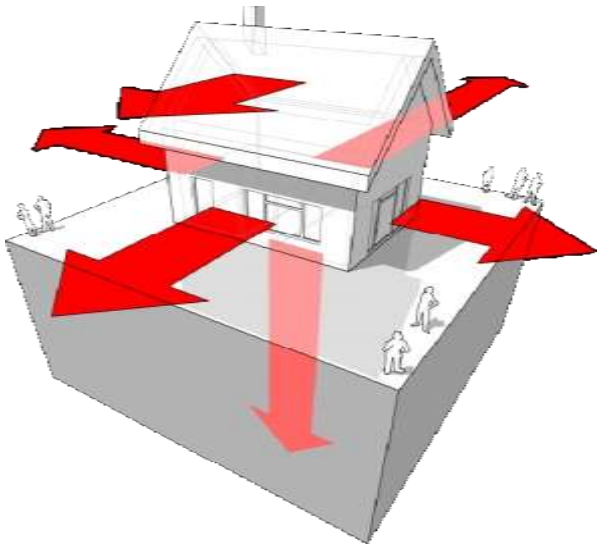
HEAT STRESS RISK ASSESSMENT AND ACTION PLAN FOR THE URBAN POOR IN BHUJ, GUJARAT

January 2022



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Prepared for

Homes In The City

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ABBREVIATIONS

CKD	Chronic Kidney Disease
GDP	Gross Domestic Product
GEER	Gujarat Ecological Education and Research (Foundation)
HAP	Heat Action Plan
HI	Heat Index
HIC	Homes in the City
ILO	International Labour Organization
IMD	Indian Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
NOAA	National Oceanic and Atmospheric Administration

1 INTRODUCTION

Urban poor communities that already exist at the intersection of multiple marginalities and vulnerabilities are also at the frontline of experiencing the brunt of climate change. In addition, climate change acts as an amplifier of their existing disadvantages and vulnerabilities. The rapid increase in global warming in recent times forebodes the intensification of climate change impacts on urban poor communities. Experts warn that "no other current concern can claim the scale of climate change – and the scope of the potential catastrophe if the world fails to act in time" (Adams & Luchsinger, 2009, p. xi). Thus, any attempt to build security and resilience of urban poor communities or empower them would be incomplete without effectively identifying and addressing their climate change-related vulnerabilities.

In its 2021 report, the Intergovernmental Panel on Climate Change (IPCC) warns of compound extreme weather events due to rapidly increasing climate change (Aggarwal & Ghosh, 2021). As per Zscheischler et al. (2020), compound weather and climate events are "combinations of multiple climate drivers and/or hazards that contribute to societal or environmental risk" (p. 333). This means that extreme weather events not witnessed much in the past are more likely to happen now. Additionally, the 2020 report by Government of India on climate change assessment in the country warns of stronger and longer extreme weather events such as heavy rains, floods, cyclones, storms, heat waves, and droughts (Krishnan et al., 2020). Moreover, climate change equally affects the vulnerable through not-so-dramatic but slowly-building, long-lasting and hard-to-reverse adverse conditions such as loss of food security, water security, green cover, critical biodiversity, and clean air (Nixon, 2011).

At the root of climate change is global warming happening due to excessive greenhouse gases released by human activities. Global warming has already caused an average 1.1˚C temperature rise between 1900 and 2021 (NOAA Climate.gov, 2021). Scientists have warned that a temperature rise of 1.5˚C should be considered as the upper threshold for warming and 2˚C warming may cause irreversible changes to the environment that may cause grave risk to human society. The temperature rise recorded in India between 1901 and 2018 is 0.7˚C (Krishnan, 2020).

The human activities driving this rapid increase in global temperature are massive industrialization, urbanization and exploitation of natural resources on the basis of which developed nations have built their wealth. The per capita cumulative carbon emissions (since the industrial revolution began) of developed nations is significantly higher, in fact by one order of magnitude, than that of developing nations (Global Footprint Network, 2022). Yet, it is the latter that are most vulnerable to climate change, particularly South Asia and the Sahel region of Africa as more drastic impacts are expected to occur in the tropics where most of the developing countries are located (Chinowsky et al., 2011; Khadka, 2021).

Climate injustice, that is commonly perceived to manifest internationally between nations (Adams & Luchsinger, 2009), also happens at local and regional levels along the pre-existing stratifications in society such as race, gender, class, and caste (for example see Bullard, 2000). The urban poor particularly experience climate injustice with respect to affluent urban communities that have/appropriate better access to resources and leave bigger ecological footprints locally (as also found in a study conducted in October 2021 by Samuchit Enviro Tech and HIC in Bhuj), while rendering the urban poor more vulnerable to climate change impacts. Urban poor communities comprise of migrants, informal workers, as well as residents of informal settlements. Often these are the same people, that is, informal workers are the ones living in informal settlements and vice versa, and majority of these people are often migrants (Satterthwaite, et al., 2018). The urban poor lack security of housing and livelihood, and access to basic services and entitlements in cities where the cost of decent living rises much faster than their earnings.

Owing to the informality of their existence in cities, the urban poor often find themselves living and working in spaces with high exposure to climate change impacts. The sites of informal settlements are often unsafe, prone to floods, landslides, or close to physical or environmental hazards (Baker, 2012; Satterthwaite, et al., 2018). Additionally, informal settlements are densely populated while being poorly built and serviced, which leaves them more vulnerable to climate change impacts. Informal workers are disproportionately exposed to climate change impacts across multiple sectors where occupational

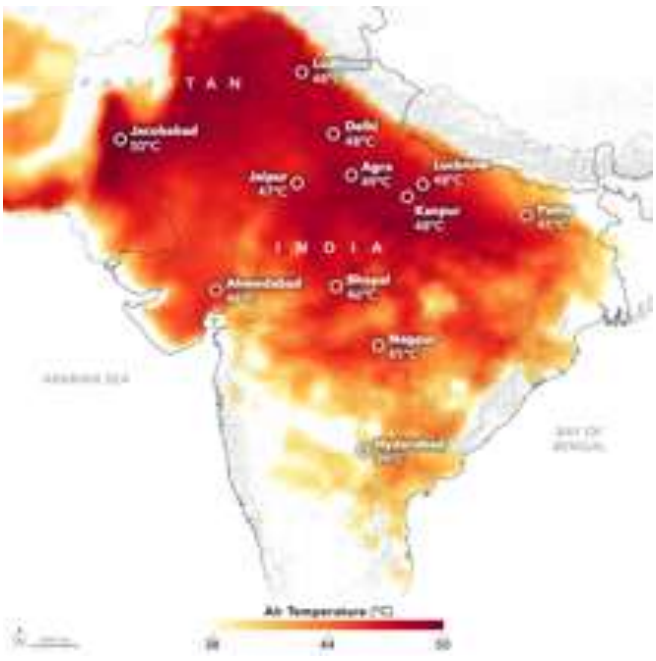
morbidity and mortality are expected to increase due to climate change impacts. Roelofs and Wegman (2014) warn that such workers may end up as the "sentinel cases" or the "canaries in the coal mine" of climate change impacts, that is be the first ones to bear the imminent climate change impacts and serve as first warning signals to society (p. 1800). In absence of government policies and employers' will to protect workers from climate change impacts, they remain highly vulnerable (Roelofs & Wegman, 2014).

Climate change impacts and hazards also potentially exacerbate the pre-existing problems of urban poor communities such as lack of financial security, livelihood opportunities, housing security, basic services, sanitation, and healthcare (Baker, 2012; Santha et al., 2016). Hazards such as cyclones or floods cause far more damage to informal houses and settlements than well-built infrastructures. The livelihood spaces, assets and resources for informal workers are also easier lost than for those in formal economy (Santha et al., 2016). In absence of securities such as savings, land tenure, income security, social security, or insurance, or local social networks in cities to help them recover from such losses, the urban poor are further dragged down into poverty and loss of means for survival. Basic services, healthcare and basic needs such as food and water that are already not much affordable or accessible become further inaccessible in times of crisis.

The climate change related vulnerabilities of urban poor communities are multidimensional, but their adaptation needs are neglected in favour of the mitigation imperatives on global warming. However, the mitigation agenda is mostly irrelevant for the urban poor who have least ecological footprints in cities (Moudgil, 2021), and live in homes that are "energy efficient out of necessity" (Dey, 2019). Mitigation is an agenda that should be taken up with the ones driving climate change and have biggest ecological footprints. Despite this, prioritizing the mitigation agenda for the urban poor over their adaptation needs would mean further subjecting them to climate injustice. Climate justice for the urban poor lies in identifying their climate change related vulnerabilities and adaptation needs, and prioritizing them over the growth of those responsible for climate change. The urban poor agenda on climate change is thus rooted in a rights-based perspective, a discourse of justice, and an understanding of power inequities from macro to micro levels.

Turning Up the Heat

One extreme weather event India was already experiencing is prolonged summer from April to September every year. Even in absence of global warming, barring hill regions, most of India experienced heat stress for at least half the year. Despite Indians being acclimatized to high ambient temperatures, studies done in Surat, Jaipur and Hyderabad indicate that there is a 11-39% increase in deaths/day in all-cause mortality when maximum day temperatures cross 40- 45ºC (see Desai et al., 2015; Rathi & Sodani, 2021; Rathi, Sodani & Joshi, 2021). Another study establishes a correlation between high temperatures and chronic kidney disease (CKD) in rural areas, by reviewing studies in several continents—Asia, North and South America and Africa (Glaser, et al., 2016). The study found study sites in India, Sri Lanka, Costa Rica, Nicaragua, El Salvador, and Guatemala as confirmed sites where CKD had a correlation with heat stress. There is a direct relationship between exposure to elevated temperatures and heat related illnesses.



Global warming has exacerbated this heat stress in most parts of India. The frequency of extreme heat waves has increased over the Indian sub-continent. In the two consecutive years, 2018-19, more than 2,500 persons died in India due to heat

waves. The map shows the 2019 heat wave over the Indian subcontinent and the table shows a glimpse of resulting mortality. Despite the world's effort to tackle climate change, the added measures that have been pledged or agreed to by countries in the November 2021 United Nations Climate Change Conference in Glasgow will fail to keep the global average temperature rise to less than 2°C. Further temperature rise will only increase heat stress related health effects on the Indian populace significantly. One study predicts that the number of climate related mortality may be as high as 8.5 lakh deaths per annum by 2100 (Carleton, 2020).

2019-20 heat waves in India and their human toll

Year	Event	Location	Deaths
2018	Heat wave	All over India	2,405
2019	Extremely high temperatures	Maharashtra, Madhya Pradesh	50

The urban (and rural) poor will be affected the most by heat stress as their risk of exposure to heat and humidity is high, and they lack adequate means to minimize such exposure or deal with heat stress. Houses in informal settlements are consistently warmer than those in affluent localities due to their construction material and design, compactness, and lack of space for ventilation (Jacobs, et al., 2019). The local heat effect is more in bigger informal settlements (Wang et al., 2019). Moreover, green cover is also less in informal settlements where houses are built densely with less space between each other, and open space is rare. The day-time heat gets trapped and make nights also warmer for a long period of time as compared to other areas. The residents of informal settlements are poor and therefore less able to afford cooling mechanisms (fans, coolers). Lack of adequate information and awareness about mechanisms to cope with heat stress exacerbate its impact. The constant exposure to heat in informal settlements creates an ongoing health risk for the residents. However, we should look at this risk compounded by their exposure to heat at work sites as well, which makes it far worse.

Heat stress impacts the overall labour productivity as well as reduces the total number of work hours (ILO, 2018), thereby impacting the earning of informal workers. Absence of social security leaves them further vulnerable. By 2030, heat stress is predicted to cause a loss of 5.8 per cent of working hours in India, equivalent to 34 million full-time jobs, and a gross domestic product (GDP) loss of more than 5 per cent (ILO, 2019). Health-wise, heat stress can be seen as a health hazard. Negative occupational health effects and workplace injuries happen from heat stress, due to which informal workers that lack health security get most affected. Informal jobs that mostly involve high levels of physical exertion or long hours of outdoors work would be particularly affected by increasing heat stress. Construction workers would be amongst the worst affected with a share of 9.04 per cent in the working hours lost to heat stress in India by 2030 (ILO, 2019). ILO (2019) warns that "exacerbated by climate change, heat stress impedes progress towards decent work and social justice… and, more generally, jeopardizes achievement of the Sustainable Development Goals unless concrete measures are taken" (pp. 18-19).

Studying Vulnerability

Kachchh district in Gujarat is among the most vulnerable regions in the country where historically multiple drastic changes in climate have been witnessed. By 2011, as per the report by Gujarat Ecology Commission, the mean maximum temperature in Kuchchh district had increased by 0.5°C and the mean minimum temperature had declined by 0.5°C (Gavali, 2011). In addition, the trend indicates rise in the day temperatures and high risk of heat waves (GEER Foundation, 2017).

Homes in the City (HIC) that works with the urban poor in Bhuj wished to work on the heat stress they face. Thus HIC requested Sagar Dhara and Dr. Sheeva Dubey to prepare a heat stress risk assessment report and a heat action plan (HAP) for them. The idea was to have an initial recommendation and action

plan in place to start working on reducing heat stress for the selected groups and identify key intervention points. Communities selected in Bhuj for risk assessment of low-cost housing include Juni Rawalwadi (142 households), Sathwarawas (135 households), and Khasra (fewer than 50 households). The informal workers groups selected for the study include daily-wage workers, street vendors, cattle rearers, and waste pickers of Bhuj.

The study was conducted between July and September 2021 in multiple phases. The data collection methods used include questionnaire-based surveys, focus group discussions, community walks, and secondary data sourced from the Indian Meteorological Department (IMD). The sample size of the survey and the number of focus group discussions conducted for the study are given in the table below. For the housing-based survey the sample size is in terms of the number of households that participated. Among the surveyed workers, 42 were men (72 per cent) and 16 were women (28 per cent). Also, 36 (62 per cent) of these were permanent residents of Bhuj while 22 (38 per cent) were seasonal migrants.

Location / group	**Number of survey responses**	**Number of focus group discussions**
Housing-based		
Juni Rawalwadi	15	2
Sathawarawas	15	2
Khasra	5	1
Total	**35**	**5**
Work-based		
Daily-wage workers	14	1
Street vendors	14	1
Cattle rearers	15	1
Waste pickers	15	1
Total	**58**	**4**

The heat stress risk assessment was conducted using a framework of four main parts – hazard assessment, vulnerability assessment, an assessment of coping mechanisms, and an assessment of risk perception among the target communities. While the hazard assessment is common for informal settlements and informal workers and summarized in Chapter 2, the other assessments have been done and presented separately in Chapter 3 and 4. Both the chapters are based on both qualitative and quantitative data from the primary data collected. All these chapters comprise the first part of this study. The second part of this report presents a heat action plan with details of emergency action for heat exhaustion and heat strokes in Chapter 5, low-cost designs for reducing heat loads in houses in Chapter 6, and some other suggested follow up measures in Chapter 7.

PART I

HEAT STRESS RISK ASSESSMENT

2 HAZARD ASSESSMENT

Heat stress

Heat stress is the net heat load exposure of a person for a given period. Heat stress can occur when a person is at work or at rest. The primary factors that contribute to heat stress are elevated temperatures and high humidity. Other factors too contribute to heat stress. The Heat Index (HI) is a measure of how hot humans perceive it feels when relative humidity is factored with the actual air temperature. Higher concentrations of relative humidity make the same temperature feel hotter and more unbearable (for further understanding of heat stress, heat stress related illness and heat index, please refer to Chapter 5: Heat Stress and Response). The table below is a quick reckoner for understanding risk levels at various heat indices.

Heat index

Relative humidity (%)	**Air temperature** (°C)											
	21	24	26	29	32	35	38	41	43	46	49	52
	Apparent temperature* (°C)											
0	18	21	23	26	28	31	33	35	37	39	42	42
10	18	21	24	27	29	32	35	38	41	44	47	50
20	19	22	25	28	31	34	37	41	44	49	55	61
30	19	23	26	29	32	36	40	46	51	57	65	74
40	20	23	26	30	34	39	43	51	58	66	77	
50	21	24	27	31	36	42	49	57	66	78		
60	21	24	28	32	38	46	56	65	76			
70	21	25	29	34	41	51	62	77				
80	22	26	30	36	45	58	69	89				
90	22	26	31	39	50	66	77					
100	22	27	33	42	56	74						

Heat index (°C)	**Risk level**
<33	Low
33-39	Moderate
39-46	High
>46	Extremely high to extreme

* Note: Above chart based on NOAA's chart and computations made from NOAA's website. Apparent temperatures rounded off to nearest integer

Bhuj climate

Bhuj has a hot semi-desert climate with hot summers and moderate winters. The annual rainfall averages around 320 mm, with much of the precipitation occurring during the months June to September (see table below). Relative humidity is high during the monsoon months. The winter months, November to February are pleasant.

Climate data for Bhuj (Bhuj Airport) 1981–2010, extremes 1963–2012

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Highest recorded temp (°C)	37.0	38.9	43.9	45.6	47.8	47.0	41.3	41.2	42.8	44.0	39.7	35.4
Avg daily max temp (°C)	27.4	30.4	35.4	38.9	39.4	37.6	34.2	32.7	34.9	36.9	33.1	28.7
Avg daily min temp (°C)	10.0	12.8	18.1	22.3	25.5	27.2	26.4	25.3	24.3	21.7	16.0	11.2
Lowest recorded temp (°C)	-0.2	0.3	5.5	12.7	16.6	16.1	19.4	20.0	17.8	11.1	6.0	0.6
Avg rainfall (mm)	1.3	0.3	1.1	0.2	1.5	35.6	130.9	99.7	48.6	2.3	1.8	0.2
Avg No. of rainy days	0.2	0.0	0.2	0.1	0.3	1.8	5.0	3.8	2.2	0.4	0.2	0.1
Avg relative humidity (%) at 5:30 pm	32	29	29	29	39	51	64	66	54	33	31	33

Source: India Meteorological Department

Heat indices and risk levels in Bhuj

Based on average monthly daily temperature and relative humidity data (at 2.30 pm) obtained from India Meteorological Department, the heat indices in Bhuj for different months were computed. The computation indicates that heat index ranges: 25-31 during the November-March, 35-38 during the months April, August-October, and 31-44 during the months May-July (see table below). Even though temperatures decrease in June-July in comparison to May, relative humidity is higher in June-July. Consequently, the heat index in June-July are high.

Heat index in Bhuj

Month	2019		2020		Average of 2019-20		Heat index	Heat stress risk
	Temperature at 2.30 pm (ºC)	Relative humidity at 2.30 pm (%)	Temperature at 2.30 pm (ºC)	Relative humidity at 2.30 pm (%)	Temperature at 2.30 pm (ºC)	Relative humidity at 2.30 pm (%)	(ºC)	
January	27.5	28	24.4	32	26	30	25	Low
February	28.1	26	30.5	23	29.3	24.5	28	Low
March	33.3	22	32	25	32.7	23.5	31	Low
April	39	18	38.7	21	38.9	19.5	38	Moderate
May	38.2	32	39	31	38.6	31.5	41	High
June	37.4	45	36.4	47	36.9	46	44	High
July	35	51	32.7	65	33.9	58	44	High
August	31.6	51	30.4	77	31	64	36	Moderate
September	32.1	57	32.8	60	32.5	58.5	38	Moderate
October	33.9	35	34	41	34	38	35	Moderate
November	30.3	41	30.8	30	30.6	35.5	29	Low
December	26.4	31	28.1	28	27.3	29.5	27	Low

Source for temperature and relative humidity data: Data purchased from India Meteorological Department

Heat stress risk is low in winter (November to March), moderate in April and August to October, and high from May to July. Heat related illness are most likely to happen during May to July, with some probability of them occurring during months when heat stress risk is moderate (April, August-October).

Protective measures

Precautions against heat related illness for living spaces and workspaces, as suggested in Chapter 5, should be adopted. These are summarized in the tables below.

Recommendations for protective measures for persons against illnesses at high heat index levels

Heat index (ºC)	Risk level	Protective measures
39-46	High	**1) Drink water often, 2) Take breaks as needed**
>46	Very high to extreme	1) **Drink water often, 2) Reschedule non-essential heavy work, if possible, 3) Alert persons about heat index for the day and identify precautions in place including who to call for medical help**

Heat related risk in workspaces and recommended measures to avoid illness

Work difficulty			Easy work		Moderate work		Hard work	
			• **Sitting, standing, light arm/hand work and occasional walking** • Walking/working on hard surface at <4 kmph & carrying <12 kg		• **Normal walking, moderate lifting** • Walking/working on loose sand, water, reeds at <4 kmph & carrying minimal load • Walking on hard surface at <5.5 kmph & carrying <17 kg		• **Heavy material handling, walking at a fast pace** • **Pick and shovel work** • Walking on hard surface at <5.5 kmph & carrying >17 kg • Walking/working on loose sand at <4 kmph & carrying minimal load	
Heat index	**Heat stress risk for prolonged physical activity or prolonged heat exposure**	**General measures to avoid heat related illness**	Work/rest cycle each hour (min)	Water intake each hour (cc)	Work/rest cycle each hour (min)	Water intake each hour (lit)	Work/rest cycle each hour (min)	Water intake each hour (lit)
<27	**Low risk of illness**	**No limit to work**	60/0	500	60/0	750	50/10	750
27-32	Low risk of illness	No limit to work	60/0	500	50/10	750	40/20	1000
32-40	**Heat cramps or heat exhaustion possible**	Modify work practice	60/0	750	40/20	750	30/30	1000
40-51	**Heat cramps or heat exhaustion likely. Heat stroke possible**	**Modify work practice; No heavy clothing**	60/0	750	30/30	750	20/40	1000
>51	**Heat stroke highly likely**	Avoid work if possible	50/10	1000	20/40	1000	10.50	1000

Note: Above recommendations made on the basis of information provided by OSHA and USFWS

For longer term solutions to reducing heat loads in living spaces, suggestions made in Chapter 6 may be followed.

3 RISK ASSESSMENT – PEOPLE IN DWELLINGS

This chapter presents the heat stress risk assessments at the three selected settlements in Bhuj – Juni Rawalwadi, Sathwarawas and Khasra. The assessment includes a vulnerability assessment, a capability assessment, and a people's risk perception assessment. Under the capability assessment, we have mainly analyzed the coping mechanisms used by the residents of the three settlements. In the following sections, the findings under each assessment are presented in detail.

3.1 Vulnerability assessment

The vulnerability assessment has been done on four fronts. First, physical vulnerability is assessed which includes any vulnerability arising due to the built of the houses, the conditions in the selected informal settlements, and the physiological condition of the residents there. Second, the economic vulnerability of the residents at the three settlements has also been analyzed. Next is an assessment of social and organizational vulnerability that looks at the community ties, leadership, and collective capacity. Fourth, informational and attitudinal vulnerability is explored to understand any gaps that can be addressed in the heat action plan.

a. Physical vulnerability

To analyze the physical vulnerability of the residents of the selected settlements, we looked at five aspects – the infrastructural built of their houses, the ventilation and issues with it, the resources available for cooling, the physiological vulnerability of the residents, and the common infrastructure and facilities available in their settlements for coping with heat stress.

Housing build

"The main problem is that of the house. Everything happens because of house only. We have small houses, if one person goes inside and then the other one enters, it feels small. There is a lot of heat all the time. The fan doesn't help. We get sick because of it. The main thing is house only." – A resident of Sathwarawas

More than half of the surveyed households have plastic sheets or wood as roofs and most of the surveyed houses have dark rooftops. While there are all types of roofing materials used in Juni Rawalwadi and Sathwarawas, all the houses in Khasra have plastic sheets for roof.

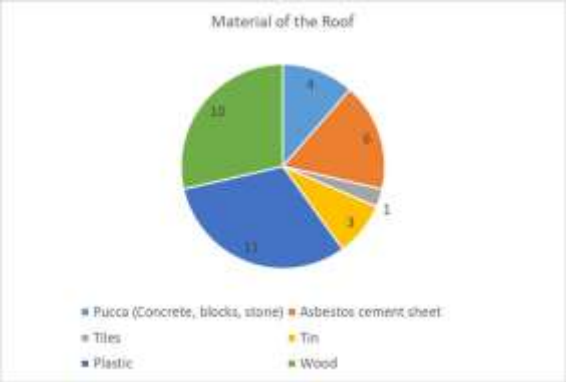
"There is a fan in every house but we cannot sit inside. The houses here are old. There is a lot of heat, a lot. A lot of sunlight comes. We then go outside to sit under any shade. We face a lot of difficulty when it is hot."
– A male resident of Juni Rawalwadi

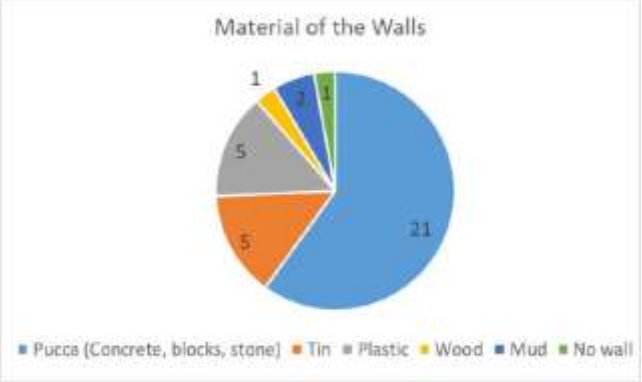
The walls and floors are pucca in majority of the surveyed houses except Khasra that has entirely kutcha houses (the picture is of a house in Khasra from the inside). Tin and plastic are also commonly used wall material in kutcha houses in all locations. Some semi-pucca houses also have kutcha flooring.

"When it rains, water fills everywhere here" – A woman resident of Khasra who lives in a kutcha house complains of flooding inside her house during rains

"My house is the oldest. Water also flows from in between the house.... We spread a plastic sheet on it and then on top of that we spread our bedding and sleep at night." – A woman resident of Juni Rawalwadi

Most houses in all the three settlements are semi-pucca and kutcha houses, which are of poor built and vulnerable to severe weather conditions. **The residents experience more heat stress inside their houses than outside in open air. High heat load incursion happen in semi-pucca and kutcha houses primarily through the roof**, changing somewhat with the roofing material and the colour of the roof.





The breathing space

"Air doesn't come inside at all. Windows don't help because there are many houses closeby."
- A woman resident of Juni Rawalwadi

Majority of the houses surveyed in all locations have only one room and the windows are smaller than 2x3 feet. Most houses have poor ventilation, and most homes do not have cross ventilation. The houses in Sathwarawas have the least ventilation. A majority of the houses have their kitchen inside the house and most homes use firewood for cooking. Most houses do not have enough space on the sides of the house for good ventilation.

"There is a lot of problem in my house. My house is smaller than this one. In that we four members live, two of us (the couple) and our two daughters. There is another daughter who is eldest, she lives with her grandparents. There is just a small fan at the centre that doesn't help any of us. We feel very hot. We feel we can't live like this. We face a lot of problem…. There is a small window which is of no use. No breeze comes from there. So I don't open it." – A male resident of Sathwarawas

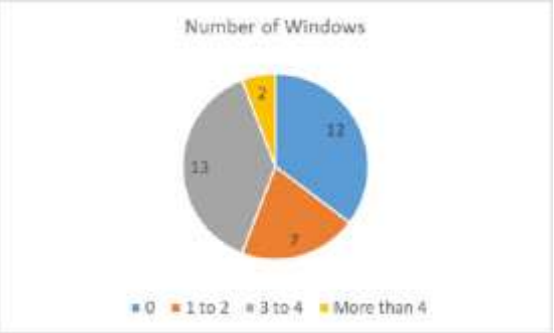
Among all the locations, the houses at Khasra have the least space inside, the least height of rooms, and no windows at all. The lower height helps cover the house completely with plastic sheets during rains. Also the residents explained that if they make taller huts, they get carried away by wind because of entirely kutcha construction.

"We have to pack the house completely in case it rains. Otherwise water gets inside." – A resident of Khasra

The residents of Juni Rawalwadi also complained of their house levels being lower than the level of roads. As a result, constant dust is a common concern in addition to poor ventilation.

"I get constant waters in my eyes. It is because of a lot of dust and pollution from the road. The doctor said so." – A woman resident of Juni Rawalwadi

Ventilation is extremely poor in the houses at all the three settlements, Sathwarawas being in the worst condition. Lack of ventilation is major factor causing more heat stress to the residents of informal houses. The factors limiting ventilation include low height of the houses; smaller, fewer or no windows; and lesser space around house for sufficient air flow.



Cooling needs

"Mosquitoes bite us all night. There is a lot of heat but no electricity here. We do not have any cot to sleep outside our huts. We have to sleep inside where there is a lot of heat and no breeze." – A woman resident of Khasra

Most of the houses in Juni Rawalwadi and Sathwarawas have legal electricity connections. However, it is at Khasra that families live without any electricity connection at all. They have been allotted the land by the government, however entitlements have not been granted yet because of which housing insecurity remains. As a result, they reported having no fan or any other cooling device at home.

"We live in an informal hut. The government can come anytime and demolish it. If we have right to make our house, then we can build it better and get electricity connection." – Another resident of Khasra.

Majority of the houses in Juni Rawalwadi and Sathwarawas also have only one fan and none has any other cooling device (see the picture of a kutcha house in Juni Rawalwadi). The houses are too small to install another fan. Refrigerators are also not common in these communities.

"Another fan cannot even fit in our houses…. When we step inside the house, the fan can even hit our head." – A male resident of Sathwarawas

Most households in Juni Rawalwadi depend on tankers for drinking water supply and find the supply inadequate. A house needs at least 2 tankers of water every month, costing INR 200 each. In Sathwarawas, half of the respondents have personal water connection and the remaining half take water from them but still find the supply inadequate. The residents of Khasra have been provided a common connection for drinking water by the government and have adequate supply, however, have to walk more to fetch water. In case of water scarcity, most avail water from neighbours or nearby areas but some also reported having to buy water to survive.

"The biggest problem here is that of water. We do not get enough water. Today I got dirty water. Now I am very worried what to do." - A resident of Juni Rawalwadi

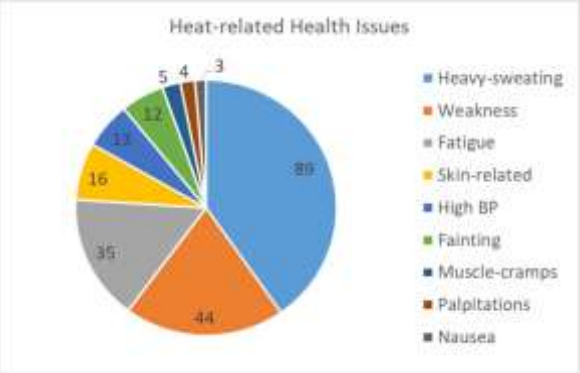
Khasra residents have little access to cooling devices due to no availability of electricity in their settlement. However, even those having electricity and fans installed in their houses do not always find them much effective. **Single fans in small and low-ceiling houses are clearly ineffective** in mitigating the high heat stress experienced by the residents. **Inadequate water accessibility is another major factor** adding to the residents' vulnerability to heat stress.

Physiological vulnerability

"We fall sick all the time due to heat. It happens so frequently. We fall sick every day…. When there is no breeze that is when we face most difficulty. The doctor says that this is happening due to weather change." – A male resident of Sathwarawas

All the respondents said that they feel an increase in heat stress every year. Two-third respondents shared that they frequently feel uncomfortable during hot days. Most common heat-related issues experienced by the residents of the three communities include frequent heavy sweating, weakness and fatigue. Some other problems reported include skin-related issues such as rashes, high blood pressure, fainting, muscle cramps, palpitations, and nausea. Fainting, high blood pressure and fatigue are more common among females than males. On the other hand, males reported experiencing heavy sweating more than females. Moreover, reportedly, more females experienced hospitalization due to heat stress than males. Also, older people were more prone to hospitalization due to heat stress.

"His wife goes to collect and get wood. The wood that we use for cooking, she cuts it and sells it. So she does the cutting work in sunlight because of which sometimes she faints. She sweats a lot because of which she faints." – A woman resident of Juni Rawalwadi speaking about her neighbour



Pre-existing health conditions reported include high blood pressure, abdominal pain, mental illness, physical disability, bone-related issues, breathing problems, and diabetes. There is also a drainage behind Khasra due to which the residents complain of mosquitoes. Some residents of Juni Rawalwadi and Sathwarawas shared being attacked by wild animals on sleeping outside their houses sometime back. Additionally, alcoholism is common among the men in these settlements.

"We are five people in my family. We cannot even sleep inside together. If we sleep outside, any insect or animal can come inside and bite us. Once I was sleeping outside, a fox came and bit me." – A male resident of Sathwarawas

Heat stress related health issues are common among the residents of the three settlements. They also vary with gender and age. Women and older people undergo more hospitalization due to heat stress, most likely because they stay indoors during peak hours of heat much more than the working men of their communities. Working men experience heavy sweating due to high-intensity and exposure work they do during the day time.

Community infrastructure and facilities

"There is no space to sit here. Where is any shade around here? We feel very hot. So then we go to the market area to sit under some shade or tree until evening when it cools down a little bit." – A resident of Khasra

"We don't have any space. Our community has nothing. We don't have access to any space. If we have to do any meeting, we conduct it on the road." – A woman resident of Sathwarawas (see the adjoining picture of narrow lanes that are common in Sathwarawas)

There are no community centers, schools or religious centers that can be used as cooling centers in all the three housing sites. Only at Juni Rawalwadi an open-air but shaded *Devipujak*-caste community center is under construction but needs more resources for completion. All the sites have very less tree cover. In Juni Rawalwadi, the complaint is that the soil is hard and doesn't support tree growth while the residents of Sathwarawas shared that there is no space to plant trees in the settlement. It has become very crowded as the third generation of residents continues to populate it.

"If someone is very sick and needs to be taken to the big hospital, it takes minimum half an hour to get there from here…. We have to arrange for a vehicle." – A woman resident of Juni Rawalwadi

In case of emergency, all the respondents at Juni Rawalwadi and Sathwarawas reported having to depend on private vehicles to reach a hospital or doctor at the earliest. Only those living at Khasra which is located on a main road reported that ambulance is the quickest means to reach a hospital or doctor in case of emergency. Only the residents of Juni Rawalwadi reported having an affordable clinic nearby. At both the other locations, the residents have to go to hospitals where treatment can cost them as much as INR 500-1200. The three settlements also do not receive basic services such as waste collection.

"There is a doctor nearby. Whatever happens to me I go to him immediately. He is nice. He doesn't charge much fee from poor people like us. He left his job at a big hospital to start his own clinic here. Now he has built a bigger facility. But he is very nice with poor people. We have been going there for 6-7 years. He never refuses, even if we go at the night. And his treatment helps as well." – A woman resident of Juni Rawalwadi

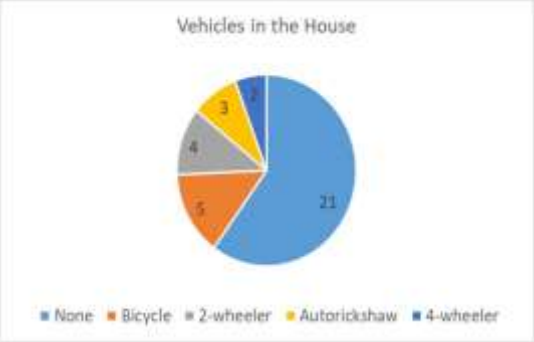
All the three settlements have no structure that can be used for shade and cooling in case of extreme heat. Tree cover is also negligible. For the residents, **there is not a single alternative for shelter within their settlements when their own houses fail to protect them from heat stress.** Medical help is also not easily accessible for some of them.

b. Economic vulnerability

The economic vulnerability of the residents has been analyzed by looking at their socioeconomic conditions and the financial impact they face due to heat stress.

Socioeconomic condition

Most of the households surveyed depend on breadwinners having informal livelihoods. The **average monthly income of the family of all respondents at all the three sites is Rs 7,883 only**. Almost all the households surveyed have no formal ownership of their houses. Majority reported having no savings and owning no vehicles.



"We mostly do labour work, on a daily basis. Sometimes we earn INR 200, sometimes INR 300, somethings we don't get anything. We just go there, sit and come back home…. People come there with jobs, they negotiate with us for work – Will you pick up this load in INR 100? We say fine we will do it. If they don't come, we just sit there the whole day and come back in the evening." – A male resident of Juni Rawalwadi who does daily-wage work

The most predominant occupations of the men at Juni Rawalwadi include daily-wage work and street vending. Some also do home-based work of electronic waste recycling. Some women in Juni Rawalwadi do domestic work in the nearby areas. On the other hand, street vending is the common caste and tradition-based livelihood source in Sathwarawas in which both men and women are engaged. They give utensils in exchange of old clothes. Later they sell these clothes in the flea market. Traditionally they used to extract gold/silver threads from clothes, but these days such clothes are not in use anymore.

"We have been living here since the days of kings. We used to do this work only. Earlier during the days of kings, we used to get clothes embroidered with zari (fine gold or silver thread) from which we used to extract zari threads…. These days we get some other kind of clothes. Everything is counterfeit. No idea what it would be like in future." – A woman resident of Sathwarawas, engaged in traditional caste-based occupation of mobile street vending for used clothes.

Unlike these, Khasra is inhabited by migrant workers only who are all employed in the construction sector as daily-wage workers. Most of these are from Madhya Pradesh. Also, women accompany men for work and they get hired together.

"We don't get much work. Today it is the fifth day we didn't get any work. How would we buy food? If we get work for two days then we don't get it for another ten days. If we get work for four days then we get none for fifteen days." – A woman resident of Khasra

Most of the residents of all the three settlements are engaged in informal work and do not have sufficient resources to effectively mitigate their heat stress. The informality of housing and the informality of work are interlinked, with migration status further marginalizing a person/community. Additionally, mostly the socioeconomic condition of the entire community at a settlement is similar. They all mostly come from same region, religion and caste group and do the same kind of informal work.

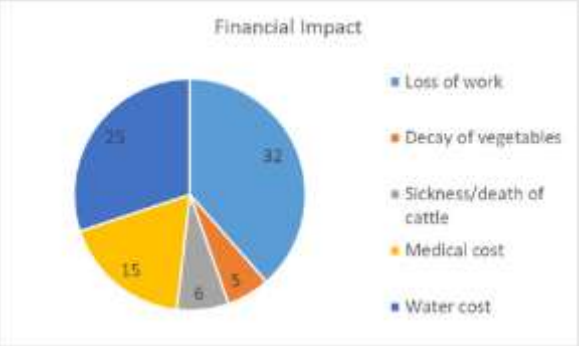
Financial impact of heat stress

"Now today I have sold just two boxes. I have roamed around the entire Bhuj all day but couldn't earn enough." – A male resident of Sathwarawas who does mobile vending of utensils for old clothes

On asking about any financial impact of heat stress, most respondents shared that they lose opportunities to work due to it or earn while working on hot days. Other costs include the increased cost of water during hot

days and increased expenses on medical care. Work-related impacts include decay of vegetables that affects street vendors the most, and sickness or death of cattle that impacts cattle rearers the most.

"If we go to the hospital it would cost a lot. That other day I went because I was sick due to heat. They charged me INR 500. That did not help me at all. They gave me a tablet and gave an injection. It didn't help. Later I had to go to another hospital and get my blood test done." – A male resident of Sathwarawas



The residents mostly see only their work-related challenges and losses in financial terms. However, apart from heat stress impacting their work and income, it also increases the cost of medical care and water that the residents have to bear. **The increase in costs of medical care and basic needs owing to heat stress are still mostly hidden and yet to become explicit to the residents.**

c. Social and organizational vulnerability

"We listen to her only (most men agreed in chorus). Nobody takes leadership here and no work has been done here under the housing scheme. That is why we have supported her. We believe in her and we believe that our work will be done…. We don't trust any political leader. They come only during their election campaigns and forget us later." – A male resident of Sathwarawas speaks about a woman community leader

The women in Juni Rawalwadi and Sathwarawas have self-help groups through which they organize and collectively negotiate for their rights. Although there is a strong caste-identity present among the *Devipujak*s in this neighbourhood, the women's group includes women from other castes as well. Apart from this, there are ward committees of residents formed at each location to participate in local governance. There are women as well in these committees but the committees are yet to become active and effective. As of now, most residents at all the three locations reported not having much access to government schemes and social security.

"We did not even get the relief we deserved, not even after the earthquake." – A woman resident of Sathwarawas

The communities in Juni Rawalwadi and Sathwarawas are better organized than the community in Khasra. However, **their collective capacity to avail better resources for their communities are negligent.** Mobilizing these communities for building heat resilience also requires setting some achievable tangible goals.

d. Informational and attitudinal vulnerability

"When we fall sick due to heat, we go to see a doctor. He puts cold water stripes on the forehead…. When children fall ill, the doctor keeps them in a cold box." – A woman resident of Sathwarawas

We asked the respondents when they think that they should visit a doctor or hospital on facing discomfort from heat. Most said that they should visit a doctor when they feel sick or when their blood pressure becomes abnormal. However, **none of the respondents reported getting any advance warning of heat or hot days so that they could take precautions in advance. Additionally, the residents at the three sites also do not think much can be done to reduce heat stress.**

"What can we do if there is heat? We cannot sit at home. We have to go out for work. All of us." – A woman resident of Juni Rawalwadi

Women dress in traditional Indian dresses made of synthetic cloths. Cotton is too expensive for them to afford. They also follow the cultural practice of covering their heads and faces when an elderly person of their community is around. There is no readiness among the women to challenge and change this practice despite the discomfort they face during hot days. The rigid gender-based social and cultural norms in their caste and native communities also play a huge role in limiting women's ability to cope with heat stress.

"This is how our dressing is. If we do not dress like this, people will mock us. They will say that city-people have come." – A woman resident of Khasra

"When our father-in-law is in the house this is how we should be (about covering the head)…. What if we feel hot? We have to dress like we should. We must cover our head like this when our father-in-law or elder brother-in-law are in the house." – A woman resident of Juni Rawalwadi

Lack of sufficient information and advance warning is a bigger challenge than a lack of the needed attitude and willingness to act on heat stress mitigation. Social norms, taboos and cultural practices also pose a challenge to some extent and need addressing.

3.2 Coping mechanisms at housing sites

There are two kinds of coping mechanisms mentioned by the respondents – a) those involving changes in the housing conditions, and b) all other coping mechanisms except altering housing conditions.

Altering housing conditions

"When it gets very hot, we put tarpaulin sheet, some people put cloths, some use dry leaves of palm tree. It cools down the house little bit. We don't feel as much heat." – A woman resident of Sathwarawas

Mostly the respondents from Sathwarawas spoke of covering rooftop with additional layers of plastic, cardboard or leaves to reduce heat. A few mentioned sprinkling water on the rooftop and in the courtyard, and hanging wet curtains on windows. Only one person at Juni Rawalwadi mentioned painting the rooftop white to reduce heat stress inside house.

The most common coping mechanism the residents at all the three locations use involves layering of the roof to add insulation and reduce the amount of heat inside the house. The material used for layering, however, need not always be as effective at cooling down the house.

Other coping mechanisms

"We use cold wet stripes to cool down the bodies of our children if fall ill due to heat. The doctors also suggest us to do that first before giving injection."

- A woman at Juni Rawalwadi

The most used coping mechanism across all sites is to step outside and sit under a shade or tree when there is excessive heat inside house. Another common coping mechanism is to drink water, buttermilk, lemonade, or cold drink. Other coping mechanisms reported include taking shower or using wet cloths to cool down head, storing more water during hot days, not going to work, and changing diet to lesser and simpler food to adapt to the environment or cut cost.

"We bathe our children 2-3 times during hot days. We ask our children to play in shade. We try to keep them in shade. But they are children. They sometimes listen and sometimes don't" – A woman resident of Juni Rawalwadi

Most of the first aid steps done to reduce heat related illness are already being used by the residents at the three settlements.

3.3 Risk perception at housing sites

"The heat has increased a lot in last five years. Earlier it used to be cooler, these days we cannot even sit in our houses." – A resident of Juni Rawalwadi

Most respondents at housing sites agree that reducing heat stress is a priority for them but do not have much savings to spend on it. The only ones not finding heat stress as a priority are those residing at Khasra where obviously other pressing needs including electricity are priority at the time being.

"We want fan, only fan. Nothing else." – A woman resident of Khasra

The residents at the three settlements understand that they face high risk from heat stress. However, in presence of other pressing needs in their lives, the action on heat stress mitigation becomes a low priority that can wait.

Summarizing housing-based vulnerability assessment

The informality of housing is a major aspect of the lives of informal workers. All the three sites are at different stages of informal housing. Sathwarawas is the oldest settlement among the three, which is why we see very less space left for any new construction. Most houses in this settlement have pucca walls. The residents complain of poor ventilation because the houses are built very close to each other. Any change in the built of their houses will cost them money which they do not have at present to spare. While their informally and incrementally built houses have taken the form of pucca or semi-pucca houses, their livelihoods are still informal and have not improved their socioeconomic conditions much.

On the other hand, Juni Rawalwadi is a relatively new settlement. Here we see more space between houses. While there are pucca houses existing here as well, we also see kutcha houses here and there, suggesting very recent inhabitation of those spaces. Khasra is an entirely new settlement where the local government moved the residents to clear the previous settlement they were inhabiting. Thus here we see most kutcha forms of houses, the ones that urban poor construct at the beginning of making a city their home. Also the residents here are most recent migrants and are thus also the most socioeconomically marginalized. The proposed action plan for housing has been designed keeping in consideration these differences and current situations in the three settlements.

In addition, the vulnerability assessment helped understand some other specific requirements and limitations of the residents of the three settlements. Water in Juni Rawalwadi and electricity in Khasra are the most pressing issues. Another major lacuna is the lack of any advance warning of hot days to any of the residents of the three settlements. There is no mechanism in place for the residents to get any advance warning. Heat stress has not been seriously considered for preventive action by anyone so far. The work on heat stress mitigation thus needs to start with awareness building and mobilization of the residents of the three settlements towards preparedness and adaptation.

Moreover, all the three settlements have common livelihood categories in which the residents are engaged that also share a common caste identity. The men in Juni Rawalwadi are mostly engaged in daily-wage work, while both men and women at Sathwarawas do their caste-based mobile street vending for old clothes and those at Khasra do construction work. The vulnerability assessment for each of these work categories is presented in the next section. The action plan and the recommendations proposed for work-based vulnerability would be helpful for the residents of the three settlements as well.

Most of the coping mechanisms shared by the residents at the three settlements are used without much facilitation or push from any external agency or ally. This indicates a high capacity and willingness of the residents to mitigate their heat stress by taking actions within their limitations. Thus, some additional coping mechanisms and alternatives, as suggested in the action plan, can also be sustainably adopted by the community members if factors such as cost, ease of use, and material availability are taken care of.

4 RISK ASSESSMENT – PEOPLE IN WORKPLACES

The work-based assessment of heat stress in Bhuj is done for four categories of informal workers – daily-wage workers, street vendors, cattle rearers, and waste pickers. The same framework of assessment has been used as the one used for housing-based assessment in the previous chapter. It includes vulnerability assessment, capability assessment, and people's risk perception assessment. However, instead of assessing the conditions and environment at the place of residence, the places of work for the informal workers have been studied.

4.1 Vulnerability assessment

The vulnerability assessment is done using the same framework used in the previous chapter – Physical vulnerability, economic vulnerability, social and organizational vulnerability, and informational and attitudinal vulnerability.

a. Physical vulnerability

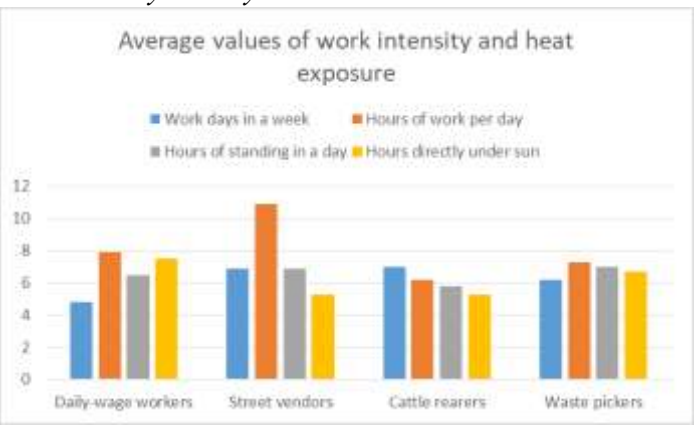
The place of work varies drastically across the four workers categories selected for the study. Thus, the physical vulnerability for each category of workers has been analyzed separately.

Daily-wage workers

"Our clothes get completely drenched in sweat… We get sick from heat often. We also get headaches from heat."

Most daily-wage workers in Bhuj are migrants. The ones we met were from Madhya Pradesh and Rajasthan and lived slums at Khasra and RTO. Daily-wage workers look for work on a daily basis which is sometimes not available. The employers are also different every time. The daily-wage workers work for about 5 days per week for about 8 hours a day. Out of this, they need to stand for 6.5 hours a day and spend almost the entire time directly under sun doing heavy intensity work. Sometimes if they are short of money, they walk for about an hour to reach the market for work instead of taking a shared ride**. Majority of the daily-wage workers can rest for at least 5 minutes every hour and drink at least one glass of water every half an hour. However, majority of the daily-wage workers also reported not having enough drinking water available at their workplace.**

"If we have gone to an outskirt location for work, we sometimes don't get good water. We have to drink that water no matter how dirty or salty it is."



Additionally, they do not always get shade/shelter to rest under at their workplaces. All the daily-wage workers felt that the heat was increasing every year. Majority of them reported sweating often during hot days. Among the most common heat-related health issues they face are fainting, skin-related issues, fatigue, and weakness.

"Our lunch also goes bad because of heat. We carry food with us to work. They don't

give it at work. When we cook it in the morning it is hot and we have to pack it hot. Later due to heat it goes bad."

Daily-wage workers have no control over their work environment or the nature of work, which is fully dependent on the employers hiring them. Also, the employers keep changing frequently or on a daily basis. **Additionally, daily-wage workers do high-intensity work and have high exposure to sun during work. Along with this, their limited access to water at work, and the most reported heat-related issue being fainting, clearly indicate that daily-wage workers experience high heat stress. Moreover, despite frequent fainting, the lowest rate of hospitalization of daily-wage workers across all categories suggests poor access to medical care while at work.**

Street vendors

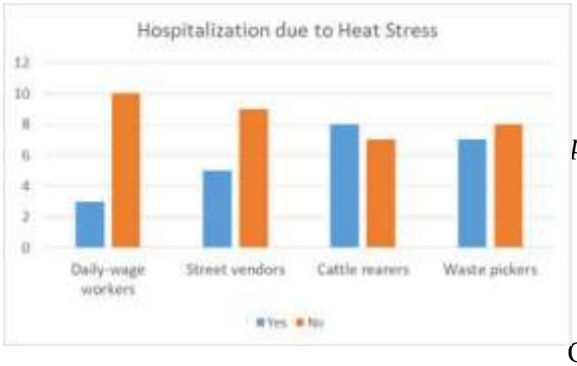
"We have to keep standing all the time. Once we open for business, we cannot sit at all." – A street vendor who sells fast food

Street vendors work almost 7 days a week for about 11 hours a day doing moderate intensity work. They have to stand for about 7 hours every day and spend an average of 5.3 hours directly under sun. Most street vendors have no fixed time to rest during work hours but can drink at least one glass of water every half an hour. However, all of them mentioned having difficulty in accessing drinking water at work sites. Also, only a few get some shade/shelter at their work sites. Mostly there are no trees around. Most street vendors feel that the heat is increasing every year. All street vendors complained of discomfort from heat and sweating during hot days. Their common health issues caused by heat are fatigue and skin- related issues.

"Umbrella can help only so much. It works only till 4 pm. After that the sunlight gets slanted and comes. Also it tears easily if there is strong wind…. Often there is no space to put up any tarpaulin for shading. Even the lorry barely fits into the available space." – A street vendor

While the work environment of street vendors is somewhat in control, there are **<u>environmental factors beyond their control</u>** **such as sunlight, tree cover, water availability, and physical exertion based on customer walk-ins. Also, although street vendors do moderate intensity work, among all work categories, they work the longest, for 11 hours a day on an average on all days a week.**

Cattle rearers



"The man who looks after cattle cannot take leave often. The cattle are happiest only with him. If he keeps taking leave then things get difficult. The cattle recognize other people in the family and manage somehow but the quantity of milk reduces. They are happiest only with the man who handles them regularly and takes them for walk. Only he knows where the cattle like to go. So he cannot take many leaves." – A cattle rearer

Cattle rearers do heavy intensity work 7 days a week for about 6 hours a day that is entirely spent standing or walking mostly under the sun directly. These traditional cattle rearers walk 10-12 kilometres every day to the outskirts of Bhuj to walk their cattle. The rearers can manage some rest during their work and regularly drink water that they carry. However, majority of them reported getting no drinking water at all on their work routes. Majority of the cattle rearers also shared that they do not have any shade/shelter along their work routes for resting.

"We have to work when it is extreme hot or cold or rains…. We face a lot of difficulty. We have to walk all

day. We cannot sleep before 11 pm. You ask any cattle rearer, he cannot get free before 11 pm. After that only he will eat food and sleep. Then he has to wake up at 5 am and start working again."- Another cattle rearer

Most cattle rearers feel that the heat was increasing every year. Majority of them reported undergoing sweating and discomfort on most days when it is hot. Their most common health issues due to excessive heat include fainting, nausea, muscle cramps, and fatigue. A high number among these respondents, as compared to other types of workers surveyed, also reported undergoing hospitalization due to heat stress. However, reaching hospital in time during work is a bigger challenge for cattle rearers as compared to other types of workers.

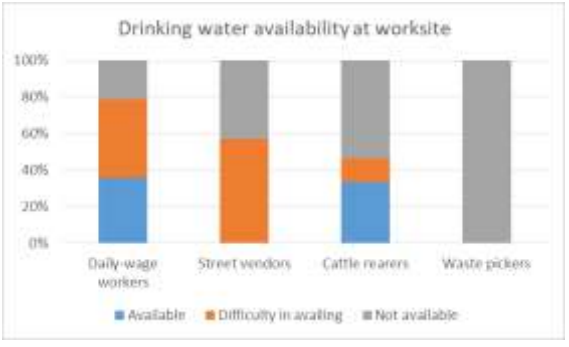
"We sweat a lot…. We cannot carry an umbrella. Sometimes we have to walk through very low thorny trees." – Another cattle rearer

The cattle rearers have to walk a lot in sunlight to graze their cattle and have to continue taking care of the cattle on return, without any day off. **The heavy intensity work they do that involves high exposure to sunlight results in them experiencing frequent fainting and being the most hospitalized workers across all the categories. Their situation is worsened by poor access to drinking water, shade and hospitals while out with cattle.**

Waste pickers

"We leave from home at 8-10 am after breakfast and roam in sunlight all day. By the time we come back in the evening by 4-5 pm, our bag weighs around 30-40 kg. We have to carry it till the highway from where we can ask a truck driver to give us ride. He will charge us INR 50-100 and drop us close to home. From that point we have to carry it again to home, sometimes on our head. Then we clean and sort it, and then sell it. We can earn up to INR 200-300. Then we buy ration for INR 100-150 to cook and eat. We do not eat anything else all day." – A woman waste picker

Waste pickers do heavy intensity work for about 6 days a week for 7.3 hours a day, standing or walking directly under the sun almost the entire time. They mostly don't get any shade or shelter while out for work. They are neither able to rest much during work hours nor do they get any drinking water where they work. Their ability to drink water while at work is poorest among all types of workers. Most waste pickers feel that the heat is increasing every year. Majority reported sweating on most days and feeling discomfort when it is hot. Almost all waste pickers mentioned experiencing fainting due to heat. This is the highest among all other workers categories. A majority also complained of nausea. Other common complaints include heavy sweating, weakness, and muscle cramps. While a large number of waste pickers have undergone hospitalization due to heat stress, hospitals are not easy to reach for all of them.



"Sometimes we don't get water at all. The society people don't even give us water when we ask for it. The rich people say go away from here…. If we take water in a bottle it gets warm quickly. There is no water tap close to where we have to work. We have to sometimes drink the water in potholes as well." – A female waste picker

Waste pickers work is of heavy intensity and low rewards in return. They undergo fainting the most and have high rate of hospitalization due to heat stress. With absolutely no water available while out

for work, the waste pickers' access to drinking water is worst across all workers categories. The social stigma associated with their work also limits the help they are offered by the people living in places they go for work.

b. Economic vulnerability

Income

"We do not have that much money to manage everything. If we spend everything for the cattle, what would our children eat? So that is why we survive by cutting down the share of each other, taking from the share of each other." – A cattle rearer talking about being unable to provide all the facilities to his cattle

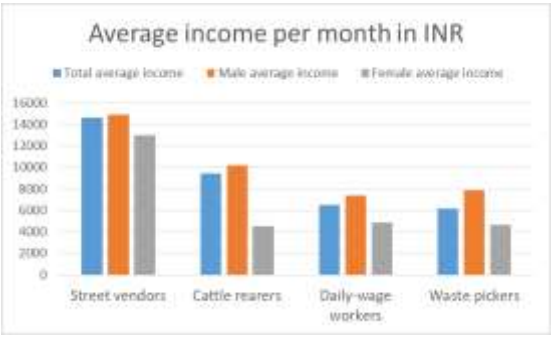
The average income of all respondents across work category is about INR 9,000 per month. Among the types of workers surveyed, lowest earning ones are waste pickers earning INR 6,167 and daily-wage workers earning INR 6,534 on an average a month. Also, female income is significantly lower than male income across the work category. Additionally, the female daily-wage workers shared that they do not get work if they are not accompanied by male workers. The trend is of hiring daily-wage workers as couples, together paid INR 800 for a day's labour. Safety is also a concern limiting opportunities for women workers.

"*We can go to work when there is our husband, otherwise no. How would we go alone? If we have someone we can trust then they take us. Otherwise we cannot go."* – A female daily-wage worker

Most economically vulnerable are waste pickers and daily-wage workers earning the least among all categories. Women across work categories are also economically more vulnerable as they earn considerably less than men.

Socioeconomic condition

"We are not able to save much. There isn't any money left to send back home. If we work for four days and then do not get work for next two days then all our saving gets spent." – A daily-wage worker



Majority of the respondents live in informal houses while some have formal ownership of their houses most of whom are street vendors. Additionally, majority reported having no financial savings for use in case of emergency, exception being street vendors. About half of the respondents do not have any vehicle in their house; mostly these include daily-wage workers and waste pickers. On the other hand, most street vendors and cattle rearers own at least one 2-wheeler/ 3-wheeler/ 4-wheeler vehicle.

"Nobody has the kind of resources to make all arrangements for cattle at home. We cannot arrange for water for ourselves, how would we manage it for cattle? That is why we have to go to the jungle…. Bigger people buy fodder and it is delivered by truck. We poor people have to go to the jungle ourselves and collect it." – A female cattle rearer

The socioeconomic condition of all workers across categories is poor but the ones in worst condition are daily-wage workers and waste pickers. As mentioned earlier, informality of housing complements the informality of livelihood.

Financial impact of heat stress

"For the last 15 days this guy was unwell. It troubled all of us. We all could not earn as much…. It was due to heat only. There is a lot of heat." – A waste picker talks about her scrap dealer. The scrap dealer fell ill because of working in a tin-shed shop all day.

Most respondents across the workers' categories shared that their speed of work gets slow during hot days and they face direct or indirect loss of income due to heat. Daily-wage workers shared losing their work-days as a result of heat.

"Due to heat, the food goes bad sooner. We have to keep checking before giving it to customer. If it normally lasts for 12-14 hours, it can go bad in 10 hours because of heat. Because of this, if we have to cook in the afternoon only for selling in the evening."- A street vendor selling fast food

For street vendors, the loss was due to fewer customers during hot days, decay of fruits, vegetables and other perishable items, higher cost of resources such as water and electricity, and higher medical cost for healthcare during hot days. The street vendors selling non-veg food items face more loss than others because they get fewer customers during hot season and the meat goes bad easily. Also, the cooked meat cannot be used for any other purpose. There is no cold storage available to street vendors. In addition, the vendors selling refreshments also lose customers during hot days if they do not have any shaded area available for them to sit and relax.

"When there is much heat, the milk produced reduces, evening and morning both times. Because she cannot sit much, she cannot eat fodder much, which is why the milk produced is less." – A cattle rearer

Majority of cattle rearers complained of financial impact because of more instances of sickness or death of cattle during hot days. Some also complained of higher cost of medical care needed due to heat. During hot days, veterinary doctor needs to be called every 3-4 days, each visit costing INR 300-1000 as per the treatment needed. Loss also happens due to milk getting spoilt from heat and even the quantity of milk produced reduces to a considerable extent in the cattle. When it doesn't rain and green grass becomes rare, its cost also goes up. Daily-wage workers and waste pickers complained of having to spend more money due to higher cost of medical care.

"If we visit hospital once it costs us INR 800-1200 at least. They put saline and injection. And then also it doesn't help much. INR 300 is only for registration. These people take more money from us." – A daily-wage worker

The nature of financial impact from heat stress varies across all the worker categories. Waste pickers and daily-wage workers that mainly depend on their own labour for livelihood are most affected when they fall ill due to heat stress and are unable to work. Street vendors selling perishable items are mostly affected because of their stock going bad from severe heat. Cattle rearers face financial impact when their cattle fall ill or die due to heat. In addition, **the cost of medication for the treatment of heat-related illness is a common concern for all workers across categories.**

c. Social and organizational vulnerability

"There is no street vendor around whom there isn't any street vendor for help." – A street vendor

While street vendors always have help at work sites if they fall ill, majority of the daily-wage workers have help only sometimes if they fall sick at work. The worst situation is of cattle rearers and waste pickers who mentioned not having any help while out for work.

The daily-wage workers shared that they have no existing organized front or any other ally or leader through whom they can negotiate for better work conditions. Recently the workers have started the process of forming a union with the help of HIC network. Most of them being migrants, they also shared that they get hostile behavior from local people, authorities, and police.

"The employer contacts us only for limited work. After 5 pm, he doesn't even recognize us… Some of them even steal our money. They tell us that finish this work and we are coming in half an hour and they never come. We have to accept whatever it is…. Nobody here listens to us outside (migrant) people." – A daily-wage worker

The street vendors are better organized. The vegetable vendors remain in touch with each other and with fast food vendors and coordinate to make sure that their remaining stock gets used and doesn't go waste. In addition, a street vendors union has also been formulated recently. They are in dialogue with the local government and civil society organizations to plan and design model markets where there is more shade, tree cover, and water availability.

"For example if he has 10 kg cauliflower and if he thinks he can sell only 8 kg and the remaining 2 kg will be left, then he would contact someone selling Chinese food who can buy all of it at the cost price." – An organizer of street vendors

The cattle rearers also have an organized group in place. But they find it difficult to access their rights. They shared that the tree cover in the areas where their cattle grazes is getting cut down, which leaves their cattle further vulnerable to heat. Sending legal notices for access to their traditional grazing land has also been ineffective. Even the lakes on which the cattle depend on for water are now getting difficult to access. The cattle rearers have no say in securing the grazing fields and lakes for their cattle.

"The land is becoming lesser now. The land that used to be available to us during our fathers' time when we were young, now that land is not there anymore. Only half of it has remained." – A daily-wage worker

All the waste pickers are from the caste community of *Bansfor/Bansphor* that were traditionally engaged in making Bamboo artefacts. They had a collective through which they used to sell their artefacts at fair price. However, this traditional work ended when Bhuj had an earthquake in 2001. The government did not support their traditional art form after that. With modernization, people have also started preferring modern goods over traditional bamboo artefacts. As a result, these traditionally skilled workers have now been rendered unskilled, having to surviving through waste picking.

"People say that wooden goods won't work now, plastic would work. Plastic comes at lower cost and lasts longer. These days nobody wants to buy bamboo artefacts. They all use plastic." – A woman waste picker

In addition, *Bansfors* face the stigma of untouchability and caste-based exclusion in Hindu society. They find very little social support. Local residents of the areas they visit eye them suspiciously and do not want them in their colonies.

"When we go to any society to collect trash, they say why you come here to collect trash? All you people steal things and leave. This is how they talk." – A woman waste picker

The waste pickers we spoke to do not have any organized front at present though they are trying to make one. However, they all go to some or the other scrap dealer at least once a day to borrow money for buying scrap and to sell their collected trash. In times of financial crisis, it is their scrap dealer they depend on for loaning money. The scrap dealers act as support to waste pickers in times of crisis as well as in day-to-day work.

"The waste pickers can collectively run a plastic recycling centre… The workers will get work, they will get better rate. This income will go to the workers group. They can recycle the same waste that they collect… They can give some space at the dump site as well. Currently all the trash collected by the municipal corporation is taken there and they burn it all. It causes pollution. If they recycle, it will be better for the environment." – A scrap dealer

The kind of social and organizational vulnerabilities also varies across workers categories. The nature of work for cattle rearers and waste pickers is such that they need to venture out alone instead of being able to work in groups. As a result, **they find it tough to get help when they fall ill during work.** On the other hand, it is **migrant daily-wage workers that have least collective capacity and organizing to help each other in times of crisis.** Cattle rearers are facing vulnerability as their traditional common grazing lands are being captured for development purpose and water resources are getting polluted while they are barely able to oppose this trend. Waste pickers face social stigma of caste and untouchability.

d. Informational and attitudinal vulnerability

When asked whether they should go to a doctor or to a hospital on illness due to heat stress, while majority said that they should go, a high number of workers also said that there is no need to go to a doctor to deal with heat-related issues.

"It is important to sweat. If a person doesn't sweat, he will fall sick. And it is not always good for sweat to dry. Wherever the sweat dries it starts itching and we get fungus. How frequently can we wipe it? Fungus is very common here. If we go to the doctor, he will tell us that you got an allergy. He will prescribe an expensive medicine." – A street vendor

Only one cattle rearer mentioned having any advance warning of hot days. All the remaining workers across categories reported not getting any advance warning of hot days. The waste pickers also shared that they have low literacy rates, which is why they do not understand the messages they get on phones.

"Those who have more money can get something done. Otherwise poor people like us cannot do anything." – A cattle rearer

Cattle rearers believe that they do not have much control over the situation and cannot do much to protect themselves and their cattle from heat. Daily-wage workers also believe that there is not much they can do to improve their work conditions and reduce heat stress during work.

"*Nobody can say anything. We don't recognize half of the people that come to hire us. If we tell them to do anything, they will tell us to quit."* – A daily-wage worker

Some workers across categories are not willing to visit a doctor when they face heat related illness while some others do not believe that they can do anything about the heat stress they experience. **In addition to their attitudinal vulnerability, there is a lot of dearth of timely information and advance warning to the workers when hot days are expected.**

4.2 Coping mechanisms at work sites

"When it gets extremely hot we sometimes rest under some tree. Sometimes we also spread our scarf and go to sleep there." – A woman waste picker

The common coping mechanisms for fighting heat stress mentioned by the informal workers surveyed include taking rest from work and sitting in a shaded area, drinking more water/cold drink/lemonade, washing face or bathing, and having medicine. Additionally, some cattle rearers and waste pickers mentioned changing

their work schedule during hot days, street vendors mentioned keeping less perishable stock and using more cooling and shading, and daily-wage workers mentioned storing more water and changing food items in diet or reduce it. Using a scarf to cover the head is also common among workers spending long hours in sunlight. The waste pickers also mentioned drinking *Neem* juice for reducing fever.

"We carry the 2 litre plastic bottle for drinking water with us otherwise we do not get any clean water while out with the cattle. But that bottle becomes very hot due to heat. So we cover it with a cloth and keep putting some water on it every half an hour to keep it cool. If the cloth goes dry, the water becomes hot." – A cattle rearer

The workers across categories use some basic coping mechanisms to reduce their heat-related discomfort during work. Rest breaks, hydration, and changing work schedule are the most used coping mechanisms for reducing physiological impact of heat.

Coping with financial losses

Some daily-wage workers said that they eat and spend less to save money during the days of less work and income, use their savings, or loan money from external sources. A few street vendors said that they can reduce their financial loss by buying more heat-resistant vegetables during hot days and using more cooling. Cattle rearers also mentioned using more cooling to prevent milk from going bad. A street vendor also mentioned that customers come only once it cools down by evening which is why it makes sense to change work schedule during hot days.

"Street vendors buy only so much goods (perishable) that it gets entirely sold by evening. Second, they stay in contact of one another and buy each other's remaining stock. Some others who sell cooked food make less quantity on the days they expect fewer customers or keep their stalls open for longer hours to sell the remaining stock." – An organizer of street vendors

Cattle rearers and waste pickers also mentioned changing work schedule or going out less during hot hours. A cattle rearer also talked of building shade for his cattle.

"If we have money to build shade for our cattle and a way to arrange for their water, we can keep them under the shades during peak hot hours and they would not fall sick so much. But right now we have no such arrangement and no water connection where we keep cattle, which is why we have to take the cattle to lake so that they can drink water…. And the lake is contaminated with gutter water but the cattle has to drink that only." - A cattle rearer

Street vendors make changes in their stock and use more cooling to reduce the losses due to heat. Cattle rearers try to provide more shade to their cattle so that they fall sick less and use more cooling for milk. Waste pickers and cattle rearers can also change their work schedule to avoid heat while street vendors have to change the schedule to suit the requirement of their customers.

4.3 Risk perception at work sites

"Heat is natural. Heat is not like electricity that it will come and go. It is there to stay. And when there is summer season, it is anyways going to be hot. We cannot do anything about it." – A street vendor

The risk perception of heat stress varied across workers' categories. Most daily-wage workers think that reducing heat stress is not a priority for them but is important. Similarly, majority of the street vendors believe that it is important but not a priority. On the other hand, majority of the cattle rearers and waste pickers think that it is a priority for them to reduce their heat stress.

"We have to go to work (during hot days) otherwise how would we earn and eat? If we don't work, who will give us money?" – A daily-wage worker

Waste pickers and cattle rearers that face most heat stress across the workers categories are the ones that put high priority to working on heat stress mitigating measures.

Summarizing the work-based assessment

The assessment helps understand the variation in the kind of vulnerability and heat stress impact faced by the different workers categories owing to the nature and site of their work. Daily-wage workers that are highly dependent on their employers for their work environment and do not find much flexibility in changing their work schedule as per their needs are among the most vulnerable ones. They are mostly migrants and are also among the least paid and least organized ones. Since they have only their labour to sell, heat stress affects them mainly by affecting their ability to work and earn money. As a result, they are the only ones having to eat less or borrow money when they are financially impacted by heat stress. However, attempts for heat stress mitigation at their work sites would be most challenging mainly because of their employers changing every other day.

Other most vulnerable category is of waste pickers that also are among the least earning workers group. Their challenges are somewhat similar to cattle rearers who also venture out to faraway places for the requirement of their work. Both waste pickers and cattle rearers face high physiological impact of heat stress and do not get much help when they are away for work because they don't have much company around. Both these kind of workers can change their work schedule in times of severe or extreme heat. However, cattle rearers face additional challenge because of their cattle facing heat-related illness during hot days. This exposes them to considerable financial impact. Comparatively, street vendors are financially better off than other workers and are also better organized.

In case of waste pickers, their caste identity plays a major role in their engagement in waste picking and lack of access to development. Their identity also subjects them to social hostility and exclusion. Their labour put in recycling waste and reducing the ecological footprint of their city gets no recognition or appreciation. The cattle rearers are also doing rearing owing to the traditional livelihood practice of their communities. These rearers are still following the traditional methods of walking their cattle for grazing and water, which is better for animal health than modern practices of mass production of milk and meat using artificial means that don't allow the cattle enough physical activity. However, the traditional and nature-based practices of these traditional cattle rearers also find no recognition and appreciation by the society. The cattle rearers are instead facing increasing challenges to secure their common grazing lands against acquisition for development and protecting common water resources from pollution.

PART II

HEAT ACTION PLAN

5 HEAT STRESS AND RESPONSE

5.1 Heat stress

Heat stress is the net heat load that a person is exposed. Heat stress occurs when the human body cannot get rid of excess heat. When the ambient temperature rises the body cools by sweating. If relative humidity is high, the evaporation rate reduces, resulting in lower heat removal from the body, the body's core temperature rises, and the heart rate increases.

Heat stress can occur when a person is at work or at rest. Factors that contribute to heat stress are elevated temperatures, high humidity, direct exposure to sun, indoor radiant heat sources, limited air environment, insufficient fluid intake, personal protective equipment and clothing that trap heat, physical contact with hot objects, strenuous physical activities, physical condition and health status, medication, pregnancy, advanced age, previous heat related illness.

5.2 Heat strain

Heat strain is the body's physiological response to heat stress, e.g., sweating. The body's temperature and heart rate rise. The person may lose concentration and may become irritable or sick. If the person is not cooled down, he may faint and even die.

5.3 Heat index

The Heat Index (HI) is a measure of how hot its humans perceive it feels when relative humidity is factored with the actual air temperature. Heat index is also referred to as the apparent temperature. Higher concentrations of relative humidity make the same temperature feel hotter and more unbearable, e.g., at 35oC and a relative humidity of 30%, the apparent temperature feels like 36oC, but if the relative humidity doubled to 60%, the apparent temperature feels like 46oC.

There are several ways to compute the heat index. One way to compute the heat index is by using the **formula**:

$$HI = c_1 + c^2T + c_3R + c_4TR + c_5T^2 + c_6R^2 + c_7T^2R + c_8TR^2 + c_9T^2R^2$$

where, HI = heat index (in degrees Celsius), T = ambient dry-bulb temperature (in degrees Celsius) R = relative humidity (percentage value between 0 and 100), and constants c_1 = -8.78469475556,c_2 = 1.61139411, c_3 = 2.33854883889, c_4 = -0.14611605, c_5 = -0.012308094, c_6 = -0.0164248277778, c_7 = 0.002211732, c_8 = 0.00072546, c_9 = -0.000003582.

There are several calculators available on the internet to compute HI by inputting temperature and relative humidity values, e.g. The NOAA calculator may be used for such computations at: https://www.wpc.ncep.noaa.gov/html/heatindex.shtml.

The chart below can also be used to obtain the HI if air temperature and relative humidity values. A heat index of less than 33ºC poses a minimal risk, 33-39ºC a moderate risk, 39-46ºC a high risk, and above 46ºC a very high risk.

Heat index

Relative humidity (%)	**Air temperature** (°C)											
	21	24	26	29	32	35	38	41	43	46	49	52
	Apparent temperature* (°C)											
0	18	21	23	26	28	31	33	35	37	39	42	42
10	18	21	24	27	29	32	35	38	41	44	47	50
20	19	22	25	28	31	34	37	41	44	49	55	61
30	19	23	26	29	32	36	40	46	51	57	65	74
40	20	23	26	30	34	39	43	51	58	66	77	
50	21	24	27	31	36	42	49	57	66	78		
60	21	24	28	32	38	46	56	65	76			
70	21	25	29	34	41	51	62	77				
80	22	26	30	36	45	58	69	89				
90	22	26	31	39	50	66	77					
100	22	27	33	42	56	74						

Heat index (°C)	**Risk level**
<33	Low
33-39	Moderate
39-46	High
>46	Extremely high to extreme

* Note: Above chart based on NOAA's chart and computations made from NOAA's website. Apparent temperatures rounded off to nearest integer

5.4 Heat related illness and response

Elevated core body temperatures may cause the following illnesses:

Heat Rash

Heat rash is skin irritation caused by excessive sweating. Excessive moisture and sweat obstructs sweatducts and forms itchy and painful red pimple/blister clusters and skin lesions. It is worsened in hot and humid weather.

Symptoms: Skin irritation and or pimples/clusters of red bumps on the neck, chest, groin, armpits, elbow creases, and behind the knees.

Actions: 1) Remove the person to a shady and cooler area (shady areas include trees, buildings, canopies,or other partial and/or temporary structures that are either ventilated or open to air movement. Interior of cars or trucks are not considered shade unless the vehicles are air conditioned or kept from heating up in the sun in some other way); 2) Keep the affected area dry; 3) Powder may be applied to affected areas of the skin, but do not apply creams

Heat Syncope

Heat syncope (fainting) or dizziness usually occurs after prolonged standing or sudden rising from a sittingor supine position. Dehydration and inadequate acclimatization often contribute to heat syncope.

Symptoms: Heat syncope symptoms include light-headedness, dizziness, and fainting.

Actions: 1) Remove the person to a cooler area; 2) Person should drink water or other cool beverages.

Heat Cramps

Heat cramps usually affect workers who sweat a lot during strenuous activity. Heat cramps are caused by the body's depleted salt and water levels from excessive sweating resulting in muscle cramps or spasms. Low salt levels in muscles causes painful cramps. They usually occur in the muscles used during work. Heat cramps may also be a symptom of heat exhaustion.

Symptoms: Cramps, pain or spasms in voluntary muscles mainly in the arms, legs, abdomen or torso.

Actions: 1) Have person rest in shady, cool area; 2) Person should drink water or other cool beverages; 3) Wait a few hours before allowing person to return to work; 4) Avoid salt tablets; 5) Seek medical help if the person has heart problems, is on a low sodium diet, or if cramps do not subside within 1 hour.

Rhabdomyolysis

Rhabdomyolysis is a medical condition associated with heat stress and prolonged physical exertion, resulting in the rapid breakdown, rupture, and death of muscle. When muscle tissue dies, electrolytes and large proteins are released into the bloodstream that can cause irregular heart rhythms and seizures and damage the kidneys. Left untreated, this can lead to kidney damage, seizures, irregular heart rhythms, anddeath.

Symptoms: Muscle cramps/pain, dark (tea or cola colored) urine, weakness; exercise intolerance, jointpains and stiffness.

Actions: 1) Have person stop activity; 2) Remove person to cooler area; 3) Provide oral hydration (water preferred); **4) Seek immediate care at the nearest medical facility;** 5) Ask to be checked for rhabdomyolysis (i.e., blood sample analyzed for creatine kinase).

Heat Exhaustion

Heat exhaustion is the body's response to an excessive loss of the water and salt, usually through excessive sweating. Persons most prone to heat exhaustion are the elderly, and those with high blood pressure, and those working in a hot environment. Heat exhaustion is often a precursor to heat stroke. It is often accompanied by elevated core body temperatures around 38°C–39°C.

Symptoms: Headache, nausea or vomiting, dizziness, light headedness, weakness, fatigue, thirst, heavy sweating, cool and moist skin, irritability, fast heartbeat, elevated temperature, and decreased urine output.

Actions: 1) Have person sit or lie down in a cool, shady area; 2) Remove unnecessary clothing; 3) Give person plenty of water or other cool beverages to drink, give frequent sips of water; 4) Cool person with cold compresses/ice packs, wash head, face and neck with water; 5) The person should not be left unattended until help arrives; **6) If signs or symptoms worsen or do not improve within 1 hour, removeperson to hospital or where professional medical attention is available** (for free ambulance call 108)**;** 7) Do not allow person to do any work that day.

Heat Stroke

Heat stroke is the most serious heat-related illness and should be treated as a medical emergency. Heat stroke occurs when the body becomes unable to adequately dissipate heat, losing the ability to regulate core body temperature. The core body temperature rises rapidly, the sweating mechanism may fail, and thebody is unable to cool down. When heat stroke occurs, the body temperature can rise to 41^{o}C or higher within 10 to 15 minutes. Thinking clearly, reality perception, ability to plan, and other mental processes become impaired, and the person may be unable to recognize dangerous situations. Heat stroke can cause death or permanent disability if emergency medical treatment is not given.

Symptoms: Confusion, clumsiness, slurred speech, fainting/unconsciousness, seizures, hot dry skin, profuse sweating, red, hot, dry skin, and high body temperature.

Actions: **1) Remove person immediately to hospital** (for free ambulance call 108)**;** While waiting for help, person should not be left unattended till medical help arrives; 2) Place person in shady, cool area 3) Loosen clothing, remove outer clothing; 4) Fan air on worker; cold packs in armpits; 5) Wet person's skin with cool

water or place cold wet cloth on skin, soak clothing with cold water, apply ice packs, cold compresses, or ice if available; 6) Provide fluids (preferably water) as soon as possible; 7) Stay with personuntil help arrives.

5.5 Protective measures

The most effective way to protect against heat-related illness and fatality is to reduce heat stress, e.g., increase air movement through proper ventilation, reduce temperature, reduce humidity, and protect from solar radiation or other radiant heat sources), ensure proper re-hydration of persons by drinking adequate water or other cool beverages throughout the day (adult males and females should have 3 and 2 L/day, respectively).

Nonwork spaces

Engineering controls (engineering devices or processes) that can be used to reduce heat stress in nonwork spaces include, 1) 22Increase general ventilation; 2) Provide cooling fans; 3) Run local exhaust ventilation where heat is produced.

Rehydration by drinking at least 1 glass (250 ml) of water or other cool beverage every 30 minutes isextremely important to ward off heat related illnesses.

Personal clothing that helps to keep heat stress low may also be used, e.g., sun hats and light-coloredclothing.

Protective measures by individuals against illnesses at high heat index levels are summarized below:

Recommendations for protective measures for persons against illnesses at high heat index levels

Heat index (°C)	Risk level	Protective measures
39-46	High	1) Drink water often, 2) Take breaks as needed
>46	Very high to extreme	1) Drink water often, 2) Reschedule non-essential heavy work, if possible, 3) Alert persons about heat index for the day and identify precautions in place including who to call for medical help

Workspaces

Workspaces require customized recommendations for reducing heat loads and heat stress. Making such recommendations for the varied workspaces in Bhuj was beyond the terms of scope of this heat action plan. However, general recommendations are being made about reducing heat stress in this section.

Engineering controls: In addition to the engineering controls suggested above for non-workspaces, the following other engineering controls may be adopted for workspaces: 1) Use reflective shields to block radiant heat; 2) Insulate hot surfaces; 3) Stop leaking steam; 4) Provide shade for outdoor work sites.

Administrative controls may be used in addition to engineering controls, particularly in workspaces, to reduce heat stress. Administrative controls, such as the ones suggested below, are often used in workplaces, e.g., 1) Acclimatizing person to work in hot environments; 2) Scheduling work earlier or laterin the day; 3) Using work/rest schedules; 4) Limiting strenuous work, e.g., carrying heavy loads; 5) Use relief workers when needed and where possible.

Recommendations for rest pauses and hydration for light, moderate and hard work: The table below supplies information for heat stress risk, measures to avoid illness, rest pauses and hydration for easy, moderate and hard work. A broad understanding of what constitutes easy, moderate, and hard work is also provided. These definitions should be refined in time after this heat action plan is in use. The rest pauseand hydration plan may also be modified with experience gained in using this heat action plan.

Heat related risk in workspaces and recommended measures to avoid illness

Work difficulty			Easy work		Moderate work		Hard work	
			• Sitting, standing, light arm/hand work and occasional walking • Walking/working on hard surface at <4 kmph & carrying <12 kg		• Normal walking, moderate lifting • Walking/working on loose sand, water, reeds at <4 kmph & carrying minimal load • Walking on hard surface at <5.5 kmph & carrying <17 kg		• Heavy material handling, walking at a fast pace • Pick and shovel work • Walking on hard surface at <5.5 kmph & carrying >17 kg • Walking/working on loose sand at <4 kmph & carrying minimal load	
Heat index	**Heat stress risk for prolonged physical activity or prolonged heat exposure**	**General measures to avoid heat related illness**	Work/rest cycle each hour (min)	Water intake each hour (cc)	Work/rest cycle each hour(min)	Water intake each hour (lit)	Work/rest cycle each hour (min)	Water intake each hour (lit)
<27	Low risk of illness	No limit to work	60/0	500	60/0	750	50/10	750
27-32	Low risk of illness	No limit to work	60/0	500	50/10	750	40/20	1000
32-40	Heat cramps or heat exhaustion possible	Modify work practice	60/0	750	40/20	750	30/30	1000
40-51	Heat cramps or heat exhaustion likely. Heat stroke possible	Modify work practice; No heavy clothing	60/0	750	30/30	750	20/40	1000
>51	Heat stroke highly likely	Avoid work if possible	50/10	1000	20/40	1000	10.50	1000

Note: Above recommendations made on the basis of information provided by OSHA and USFWS

Other recommendations

Heat alert programme: Based on Indian Meteorology Department's weather forecasts for the coming week, a heat alert programme should be instituted to warn public to take added precautions to reduce heat stress on days when the heat index is predicted to be high. Disaster management and health officials shouldbe trained in how to check weather reports and weather advisories, as well as how to compute and interpretheat index to make proper decisions.

Training programme that helps people to recognize heat-related illness symptoms and what to do when there is a heat-related illness emergency. Training should include information about recognizing heat- related illness symptoms; proper hydration; heat-protective clothing; other factors that affect heat tolerance(e.g., medications, alcohol, obesity, etc.); and how to report symptoms and give proper first aid.

6 LOWCOST HEAT LOAD REDUCTION DESIGNS FOR LOWCOST HOUSING IN BHUJ

This section suggests low-cost design interventions for existing low-cost housing in Bhuj that will helpreduce excess heat loads.

6.1 Classification of Bhuj dwelling

Bhuj dwellings that were considered for this Bhuj HAP were of the following:

Type 1 dwellings (Kuchha houses): Houses with basic framework made of bamboo/wooden logs with walls and roofing made of plastic tarpaulin or houses having walls and roof of corrugated sheets, etc. Thesedwellings are not permanent structures and are usually found in rural areas and cities where people build makeshift homes.

Type 1 dwellings (Kuchha houses)

The challenges for this category of dwellings are: 1) The structures have very low load bearing capacity, making heat load reduction modifications difficult to install; 2) People living in this type of dwellings can make minimal monetary investment to reduce heat loads, 3) These type of settlements are temporary, hence investments to improve dwellings may not happen.

Type 2 dwellings (Semi pucca houses): Houses had walls made of brick and mortar with roofs made of corrugated sheets, clay tiles or shingles. These types of houses cannot take another floor on top.




Type 2 dwellings (Semi pucca houses)

The challenges for this type of housing are: 1) Planning air circulation in the interiors of houses with minimum structural interventions is difficult, 2) As weakness of the roof structure prevents the addition ofa top floor or make heat reduction interventions to it, heat received by the roof is convected into the house.

Type 3 dwellings (Pucca houses): Houses are made of concrete and load bearing brick walls and roofs. Since such houses have load bearing ceilings, expansion of houses take place vertically and horizontally. The challenges for this housing are: 1) Planning air circulation in the interiors of houses with minimum structural interventions is difficult, 2) As no additional floor can added Due to the nature of roofs used inthis housing and because no additional floor can be added on top, heat convected through roofs.


Type 3 dwellings (Pucca houses)

The challenge of these houses is that: 1) Their expansion may take place horizontally and vertically and adding heat load reduction structural additions may not be preferred; 2) Adding certain kinds of heat load reduction alterations, e.g., mud walls, to a pucca house may not be socially acceptable as it may be considered to be a "social comedown."

Commercial structures: These structures consist of roadside vending shops selling fruits and vegetables. These structures are made of bamboo/wooden logs with roof covering of box boards coveredwith tarpaulin sheets.

Commercial structures

The challenge of these structures is that: 1) They have no direct heat barriers insulating them from heatingress from the environment; 2) Each structure is different from the other, making it difficult to standardize heat load reduction design for all the structures.

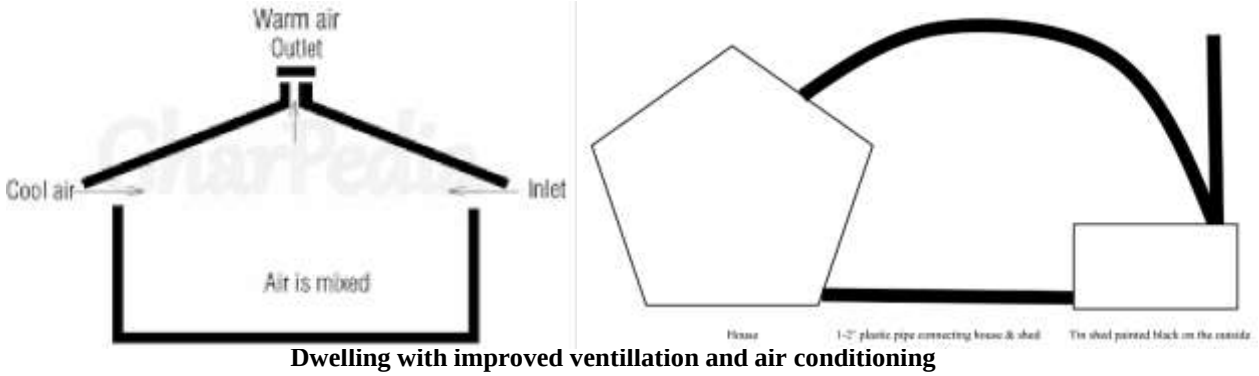
6.2 Principles for low-cost heat load and heat index reduction interventions

Insulation: Insulating the dwelling reduces the amount of heat load that it receives from the ambient environment. Examples of insulation are below:


Walls with air pockets (left picture) and fixing a yawning on roof provide insulation

Creepers on roof and walls provide insulation

Ventilation: Dwellings with better ventilation and air conditioning (moisture and temperature reduction)to decrease the heat index (examples. below):



Dwelling with improved ventillation and air conditioning

Increasing albedo: External surfaces, particularly roofs, with high reflectivity will reduce heat absorption.

Roof painted with lime reflects solar radiation

Lime paint on interior walls to reduce internal moisture content

Increasing evapotransiparation and evaporation in the environment with more greenary and water bodies: More tree cover around dwellings and in parks increases evapotranspiration (removal of water vapour from vegetation) and more water bodies in the neighbourhood increasesevaporation of water both evapotranspiration and evaporation remove heat from the environment.

6.3 Heat load reduction interventions

Lowcost heat load reduction interventions for Type 1-3 dwellings in Bhuj are provided below. These interventions may require adaptation for implementation. Intervention designs should be modular for easy replicability. Each intervention is provided with a unique number, e.g., I.4.SP/P.The first letter denotes the insulation design principal (I-Insulation, V-Ventillation, R- Reflection,'O'-Others). The number in the middle denotes the intrvention number of each design principle. The last letter/letters indicates the type of structure (K-Kuchha, SP-Semi pucca, P-Pucca, C- Commercial) for which the intervention is applicable, e.g., I.4.SP/P indicates that it is insulation intervention # 4 that can be used for Semi pucca and Pucca housing.

Interventions for Type 1 dwellings (Kuchha houses)

Intervention I.1.K for Type 1 dwellings (Kuchha houses)

Intervention on walls

- Free standing wall shading partitions made of recycled wood crates/ bamboo members

Wooden crate partition preparation

1. Collect waste old wooden crates from vegetable markets, industrial units.

2. Take apart the crate to individual members.

3. Prepare a screen using the members fixed with nails to make a self standing partition.

Bamboo partition preparation

1. Collect waste old bamboo (7-15mm dia).

2. For the screen, crooked bamboo to be split in half. Straight bamboo to be used for vertical framework.

3. Tie the half split bamboo's on vertical framework using nylon/ jute ropes.

Intervention I.2.K for Type 1 dwellings (Kuchha houses)

Intervention on walls

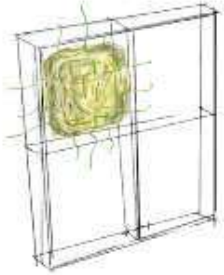
- Local vines and creepers on frames. (Edible plants to be encouraged for economic benefits)

- Straw free standing panels

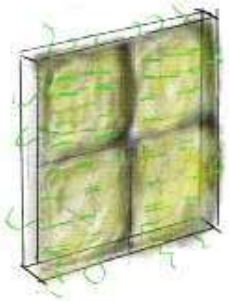
Straw free standing panel preparation

1. Collect agricultural waste, hedge grass, etc. Dried date palm leaves can also be used. Some green leaves may be added to make the panel fire resistant.

2. Prepare a frame using recycled wood, tree logs etc.



3. Bind the waste in a dense packet and bind it with frame using nylon/ jute rope.



4. Bind the waste in a dense packet and bind it with frame using nylon/ jute rope.

Intervention I.3.K for Type 1 dwellings (Kuchha houses)

Intervention on walls

- Waste plastic bottle walls

Waste plastic bottle wall preparation

1. Collect waste plastic bottles. Bottles should be cleaned and reinflated for ease of usage.

2. Prepare a basic frame from recycled wood (waste crates).

3. Fix chicken wire mesh on the frame using nails. Basic metal wire can also be used.

4. Fill the frame with plastic bottles. Sand (water may be experimented with as a substitute) to be filled in base bottles to act as solid base, with empty bottles stacked on top.

Intervention I.4.K/SP for Type 1 & 2 dwellings (Kuchha and Semi pucca houses)

Intervention on Ceiling/ Roof

- False ceiling made of panels made of recycled cement bags with thermocole filled inside and sealed to create an air pocket in between. Straw can be used as a substitute for thermocole. (https://www.youtube.com/watch?v=DxpGhIWGA-4)

Thermocole ceiling panels preparation

1. Collect waste packaging thermocole. Thermocole with fine grains has high insulation value.

2. Cut the thermocole into pieces of equal length. Each piece should be of equal thickness. Join the pieces together to make a rectangular solid panel.

3. Take waste cement bags and clean them. The bags should be turned inside out.

4. Insert the thermocole panel in the bag and stitch closed. A parallel stitch to be made to act as an channel to carry the rope for fixing.

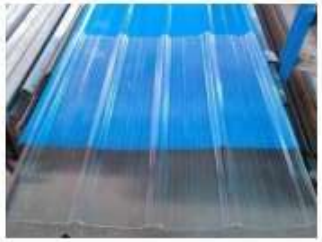
5. Insert the rope in the channel previously made. Arrange multiple panels in similar manner as per width of the room with some additional rope left on ends for fixing.

Intervention V.1.K/SP for Type 1 & 2 dwellings (Kuchha and Semi pucca houses)

Intervention on Ceiling/ Roof

- Airlite panels can be installed in ceiling to facilitate air circulation and allow diffused natural lighting inside. (to be used in case of corrugated sheets in ceilings). Air circulation helps in the removal of heat and moisture.

Airlite panels preparation



1. Buy 2 ft long fibre reinforced plastic sheet. (Rs 25/sqft)

2. Cut the sheet in two equal parts. One part to be heat bended into half conical shape as shown in image.

3. The other part is to be cut as per the half cone molded before. The cut should be a little smaller than the actual shape for easy fixing.

4. Both of the parts to be pasted together using proper adhesive. Mouth of the cone to be closed using gunny bag to prevent entry of dust, insects etc.

5. Install the panel by replacing metal/ cement corrugated sheet.

Intervention R.1.K/SP/P for Type 1, 2 & 3 dwellings (Kuchha, Semi pucca and Pucca houses)

Intervention on Ceiling/ Roof

- Application of white cool roof paint on ceiling top.

Brands

Excel cool coat

Rs 7434/20L

Asian Paints
Smartcare Damp Proof

Rs 5236/20L

Berger Weathercoat Exterior
Roof Coating Paint

Rs 340/L

Interventions for Type 2 dwellings (Semi pucca houses)

Intervention I.4.K/SP for Type 1 & 2 dwellings (Kuchha and Semi pucca houses)

Intervention on Ceiling/ Roof

- False ceiling made of panels made of recycled cement bags with thermocole filled inside and sealed to create an air pocket in between. Straw can be used as a substitute for thermocole. (https://www.youtube.com/watch?v=DxpGhIWGA-4)

Thermocole ceiling panels preparation

1. Collect waste packaging thermocole. Thermocole with fine grains has high insulation value.

2. Cut the thermocole into pieces of equal length. Each piece should be of equal thickness. Join the pieces together to make a rectangular solid panel.

3. Take waste cement bags and clean them. The bags should be turned inside out.

4. Insert the thermocole panel in the bag and stitch closed. A parallel stitch to be made to act as an channel to carry the rope for fixing.

5. Insert the rope in the channel previously made. Arrange multiple panels in similar manner as per width of the room with some additional rope left on ends for fixing.

Intervention I.5.SP for Type 2 dwellings (Semi pucca houses)

Intervention on Ceiling/ Roof

- Creepers and vines intervened on roof

Examples of types of vines/ creepers

1. Skyblue clustervine

2. Garlic vine

3. Dalbergia sympathetica Nimmo ex Grah

4. Entada pusaetha DC

Intervention I.b.SP/P for Type 2 & 3 dwellings (Semi puccca & Pucca houses)

Intervention on walls

- Wall creepers/ vines on external walls. (dry climate based)

Examples of types of vines/ creepers

1. Skyblue clustervine

2. Garlic vine

3. Dalbergia sympathetica Nimmo ex Grah

4. Entada pusaetha DC

Interventions I.7.SP/P for Type 2 dwellings (Semi pucca and Pucca houses

Intervention on walls

- Sand filled bottles hung on the outside to act as shading wall. Based on feasibility, bottles can be converted to planters.

Preparation Recycled plastic bottle planters

1. Take 2 liters PET bottle and cut it from the top.

2. Puncture the bottle at both ends and cross MS wires from it. Fix the bottles at equal spacing.

3. Fill the bottles with soil well mixed with manure.

4. Install the bottle on external wall.

Intervention I.8.SP for Type 2 dwellings (Semi pucca housing)

Intervention on walls

- External mudcake (mud, dung and straw) plaster on outer wall.

Mudcake plaster preparation

1. Mix mud, dung and straw in equal proportions with water to form mortar mix.

2. Wet the walls before mortar application.

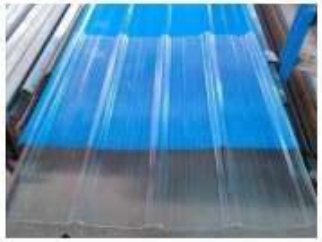
3. Apply a thick mortar paste (1" -2") on the external walls.

Intervention V.1.K/SP for Type 1 & 2 dwellings (Kuchha and Semi pucca houses)

Intervention on Ceiling/ Roof

- Airlite panels can be installed in ceiling to facilitate air circulation and allow diffused natural lighting inside. (to be used in case of corrugated sheets in ceilings). Air circulation helps in the removal of heat and moisture.

Airlite panels preparation



1. Buy 2 ft long fibre reinforced plastic sheet. (Rs 25/sqft)

2. Cut the sheet in two equal parts. One part to be heat bended into half conical shape as shown in image.

3. The other part is to be cut as per the half cone molded before. The cut should be a little smaller than the actual shape for easy fixing.

4. Both of the parts to be pasted together using proper adhesive. Mouth of the cone to be closed using gunny bag to prevent entry of dust, insects etc.

5. Install the panel by replacing metal/ cement corrugated sheet.

Intervention V.2.SP/P for Type 2 and 3 dwellings (Semi pucca and pucca houses)

Intervention on walls

- Lime paint on interior walls to reduce internal moisture content.

Preparation: for Lime painting process

1. Purchase lime paint from local hardware store and prepare the powder by crushing lumps and making the powder even.

2. Mix your lime paint gradually to a paint bucket stirring continuously. Add more powder once it gets completely dissolved.

3. To get an idea for required composition, lime powder needs to be mixed in 1.7 lit of water to achieve 2 lit of complete solution.

4. Limewash should be applied in several thin coats using a long-haired or masonry paintbrush that creates feathered strokes.

Intervention R.1.K/SP/P for Type 1, 2 & 3 dwellings (Kuchha, Semi pucca and Pucca houses)

Intervention on Ceiling/ Roof

- Application of white cool roof paint on ceiling top.

Brands

Excel cool coat

Rs 7434/20L

Asian Paints
Smartcare Damp Proof

Rs 5236/20L

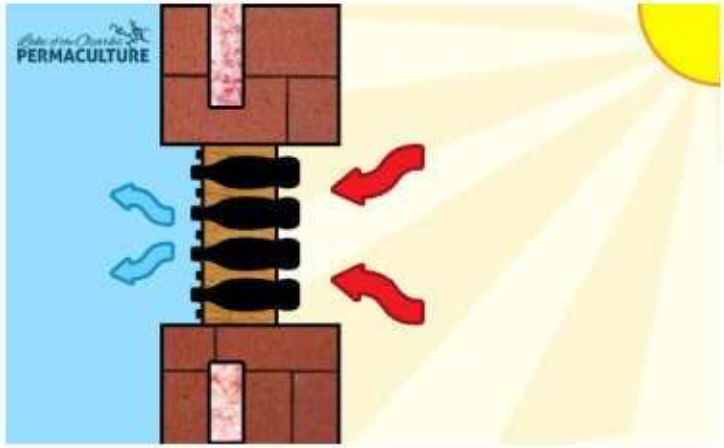
Berger Weathercoat Exterior
Roof Coating Paint

Rs 340/L

Intervention 0.1.SP/P for Type 2 & 3 DWELLINGS (Semi pucca and Pucca housing)

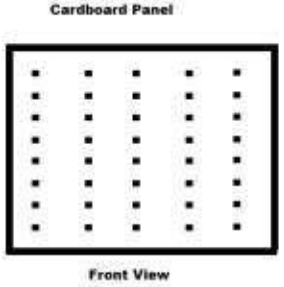
Intervention on walls

- Funnel shaped ventilator
  (https://www.youtube.com/watch?v=1Qyb2axBQzQ)



Preparation of Funnel ventilators

1. Cut 2 liters PET bottle into two halves.



2. Make a cardboard panel of same size as of opening. Create punctures in the sheet at two bottle's spacing.

3. Fix the bottles in the frame using the open ends of the bottles. Close the caps on the bottles after fixing. Top of the caps should be cut to allow air passage through the bottle

4. Install the ventilator on window opening. Smaller end should be kept facing inside the room.

Interventions for Type 3 dwellings (Pucca houses)

Intervention I.b.SP/P for Type 2 & 3 dwellings (Semi puccca & Pucca houses)

Intervention on walls

- Wall creepers/ vines on external walls. (dry climate based)

Examples of types of vines/ creepers

1. Skyblue clustervine

2. Garlic vine

3. Dalbergia sympathetica Nimmo ex Grah

4. Entada pusaetha DC

Interventions I.7.SP/P for Type 2 dwellings (Semi pucca and Pucca houses

Intervention on walls

- Sand filled bottles hung on the outside to act as shading wall. Based on feasibility, bottles can be converted to planters.

Preparation Recycled plastic bottle planters

1. Take 2 liters PET bottle and cut it from the top.

2. Puncture the bottle at both ends and cross MS wires from it. Fix the bottles at equal spacing.

3. Fill the bottles with soil well mixed with manure.

4. Install the bottle on external wall.

Intervention I.&.P for Type 3 dwellings (Pucca houses)

Intervention on Ceiling/ Roof

- Roof top plantation in recycled vegetable and milk cartons.

Preparation Recycled carton planters

1. Take waste milk cartons.

2. Place a waste gunny sack inside the container to hold soil.

3. Fill the container with soil mixed manure.

4. Place the filled container over empty container to create air pocket below.

Intervention I.9.P for Type 3 dwellings (Pucca houses)

Intervention on Ceiling/ Roof -

- Double roof with wet gunny sacks.

Preparation Double roof with wet gunny sacks

1. Install temporary frame made of bamboo over roof. Frame work can be made of metal pipe. Fix green shade net over the framework.

2. Collect waste gunny sacks and spread them on the roof.

3. Wet the gunny sacks. The gunny sacks will need to watered again at an interval of 3-4 hours.

Intervention V.2.SP/P for Type 2 and 3 dwellings (Semi pucca and pucca houses)

Intervention on walls

- Lime paint on interior walls to reduce internal moisture content.

Preparation: for Lime painting process

1. Purchase lime paint from local hardware store and prepare the powder by crushing lumps and making the powder even.

2. Mix your lime paint gradually to a paint bucket stirring continuously. Add more powder once it gets completely dissolved.

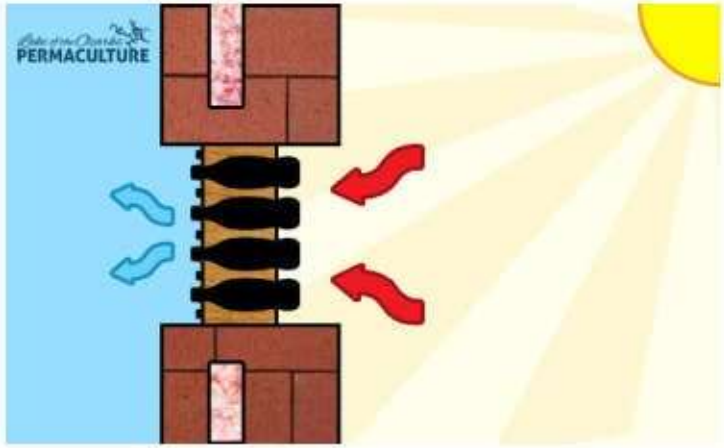
3. To get an idea for required composition, lime powder needs to be mixed in 1.7 lit of water to achieve 2 lit of complete solution.

4. Limewash should be applied in several thin coats using a long-haired or masonry paintbrush that creates feathered strokes.

Intervention 0.1.SP/P for Type 2 & 3 DWELLINGS (Semi pucca and Pucca housing)

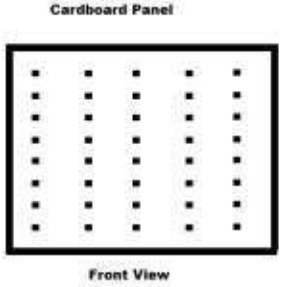
Intervention on walls

- Funnel shaped ventilator
  (https://www.youtube.com/watch?v=1Qyb2axBQzQ)



Preparation of Funnel ventilators

1. Cut 2 liters PET bottle into two halves.



2. Make a cardboard panel of same size as of opening. Create punctures in the sheet at two bottle's spacing.

3. Fix the bottles in the frame using the open ends of the bottles. Close the caps on the bottles after fixing. Top of the caps should be cut to allow air passage through the bottle

4. Install the ventilator on window opening. Smaller end should be kept facing inside the room.

Intervention R.1.K.SP/P for Type 1, 2 & 3 dwellings (Kuchha, Semi pucca and Pucca houses)

Intervention on Ceiling/ Roof

- Application of white cool roof paint on ceiling top.

Brands

Excel cool coat

Rs 7434/20L

Asian Paints
Smartcare Damp Proof

Rs 5236/20L

Berger Weathercoat Exterior
Roof Coating Paint

Rs 340/L

Interventions for commercial structures

Interventions 0.2.C for Commercial structures

Intervention on Ceiling/ Roof

- Do-it-yourself ceiling misting unit made of Reverse Osmosis pipes, mist nozzles and cooler pump.

Items Required

1. 1/4" PVC pipes (10m)

2. Misting nozzles with T joints

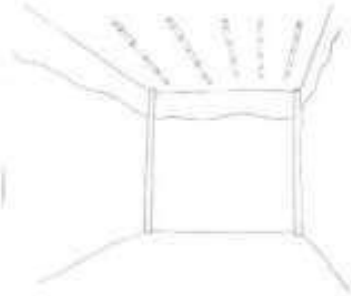
3. 18W submersible cooler pump

4. 1/4" to 1/2" Thread

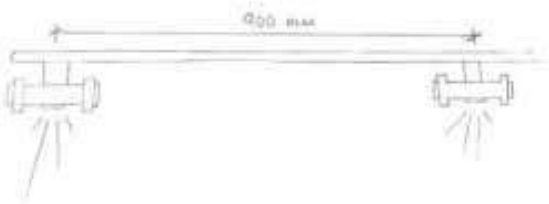
4. 20L Waste bucket with cap.

Setup

1. Install R0 pipes all along the periphery of the shop on the ceiling using U clips with ends of the pipes to be terminated at same place.



2. At every 900mm distance spacing on the ceiling, fix a misting nozzle using T-joints. Nozzles should be positioned to face shop interiors.

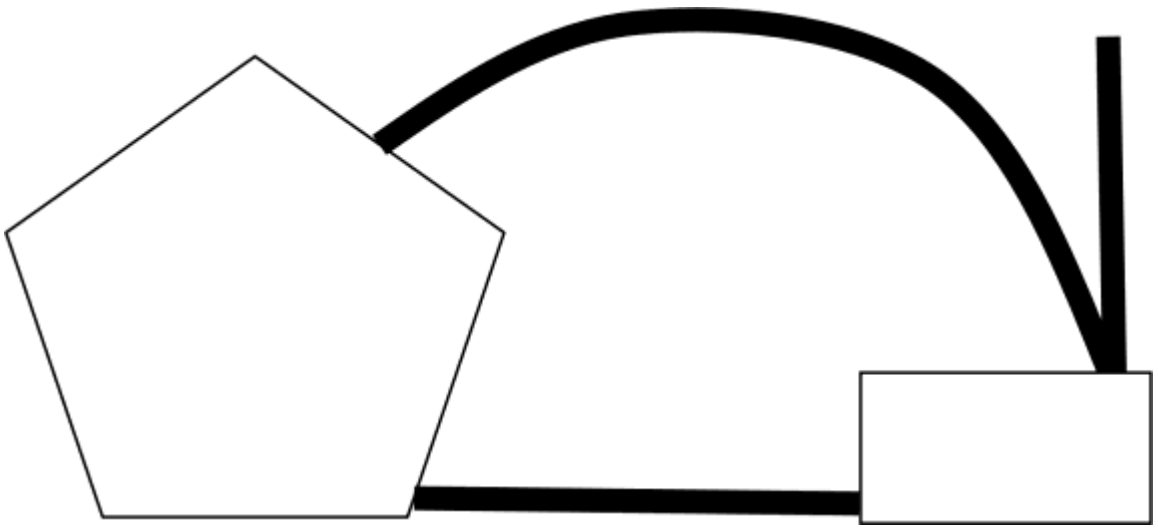


3. Fix the cooler pump inside a 20L waste bucket. Install 1/2" to 1/4" reducer on top of the pump.

4. Puncture two holes of 1/4" in the bucket cap. Insert both of the open ends of the pipe inside it.

5. Connect one end of the pipe with the pump. Another end to be left open. This is done so as the complete system is in a closed loop.

Intervention V.3.P/C for Type 3 dwellings (Pucca houses) and commercial structures (where they are enclosed)



House 1-2’ plastic pipe connecting house & shed Tin shed painted black on the outside

House/structure connected to a hot shed painted black on the outside

A house using principles of convection currents—the shed made of tin sheets is painted black on the outside to make it a hot shed. The pipe connecting the house and shed draws air from the house into the hotshed because of convection currents. During winter, the pipe from the hot shed is connected to the house’s roof to draw warm air from the hot shed. In summer, the pipe from the hot shed roof is left unconnected so that hot air from the house is drawn into the hot shed because of convection currents, A *khas-khas* fixed to the window in the house cools incoming air into the room. The temperature in the living room connected tothe hot shed can be lower by 3-4^{o}C in summer and higher by 3-4^{o}C in winter. The hot shed can be connected either to a pucca house or a commercial establishment that is closed on all sides.

6.4 Interventions for the neighbourhood environment

The area in and around the low cost housing colonies is quite bare with little vegetation and no water bodies. If more tree cover, parks and water bodies can be developed in and around the dwellings, they will increase evaporation and evapotranspiration (removal of water vapour fromvegetation), and that will help cool the micro-neighbourhood around the colonies by removing heat from the environment.

Developing such an environment will pose challenges such as land ownership, municipalitypermissions and finances to plant trees and develop parks and water bodies.


Area in and around the low-cost housing colonies in Bhuj

7 OTHER RECOMMENDATIONS FOR ACTION

Besides the recommendations shared in the previous two chapters, here we are sharing some additional recommendations that can be implemented for improving the heat resilience among the target communities. Some recommendations are generic for both the residents of informal settlements and workers groups while specific recommendations have also been provided.

7.1 Generic recommendations

1. With the help of health experts, **awareness programs** are recommended for community members to recognize the first signs of heat stress impact on health and do first aid themselves.
2. **Awareness** programs are also recommended for **local healthcare professionals** to prepare them better for handling heat stress related cases, to offer affordable healthcare to the poor, and to provide better emergency services like ambulance for informal settlements and remote worksites of informal workers.
3. **Health camps** can be organized during hot days for better access to medical care for the community members experiencing persisting issues. Such camps can be organized in both informal settlements as well as the work sites of informal workers. Special attention should be given to senior persons.
4. **Early warning systems** are recommended to be set up in the target communities with the help of Municipal Corporation and weather department. The warnings should be communicated through multiple modes to ensure wider reach and overcome low literacy and internet connectivity in the target communities.
5. **Advocacy** with the local government to initiate drafting of a Bhuj Heat Action Plan.
6. Local **food** items that help reduce heat stress should be promoted among all the target communities.
7. **Common coping mechanisms** used by communities at their housing sites and work sites can be discussed, collectively improved and further promoted.
8. **Awareness** should also be created among all the communities about climate change and its impact on the urban poor so that they can participate in policymaking and implementation given an opportunity.

7.2 Recommendations for informal settlements

1. Each informal settlement should be supported to establish **shaded areas, and shelter/ cooling centers** for use during extreme hot days and heat waves. In case of lack of space in the community, nearest possible place should be identified for the purpose and arrangements should be made.
2. **Tree and kitchen garden plantation** drives should be organized to improve the green cover in target communities.
3. **Water conservation** initiatives would benefit the communities that suffer from water shortage during hot days.
4. **Organize communities** to build their collective capacity for building heat resilience in the community and intervene in cases where houses are being newly built in their settlement to share knowledge of heat resilient designs. The residents of Juni Rawalwadi are recommended to engage in **advocacy** for water connection. The resident community in Khasra should also engage in advocacy for getting land entitlements and electricity connection.

7.3 Recommendations for informal workers

Daily-wage workers

1. **Advocacy** with the government for drinking water arrangement and shade at their site for waiting in the marketplace
2. **Organize** daily-wage workers for building their collective capacity to negotiate better work conditions at worksites.

3. Set up **emergency response networks** among daily-wage workers for help in such times.

Street vendors

1. Each street vendor dealing in perishable goods can be connected with at least one **cold storage center** during hot days.
2. **Organize** street vendors to improve collective capacity to work for their heat resilience.
3. **Tree plantation** can be encouraged among street vendors for their worksites.

Cattle rearers

1. **Organize** cattle rearers to build collective capacity for action to protect cattle and cattle rearers during the times of high heat stress.
2. Set up **emergency response networks** among cattle rearers for help in such times.
3. Advocacy with the government for provisions of shade and drinking water along the work routes of cattle rearers.
4. **Advocacy** is also needed by the community collective for protection of their traditional grazing land and water sources for the cattle. They should also promote their traditional animal-friendly cattle rearing practices.
5. Community members and the government can be encouraged to set up **cold storage facilities** to help cattle rearers store milk to reduce their financial loss.

Waste pickers

1. **Organize** waste pickers to build their collective capacity for preventive measures during the times of high heat stress.
2. Set up **emergency response networks** among waste pickers for help in such times.
3. **Advocacy** with the government for provisions of shade and drinking water along the worksites and routes of waste pickers.
4. **Advocacy** can also be done with the government to get waste pickers' contribution towards reducing the city's ecological footprint recognized and appreciated.
5. Efforts can be made to **revive the traditional bamboo craft** of *Bansfor* community to reduce their economic dependence on waste picking.

In conclusion, we recommend a longitudinal study with community members to understand and document their heat stress risks in further detail and bring out locally developed practices of resilience through community participation.

ACKNOWLEDGEMENTS

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Mr. Sagar Dhara is an environmental Engineer with expertise in risk analysis and air quality management. He has been a member of UNEP, government, Supreme Court committees, a founding member and Co-Convener of South Asian People's Action on Climate Crisis (SAPACC).

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