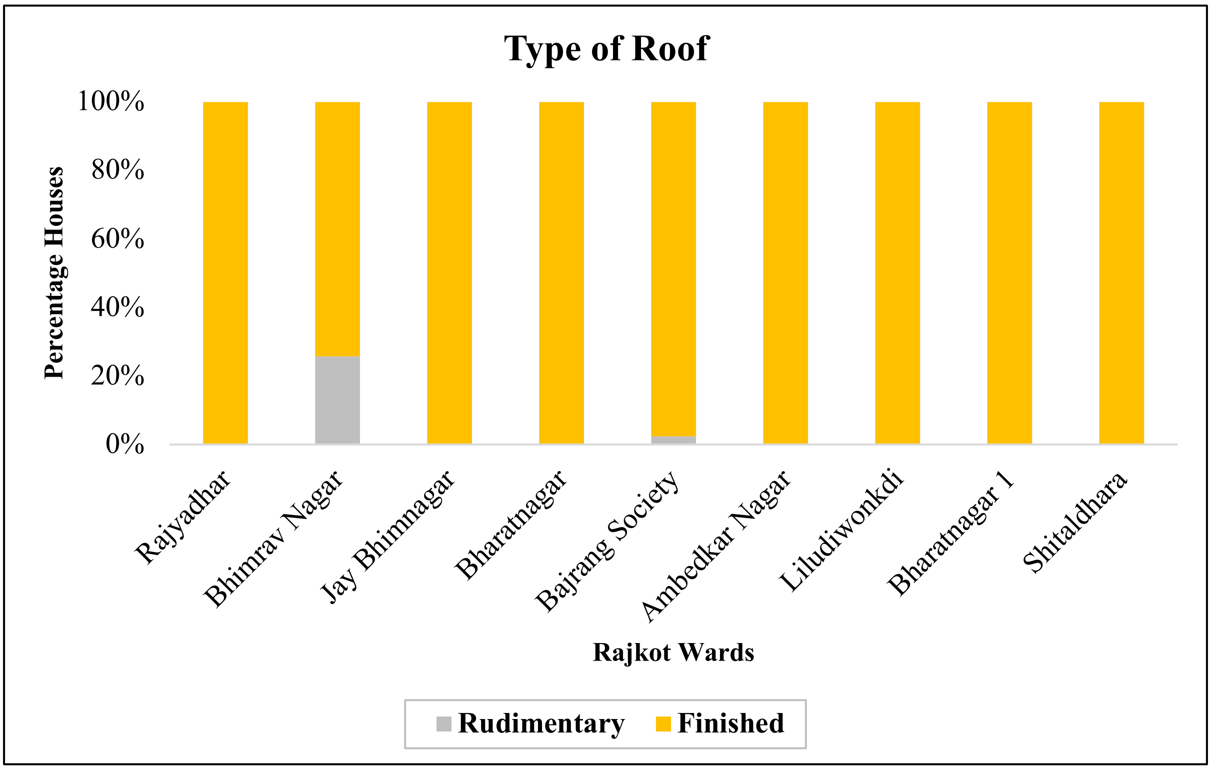


Figure 11: Housing Typology

6.2Heat Stress Awareness

The survey revealed that the majority of the people are unaware of the heat stress phenomenon in the city, refer Fig. 12. The people lacked the awareness regarding medical facilities for heat and the available adaptive measures taken by Urban Local Bodies (ULB) to mitigate the impact of heat stress.

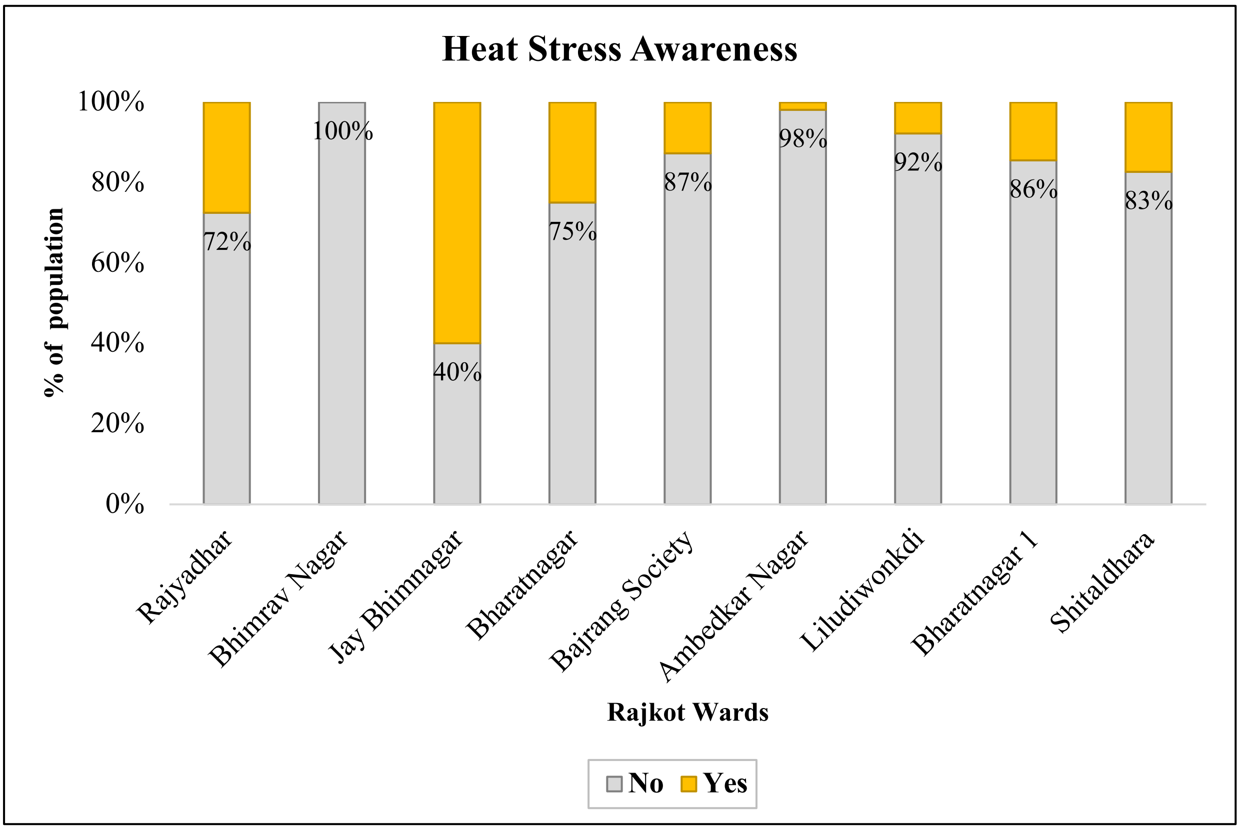
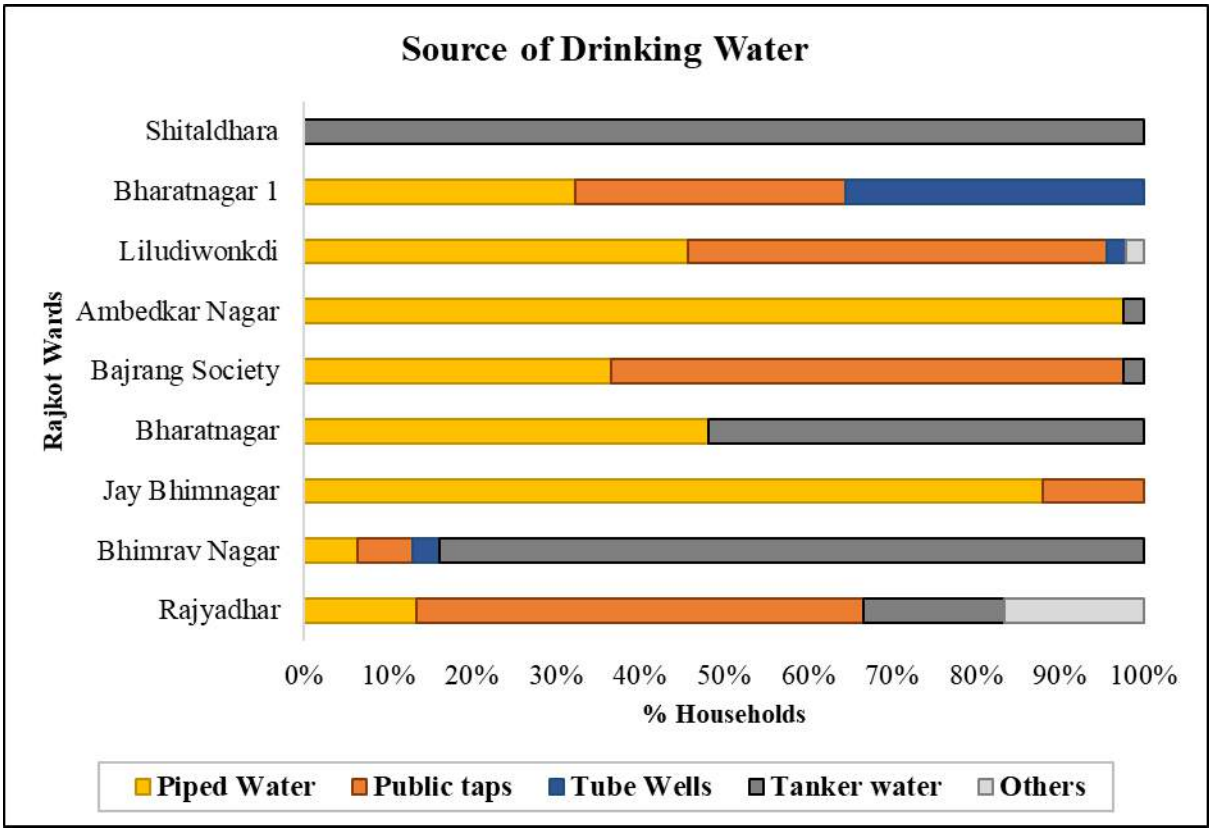


Figure 12: Awareness to Heat Stress

6.3Access to Water

Being an arid region, water availability is a major issue in Rajkot with the average frequency of water supply in the city being once a day. The accessible sources of water in the city are piped water and public taps. In Bhimrav Nagar, Bajrang Society, Rajyadhar and Shitaldhara Majority of the people do not have a water source in their own dwelling. Refer to Fig. 13.



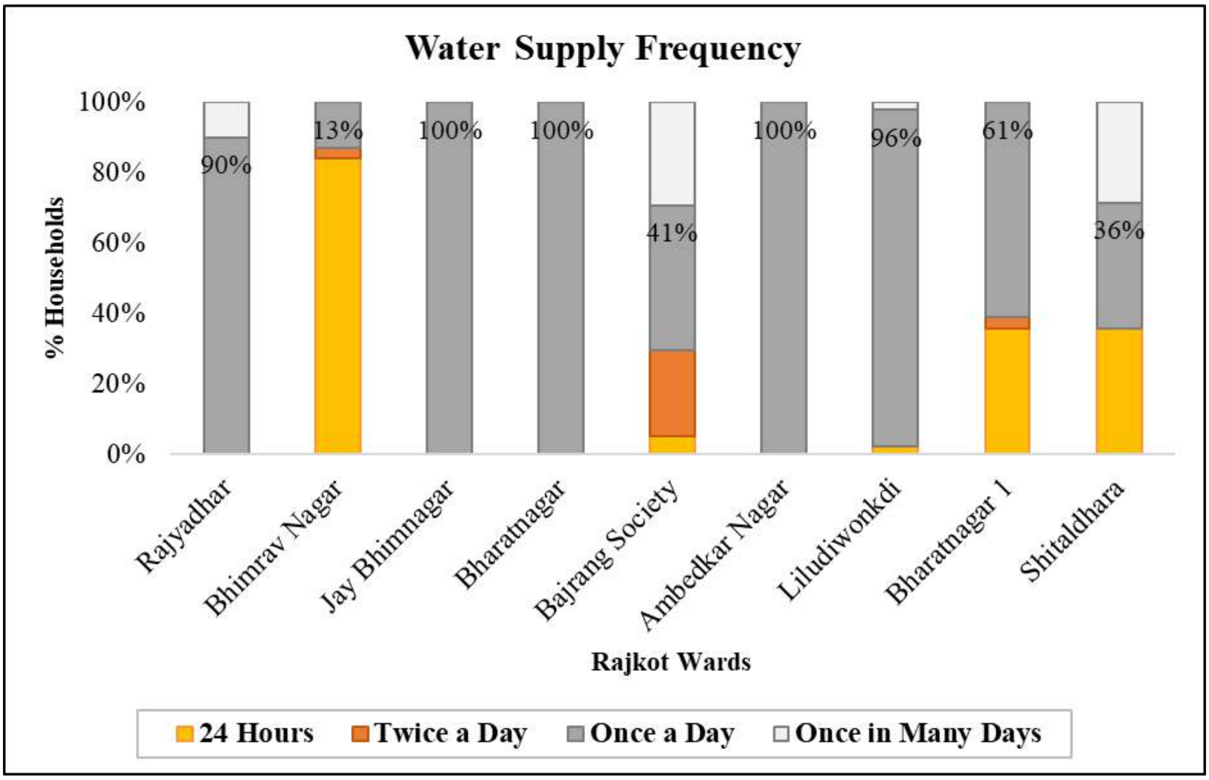
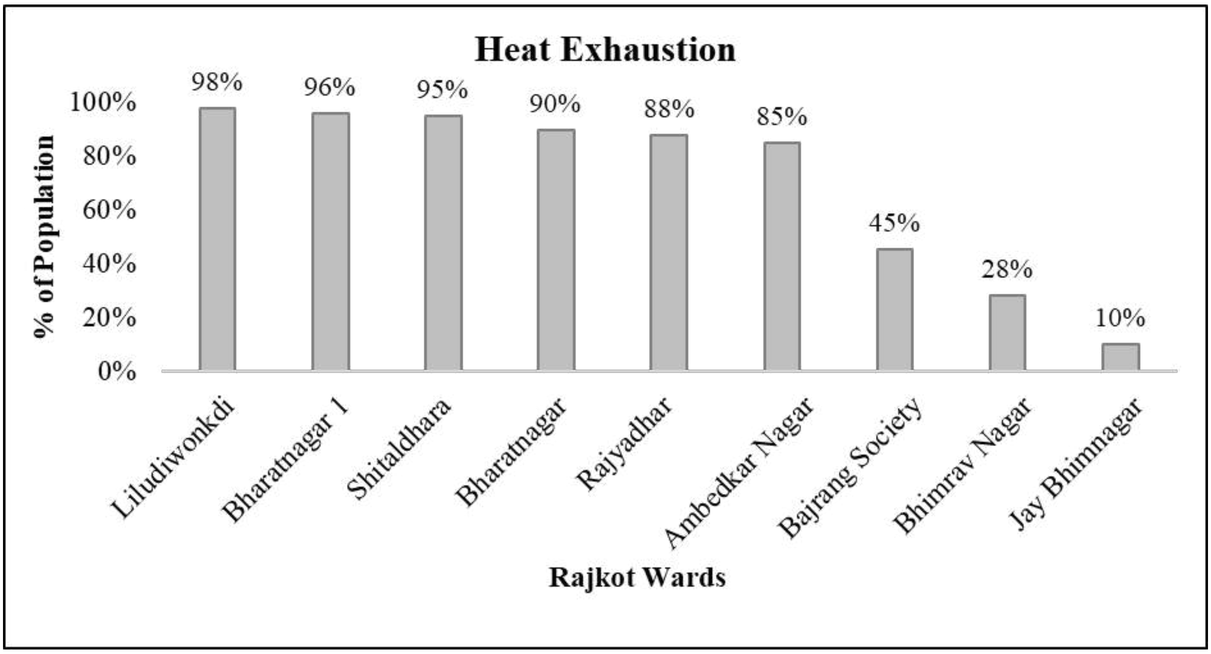


Figure 13: Portable Water Source and Supply Frequency

6.4Health Impacts: Heat Exhaustion and Heat Stroke

As per the household surveys conducted in Rajkot thermal hotspots, it was recorded as per the response from the survey participants, that majority of the people suffered from Heat Exhaustion and Heat stroke as a direct impact of heat stress on health. The most affected wards include – Rajyadhar followed by Ambedkar Nagar. Refer to Fig. 14.



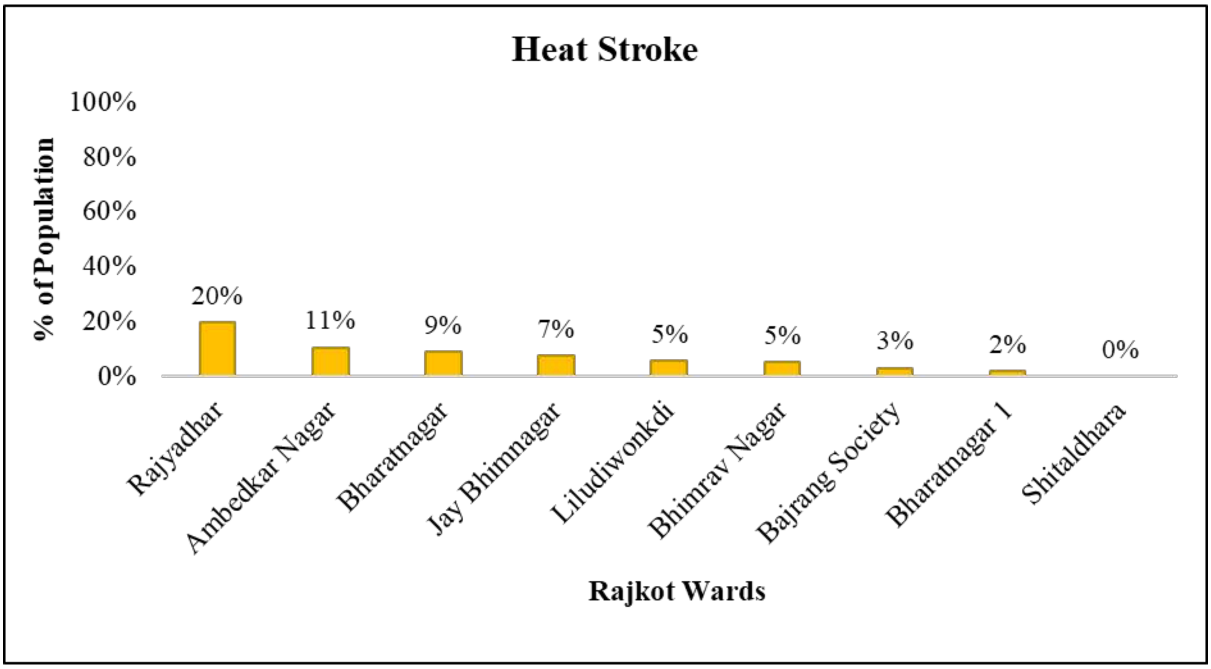


Figure 14: Impact Heat on Health

6.5Awareness and Access to Health Infrastructure

The survey indicated that in almost all the wards the awareness regarding the available heat-related treatment is low, more than 30% of the people are unaware of the facilities. Refer to Fig. 15

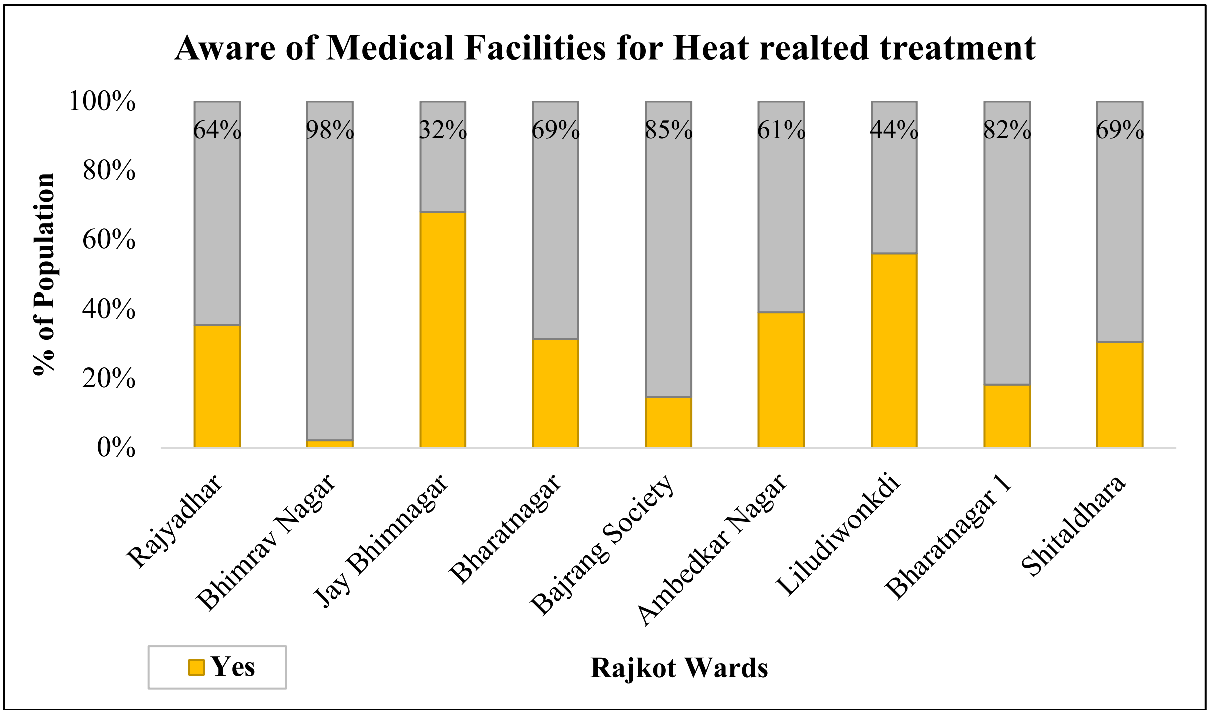


Figure15: Awareness Regarding availability of Medical Facilities for Heat Stress

The survey also indicated that access to public medical facilities in and around the respective wards, hence they approach private facilities which are expensive and economically weaker sections avoid to approach. Refer to Fig.16. The Distance from the health care centres indicate that majority of the wards require minimum 16-30 minutes to reach the nearby health care 4 (public / Private), hence at the time of emergency, it becomes difficult to reach the nearest health centres. Refer to Fig.17.All nine wards are highly vulnerable in access to health services.

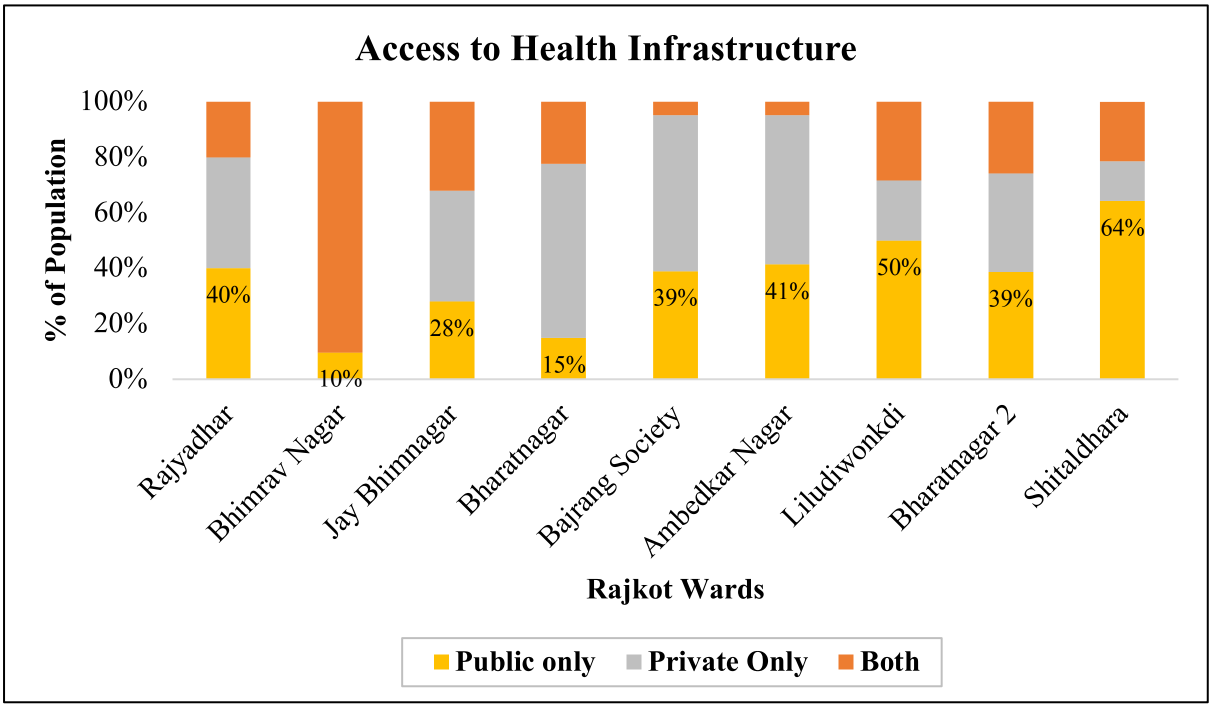


Figure16: Access to Health Infrastructure

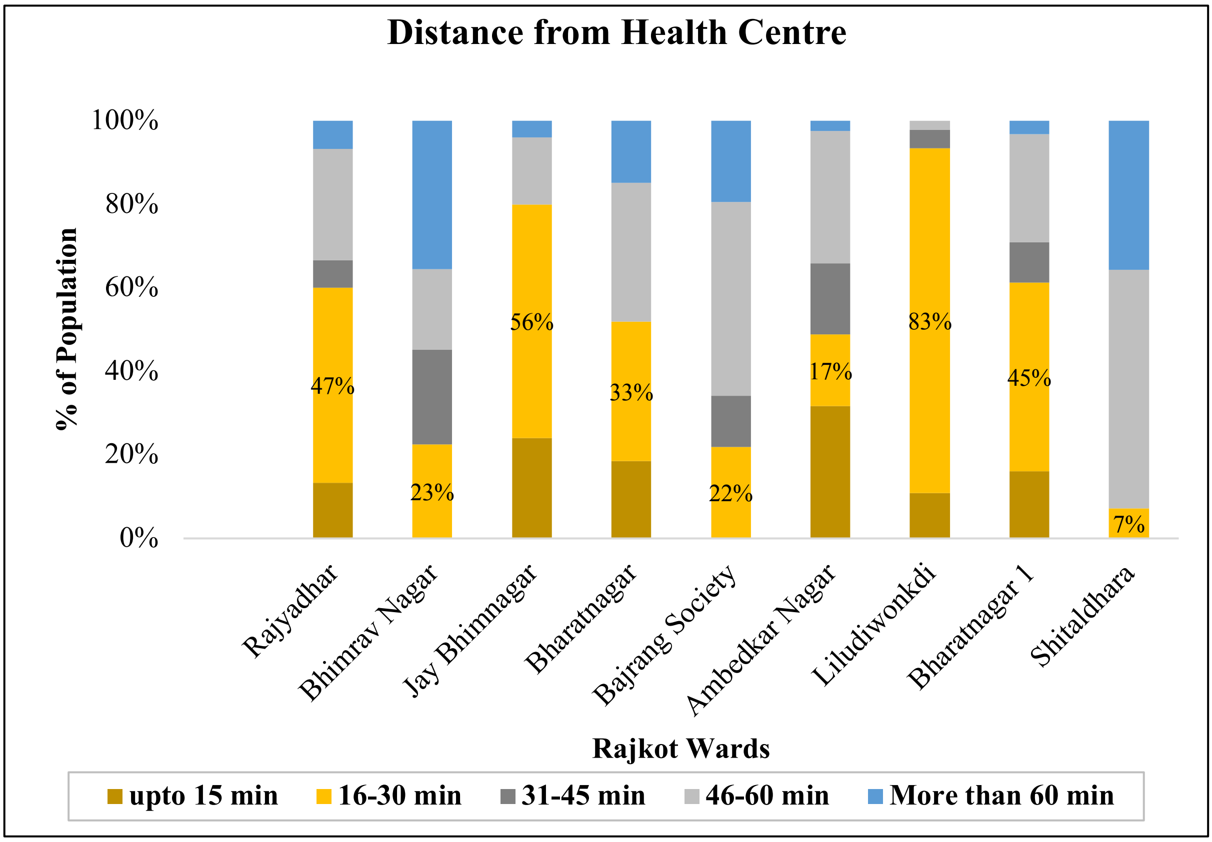


Figure17: Distance from Health Care Centres

6.6 *Access to Electricity*

Rajkot was found to have a reliable electricity supply to all areas. Of the surveyed households 98% reported uninterrupted access to electricity. Of the remaining 2% of households, 1% did not have an electricity connection and the other 1% reported electricity supply for 15 hours a day. About 7% of the sampled households reported minor outages during summers , refer to Fig.18. This factor, therefore, poses low vulnerability.

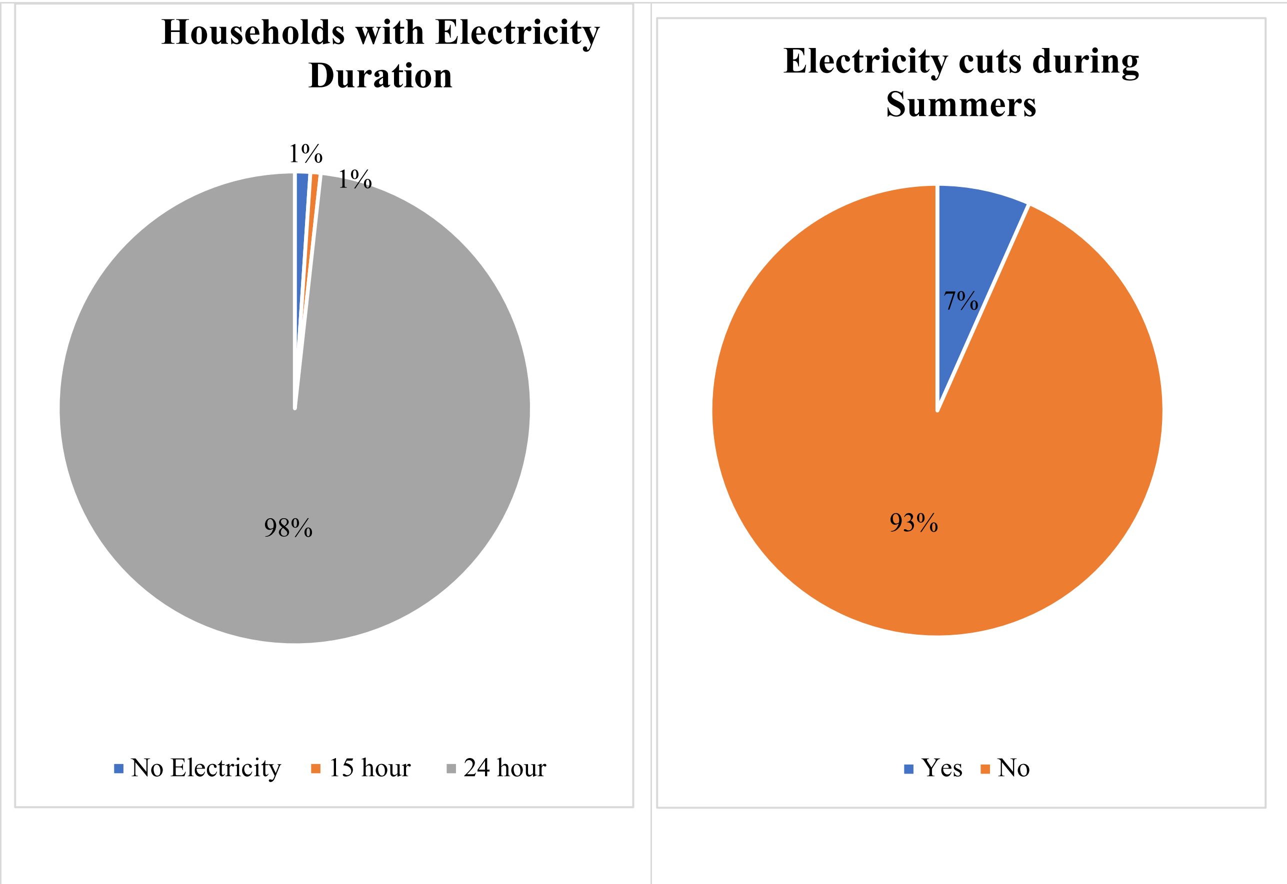


Figure18: Access to Electricity

6.7 *Access to Sanitation*

The survey showed that only 82% of the households had toilets, either pit latrines or flush toilets. Of these, about 16% of households shared toilets. Members of 14% households either used community toilets or practised open defecation, refer to Fig.19. Access to sanitation and piped water supply for all households is a major step for checking peak summer disease caseloads.

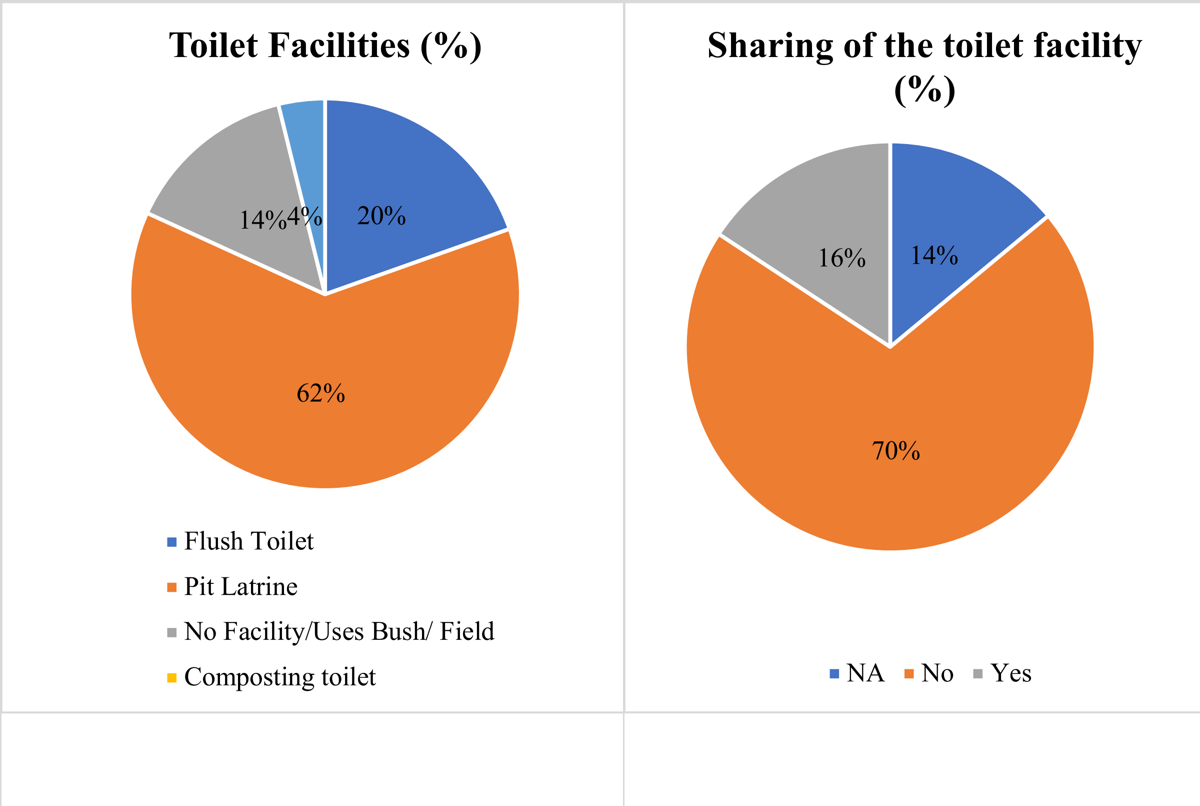


Figure19: Access to Sanitation

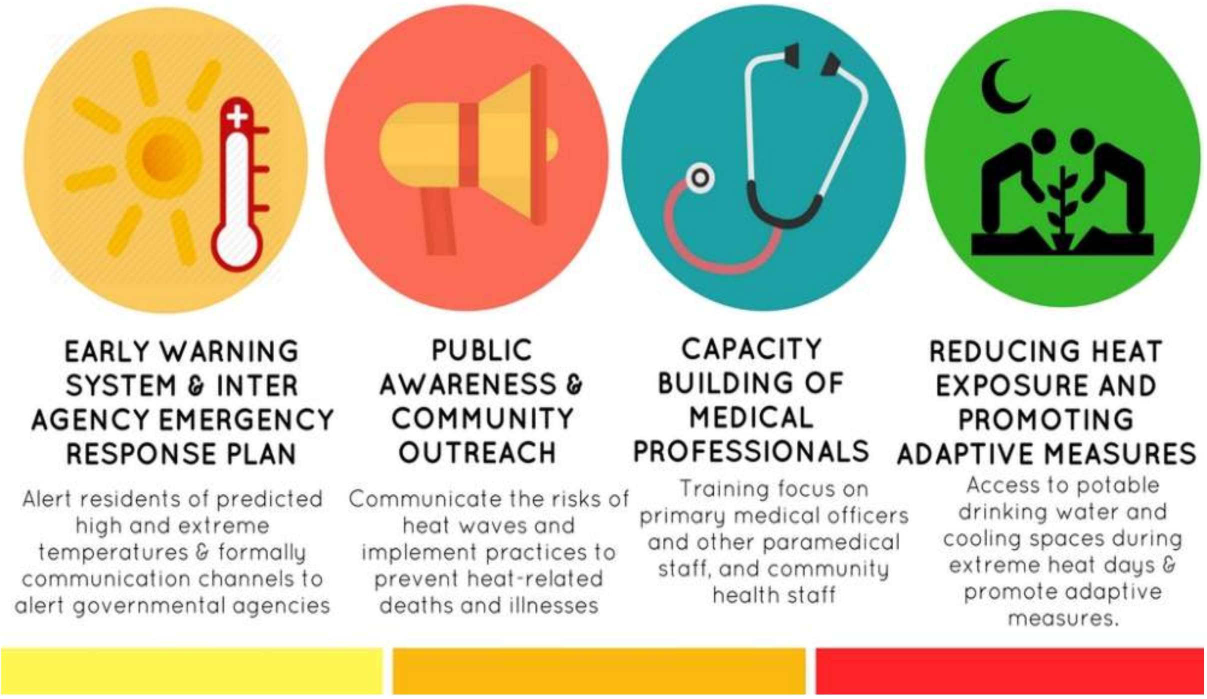
6.8 *Access to Clean Cooking Facility*

All surveyed households use clean fuel — 96% of households use LPG, 3% use electricity and 1% biogas. Therefore, the cooking fuels used are not the matter of concern. However, unplanned or improper location and ventilation of cooking area can trap heat in the living area. This is of concern particularly in small housing units.

7. Climate Adaptive Heat Action Plan, Rajkot

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 20.



The Action Plan divides responsibilities into pre-, during- and post-event categories, detailing preparation for a heatwave (pre-event responsibilities), steps to be taken to reduce heat stress during a heatwave (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 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.

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, 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.

7.3 Capacity Building

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

8. Conclusion

Heat stress action plans are key to city climate adaptation strategies. With the forecast of increased frequency and intensity of heatwaves 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. Through identification of heat hot spots and vulnerable populations at ward level, heat action plan provides adaptation strategies which are localised and target action at ward level.

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.

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