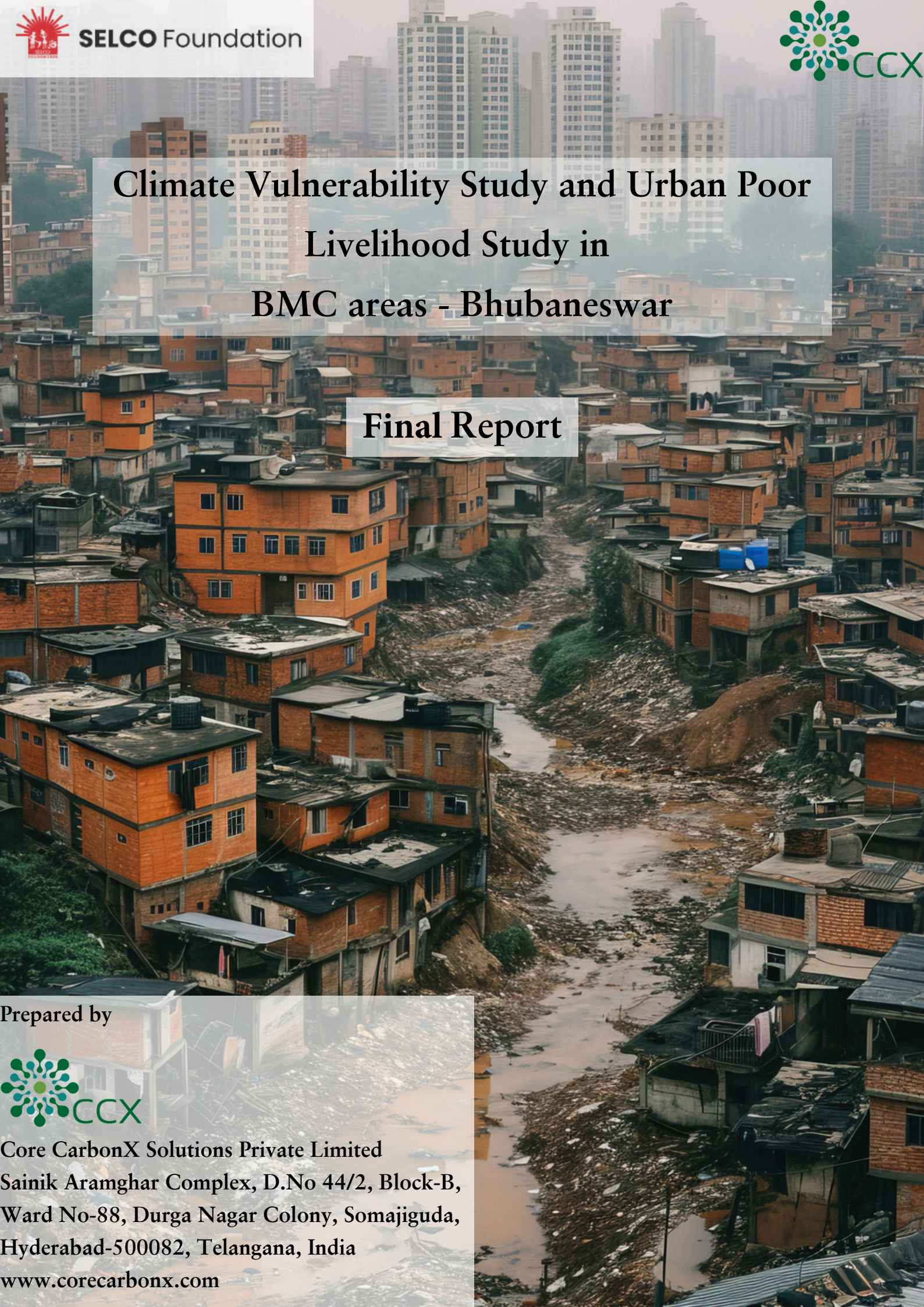


SELCO Foundation

CCX

Climate Vulnerability Study and Urban Poor Livelihood Study in BMC areas - Bhubaneswar

Final Report

Prepared by

CCX

Core CarbonX Solutions Private Limited
Sainik Aramghar Complex, D.No 44/2, Block-B,
Ward No-88, Durga Nagar Colony, Somajiguda,
Hyderabad-500082, Telangana, India
www.corecarbonx.com

Acknowledgment

At SELCO Foundation, we extend our sincere gratitude to our consulting partner, Core CarbonX Solutions Private Limited, for providing their expertise and services in conducting the in-depth study in Bhubaneswar and preparing the report.

We are grateful to the Bhubaneswar Municipal Council (BMC), Department of Health & Family Welfare, Odisha Livelihood Mission, and other key stakeholders for their valuable guidance, constructive feedback, and unwavering support throughout the course of this study. Their expertise has been instrumental in shaping the direction and depth of this work.

We are especially thankful to all the community member respondents who generously shared their time, insights, and experiences. Their on-ground knowledge significantly enriched the findings of this study report. We express our gratitude to Mahila Housing Trust, for their continued support and participation in connecting our consulting partner with community members from identified settlements for Focus Group Discussions and surveys, which enabled deeper engagement at the grassroots level.

This report is the result of collective effort, collaboration, and commitment. We deeply appreciate the contributions of each individual and institution involved.

This report is intended for policymakers, development practitioners, and ecosystem enablers working to develop sustainable and resilient urban programs in Bhubaneswar. It also serves as a valuable resource for NGOs, financial institutions, and researchers seeking insights into urban gaps and opportunities within the Climate-Livelihood Nexus.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

BMC	Bhubaneswar Municipal Corporation
BPL	Below Poverty Line
CHC	Community Health Centre
CMIP *6*	Coupled Model Intercomparison Project Phase *6*
FGD	Focus Group Discussions
GEE	Google Earth Engine
GHG	Greenhouse Gas
IARI	Indian Agricultural Research Institute
ICLEI	International Council for Local Environmental Initiatives
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
JAICA	Japan International Cooperation Agency
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KII	Key Personnel Interviews
MHT	Mahila Housing Trust
NGO	Non-Governmental Organisations
NULM	National Urban Livelihoods Mission
OSDMA	Odisha State Disaster Management Authority
PDS	Public Distribution System
PMAY	Pradhan Mantri Awas Yojana
RAY	Rajiv Awas Yojana
RO	Reverse Osmosis
SAPCC	Odisha State Action Plan on Climate Change
SDA	Slum Dweller Association
SHG	Self-Help Groups
SSP	Shared socio-economic pathways
SUDA	State Urban Development Agency
UNDP	United Nations Development Programme
UPVC	Unplasticized Polyvinyl Chloride
USEP	Urban Self-Employment Program
UWEP	Urban Wage Employment Program
UWSP	Urban Women Self-Help Program
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

EXECUTIVE SUMMARY

The extreme weather events and their damage significantly impact the livelihoods of the urban poor. The Bhubaneswar Climate Vulnerability and Urban Poor Livelihood study was conducted with initial desk-based research to frame the study into two major phases. The climate vulnerability study involves secondary climate pathway analysis using Shared Socio-Economic Pathways (SSP) to project future effects of climate vulnerabilities in Bhubaneswar city, along with an exhaustive ward-wise analysis that develops a total climate vulnerability score to identify potentially vulnerable wards. The urban poor livelihood study aims to identify the livelihoods affected by climate hazards and explore potential adaptation measures to improve their livelihoods by tackling climate vulnerability.

The Climate pathway results suggest that there will be a reduction in total rainfall of 174mm and an increase in maximum temperature up to 3°C from the baseline (1995-2014) to the medium term (2041-2060) in SSP 245. An increase in precipitation and temperature of up to 36mm and 3°C in the medium term compared to the baseline indicates that Bhubaneswar is more vulnerable to climate hazards such as Cyclones, floods, heavy rainfalls and heatwaves, etc. The ward-wise analysis of Bhubaneswar, incorporating GIS mapping and a vulnerability index using slum demographics, climate events, and trends, resulted in 27 highly vulnerable wards. To widen the scope of the urban poor livelihood study, the primary survey was conducted by defining criteria and performing a rapid assessment.

To understand the climate vulnerabilities and urban-poor livelihood impact, qualitative surveys were carried out as key informant interviews (KIIs) from 3 public institutions and five focus group discussions (FGDs) from notified and non-notified slums and Anganwadi's. With 10% of the representative slum population, the quantitative primary survey was carried out on 175 households from 15 slums in 9 highly vulnerable wards, where two unnotified slums are more susceptible to climate vulnerabilities. The Quantitative primary survey identified potential challenges, vulnerabilities, and adaptation measures. 79.6% of the respondents live in semi-pucca-owned houses with asbestos and tin roofs. Out of the 175 respondents, 45.71% (80 respondents) are affected by heat-related illnesses, and 36.5% have experienced the combined impact of heavy rains, heatwaves, and cyclones in the past five years. With respect to access to energy, 0.5% (71 respondents) indicated that they experience frequent power cuts, while 5% (9 respondents) stated they do not have electricity connections. Several government initiatives and action plans have been introduced in the state of Odisha, addressing the issues faced by vulnerable communities.

However, there is a significant gap in the formulation and implementation of the Cool Roof policy in Odisha. The adaptation measures to cope with extreme weather may include cool cart, cool roofs, membrane cool roofs, tiled cool roofs, cool roof painting, cool roof–green net shading, Unplasticized Polyvinyl Chloride (UPVC), etc., act as a resisting mechanism from the extreme weather events. Based on quantitative and qualitative surveys,

1 Introduction

1.1 Background of the study

Climate change is a global phenomenon marked by shifts in average weather patterns and an increase in the frequency of extreme events over extended periods. A defining feature of climate change is the disruption of atmospheric balance, particularly the increasing concentration of greenhouse gases (GHGs). Human-induced GHG emissions are the primary drivers of global warming. In 2007, the United Nations' Intergovernmental Panel on Climate Change (IPCC) reported with over 90% certainty that the principal cause of global warming is the anthropogenic production of CO2. Based on the IPCC's climate models, Earth's surface temperatures are projected to rise by 0.5°F to 8.6°F (-17.5°C to -13°C) above the 1986–2005 baseline by the century's end, depending on future emissions scenarios (IPCC, 2007).

Urbanisation is the primary driver of climate change in urban metropolitan areas. Over 55% of the global population resides in urban areas, and population growth is expected to reach around 68% by 2050. (UN-DESA, 2018)[1]70% of global GHG emissions are contributed by the construction and transportation sectors, resulting from housing, infrastructure, livelihood demands, etc. Urban cities are a major contributor to GHG emissions and damages due to climate vulnerability intensified through rising temperatures, sea-level rise, and extreme weather events.

Studying climate vulnerability and urban-poor livelihood in a tier-II city like Bhubaneswar plays a major role in understanding the climate crisis. Activities, including energy-intensive operations, transportation and urban development, intensify GHG emissions in the region. At the same time, the vulnerable populations, particularly the urban poor, face higher risks from extreme weather events due to climate change impacts, including cyclones, floods, heat waves, etc.

Approximately 35% of Bhubaneswar's population lives in slum areas, facing multiple issues, such as limited access to water, sanitation, and proper housing. Nearly 50% of the wards with informal settlements are classified as medium to high risk of climate-related disasters, such as urban flooding, waterlogging, and heavy rainfall. Furthermore, all wards in Bhubaneswar have been impacted by cyclonic events. Extreme temperatures, including heat waves, affect 20% of the wards with informal settlements. These erratic weather patterns disrupt livelihoods and worsen living conditions for slum residents. (BMC, 2024)[2].

Livelihoods in Bhubaneswar are very diverse, and a sizable portion of the slum population engages in the unorganised sector, such as daily wages, street vending, construction labour, household work, small-scale

[1] https://population.un.org/wup/assets/WUP2018-KeyFacts.pdf

[2] https://www.bmc.gov.in/about/profile

businesses, etc., Understanding the livelihoods of these underprivileged communities where the people lack basic infrastructure, WASH services, and health and energy access. are affected by climate events and disease outbreaks.

As Bhubaneswar City became a centre of regional trade and economic activity, climate risks intensified, along with challenges in ensuring the resilience and sustainability of livelihoods for marginalised communities and populations residing in Slum areas. Understanding the livelihood of these communities is crucial for introducing climate adaptation strategies by ensuring equitable and targeted interventions for urban slums in Bhubaneswar to improve their livelihoods.

1.2 Objectives

The objective of Bhubaneswar's climate vulnerability and urban poor livelihood study was divided into two major components.

A. Climate Vulnerability Study:

- Assess the current and future climate risks in Bhubaneshwar.
- Identify vulnerable areas and communities, especially urban-poor neighbourhoods.
- Analyse local infrastructure resilience and the ability to cope with climate-related events.
- Recommend adaptation strategies for the cities and vulnerable communities. Urban Poor.

B. Livelihood Study:

- Analyse the livelihood strategies of poor urban communities in Bhubaneswar
- Assess the socio-economic impacts of climate change on their livelihoods.
- Identify key factors that enhance or hinder their resilience to climate change

The following sections describe the approach and methodology for climate vulnerability and urban poor livelihood assessment. This is followed by results from KIIs, FGDs and quantitative surveys, from which the team has identified adaptation measures for the urban poor.

2 Approach and Methodology

The Climate vulnerability and livelihood study of urban areas was carried out in two phases. The first phase involved secondary data assessment with initial desk research and primary data covering urban livelihood impacts. The steps taken to implement adaptation measures and potential interventions that will enhance the livelihoods of the urban poor facing climate vulnerability are illustrated in the flowchart below.

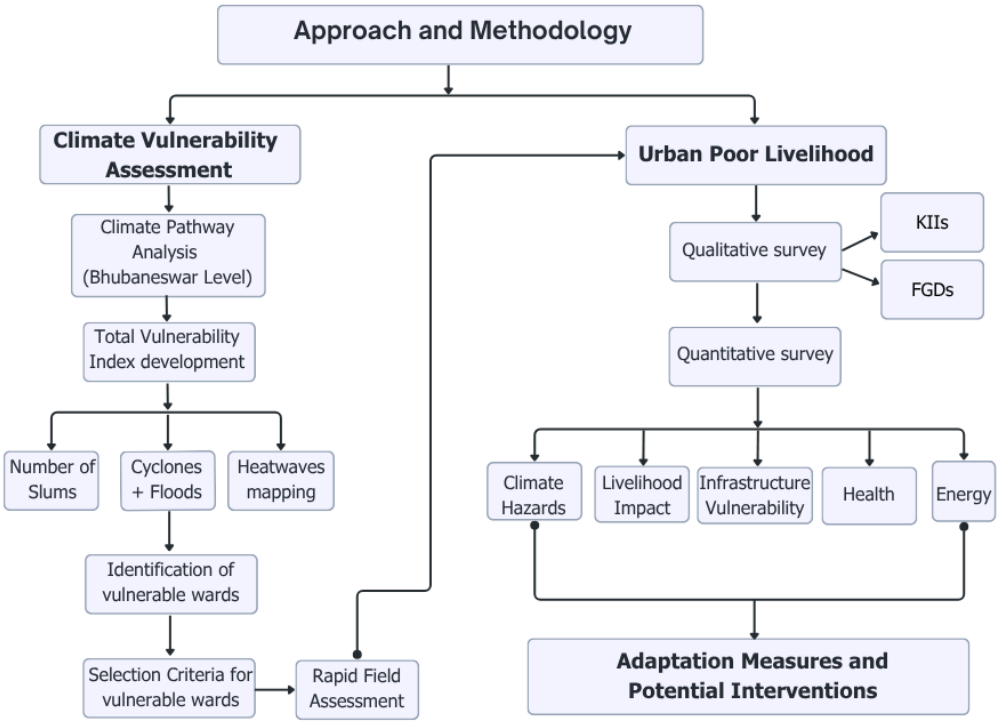


Figure 2. 1 Approach and Methodology

2.1 Secondary Data Analysis

The climate vulnerability assessment was conducted in two phases: to analyse the Bhubaneswar-level future climate projections and ward-level analysis by developing vulnerability index categories and GIS mapping. The future climate projections of Bhubaneswar will incorporate the International Panel on Climate Change's (IPCC) shared socio-economic pathways (SSP).

The ward-level study has been carried out to identify potential vulnerable wards due to climate hazards, and that has been mapped by layers of vulnerability index, such as the Slum demographics, with extreme weather events like cyclones, floods, and heatwaves. To ensure ground realities, we conducted a rapid field survey on the existence of vulnerable slums and urban poor in highly vulnerable wards.

2.2 Primary Data Analysis

A primary survey, conducted in both qualitative and quantitative form, was conducted to understand the urban poor's livelihoods and the impacts of climate vulnerability.

The qualitative survey includes Key Informant Interviews (KIIs) to understand the potential issues faced by the urban poor and challenges that hinder the interventions from the government departments. Once the KIIs are done, the Focus Group Discussions (FGDs) are conducted with the various households and livelihoods, market spaces, street vendors, etc, to understand their challenges, responses and coping mechanisms.

The quantitative livelihood perception survey was conducted with a representative sampling from the selected vulnerable slum settlements. This will give an understanding of livelihoods, typologies, living conditions, and the impact of climate hazards, energy access, financial conditions, and their health impacts due to climate vulnerability. This information will give a better understanding of urban-poor livelihood and to provide targeted interventions and adaptation measures to improve their living and livelihood conditions by tackling the climate vulnerability in these slum settlements.

3 Section – I: Climate Vulnerability Assessment

3.1 Climate Pathway Scenario

Climate pathway analysis provides a comprehensive understanding of Bhubaneswar's historical climate scenario (Baseline) and future scenarios as per the International Panel for Climate Change (IPCC), covering five scenarios named shared socio-economic pathways (SSP). These climate scenario analyses will evaluate and compare climate indicator changes from near-term (2021-2040) to medium-term (2041-2060) in comparison with the baseline (1995-2014). The findings will highlight the trend in climate variability and extreme weather events.

These scenarios provide an evaluation of multiple potential results of the consequences of various socioeconomic trajectories for mitigation, adaptation, and formulation of policies in relation to climate change. This helps us understand the complex interactions among human activities, socioeconomic elements, and environmental change under different climate change scenarios.

The SSP245 and SSP585 scenarios are widely used for future projections and decision-making in climate research. SSP 245 represents a moderate emissions pathway where adaptation measures are partially implemented, but urban poor populations still face significant risks, particularly in unplanned settlements lacking infrastructure resilience. SSP 585, on the other hand, represents a high-emissions pathway with extreme climate consequences, significantly affecting the urban poor through heat stress, flooding and food insecurity. Given this background, CCX has analysed various climatic parameters as per the SSP 245 and SSP 585 for near-term and mid-term.

3.1.1 Approach and Methodology for Climate Projections

To perform a Climate Vulnerability Assessment, the climate parameters of rainfall, alongside the minimum and maximum temperature, were extracted using the Coupled Model Intercomparison Project Phase 6 (CMIP 6). Historical trends and projections were analysed to understand the scope of potential risks, such as extreme weather events, cyclones, flooding, and urban heat islands.

The climate pathway projections were assessed under two warming scenarios run from CMIP 6 models—SSP 245 and SSP 585. The study period was separated into two future term periods: near term (2021-2040) and Medium Term (2041-2060) compared to the Baseline period (1995 -2014) as per the IPCC 6th Assessment Report.

The historical data were extracted from ERA5-Land Daily (dataset), which provides high-resolution daily meteorological observations. Historical and projected climate trends were analysed at the city level, reflecting overall changes in Bhubaneswar's climate profile. The Future scenario data SSP 245 and 585 have been extracted using Google Earth Engine (GEE), enabling reliable climate projections that can be predicted through the year 2100.

The table below describes the climate indicators considered in the assessment. These indicators are calculated for the near-term and medium-term periods relative to the baseline period on both

Scenarios, SSP 245 and 585, to evaluate the changes in Bhubaneswar's climate. The climatic indicators used for assessment are presented in the table below.

Table 3. 1 Indicators for Climate Pathway Analysis

S. No.	Indicator	Description
1	Total Rainfall	Total rainfall is the cumulative amount of rainfall observed in a day for a given year
2	Rainy Days	Rainy days are considered only if the rainfall is observed more than 2.5 mm per day.
3	Max daily rainfall	The highest recorded rainfall total for any single day within 24 hours and their Change in the near term (2041-20260), and medium (2021-2040) relative to the baseline (1995-2014).
4	Daily Rainfall 95th & 99th Percentile	Daily extreme rainfall is the precipitation amount that exceeds the 95th & 99th percentiles of the daily rainfall distribution for a year.
5	Max 3 days Rainfall	The highest total rainfall accumulated over three consecutive days within a year.
6	Maximum Temperature	The highest maximum temperature reached on a given day, which will be averaged each year
7	Minimum Temperature	The lowest minimum temperature reached on a given day, which will be averaged each year
8	Average Temperature:	The average temperature is the mean of the maximum and minimum temperatures observed in a single day, which will be summarised in the average for each year
9	Maximum & Minimum Temperature at 95th Percentile	Temperature exceeding the 95th percentile in both the daily maximum and minimum temperature for a given year
10	Extreme Hot days	The cumulative of days where the maximum temperature exceeds the threshold of the 95th & 99th percentiles of the daily maximum temperature from the base year and validated with near and medium-term years
11	Extreme Cold Days	The cumulative of days where the temperature exceeds the threshold of the 95th & 99th percentiles of the daily maximum temperature from the base year and validated with near and medium-term years

3.2 Climate Scenario Projections Results:

The above indicators have been used to analyse and compare near-term and mid-term data with the reference to baseline data.

3.2.1 Rainfall Analysis:

Under the SSP 245 scenario relative to the baseline, Bhubaneswar is projected to receive less annual rainfall, with total rain projected to decline considerably by 174 mm by mid-term. Also, there is a marginal increase in the number of rainy days. In terms of extreme daily rainfall, there is a marginal decrease at the 95th percentile (top 5%), but a substantial decrease for the 99th (top 1%), indicating fewer extreme rainfalls in the city. Likewise, the maximum 3-day rainfall diminishes by approximately 50% from the baseline, suggesting a reduced flood risk and an increased drought-based conditions under the SSP 245 scenario.

Table 3. 2 Rainfall Projections as per SSP 245

Average	Total Annual Rainfall (mm)	Rainy Days (no. of days)	Max daily Rainfall (mm)	Daily Rainfall 95th (mm)	Daily Rainfall 99th (mm)	Max 3 day Rainfall (mm)
Baseline	1597.50	116.70	88.06	20.34	41.24	414.64
Near Term	1395.14	118.65	60.56	17.73	30.30	322.32
Medium Term	1423.00	118.90	41.47	18.28	27.73	251.45

The SSP 585 scenario, Bhubaneshwar, is projected to experience an increase in total rainfall and rainy days, indicating wetter conditions. Conversely, the extreme rainfall parameters like maximum daily rainfall will drop from 88.06 to 58.79 (near-term) and 39.16 (medium-term) and daily rainfall at 95th and 99th percentiles will also decline significantly compared to the baseline. Similarly, the maximum 3-day rainfall declines in both scenarios. These changes point to a reduction in intense flooding events, creating favourable conditions for implementing watershed management and enhancing rainwater harvesting infrastructure for sustainable water conservation.

Table 3. 3 Rainfall Projections as per SSP 585

Average	Total Annual Rainfall (mm)	Rainy Days (no. of days)	Max daily Rainfall (mm)	Daily Rainfall 95th (mm)	Daily Rainfall 99th (mm)	Max 3 day Rainfall (mm)
Baseline	1597.50	116.70	88.06	20.34	41.24	414.64
Near Term	1646.25	127.90	58.79	20.18	32.73	317.59
Medium Term	1633.80	130.15	39.16	19.67	28.58	251.75

3.2.2 Temperature Analysis

Climate projections from SSP 245 (moderate emissions) and SSP 585 (high emissions) scenarios indicate a warming trend in Bhubaneshwar city over the next few decades. This includes a rise in average, maximum, and minimum temperatures and significant increases in extreme heat

conditions. These increases in temperatures will have direct repercussions on health, infrastructure and livelihoods in Bhubaneswar.

Under SSP 245 scenario. The average maximum temperature is expected to increase by 1.3°C in near-term and 2.4 °C in the medium -term. The number of extremely hot days—defined as days when temperatures exceed the 95th percentile —is expected to increase from approximately 18 days per year during the baseline period to 21 days in the near term, and further to 34 days in the medium term.

A major concern arises due to an increase in minimum temperature in both near-term and mid-term scenarios, indicating warmer nights.

Table 3. 4 Temperature Projections as per SSP 245

Average	Max Temp (°C)	Min Temp (°C)	Avg Temp (°C)	Max temp_95 (°C)	Min temp_5 (°C)	Min_ temp_95 (°C)	Extreme hot days 95th (days)	Extreme hot days 99th (days)	Extreme cold days 5th (days)	Extreme cold days 1st (days)
Baseline	31.60	22.68	27.14	38.41	14.00	28.17	18.30	3.70	18.30	3.70
Near Term	32.94	23.74	28.34	38.73	16.11	28.67	21.05	5.70	3.40	0.60
Medium Term	34.06	24.59	29.33	39.55	17.17	29.67	34.30	9.05	0.10	0.00

Additionally, there is a notable increase in the frequency of days with extremely high temperatures, which is projected to increase from 18 days (baseline) to 34 days (medium-term) and 52 days (medium-term) in both the SSP 245 and 585 scenarios, respectively. The frequency of cold days would also decline notably in both the scenarios. In the medium term, the cold days will decrease from 18 days to nearly 3 days and almost nil.

Table 3. 5 Temperature Projections as per SSP 585

Average	Max Temp (°C)	Min Temp (°C)	Avg Temp (°C)	Max temp_95 (°C)	Min temp_5 (°C)	Min_temp_95 (°C)	Extreme hot days 95th (days)	Extreme hot days 99th (days)	Extreme Cold days 5th (days)	Extreme Cold days 1st (days)
Baseline	31.60	22.68	27.14	38.41	14.00	28.17	18.30	3.70	18.30	3.70
Near Term	32.84	23.66	28.25	38.78	15.98	28.73	22.25	4.80	3.10	0.60
Medium Term	34.43	24.96	29.70	40.58	17.39	29.98	52.60	23.10	0.10	0.00

These temperature projections underscore the increasing impact and duration of heat stress conditions in Bhubaneswar, which will disproportionately affect outdoor workers, low-income households, vulnerable groups, and households living in informal settlements with poorly built infrastructures. This heat stress causes reduced work productivity, increased energy demand, extensive usage of cooling systems, and increased health risks to outdoor workers and targeted impacts in children and women. This motivates the need to integrate heat risk reduction into urban planning, public health systems, and livelihood protection strategies.

3.3 Climate Vulnerability Assessment (ward-wise)

Climate projections studied at the city level provide a comprehensive understanding of future trends and impacts in Bhubaneswar. However, there will be a limitation on intra-urban variations that exist in which Bhubaneswar has a diverse landscape of urban infrastructure, informal slum settlements, and varying climate exposure, ward-wise analysis becomes essential to understand the vulnerability, exposure, and adaptive capacity of urban slums and their livelihoods across slums and the various parts of the city.

The ward-wise analysis helps us in:

1) Understanding and identifying the specific wards that are most vulnerable due to climate risks, such as cyclones, floods, and heatwaves.
2) Identifies vulnerable settlements and communities, particularly those living in slum areas that are most susceptible to extreme weather events.

This GIS-based analysis lays the foundation for a deeper investigation into the livelihoods of those living in these vulnerable slums. This will allow a more localised level of climate vulnerability, allowing the identification of priority areas where interventions are needed and increasing the resilience of livelihoods in the slum areas.

3.3.1 Data and Methodology

The indicators listed below were used to identify vulnerable wards in Bhubaneswar. Each ward was assigned a score from 1 to 5 based on its relative ranking among all wards, with 1 indicating low vulnerability and 5 indicating high vulnerability.

Table 3. 6 Description of Variables for GIS Mapping

S. No.	Indicator	Variables	Description	Source	Index (Categories)
1	Demographics	Slum Area	Number of Slums per Ward	Disaster Management Plan, BMC (2024-25)- Pg No: 22,23	1 to 5 from equal percentiles
2	Extreme Weather Events	Cyclone & Floods	Occurrence of Cyclones & Floods per each ward	Disaster Management Plan, BMC (2024-25)- Pg No: 22,23	0 & 5 from Disaster Management Plan
3		Heat waves	Occurrence of heatwaves per each ward		
4	Climate Indicators	Minimum Air Temperature	Index of Minimum Air Temperature at 2m above ground level by estimating slope using percentiles.	ERA5 Data, Year- 1990 to 2024	1, 3 and 5 from Trend Slope Percentiles

S. No.	Indicator	Variables	Description	Source	Index (Categories)
5		Minimum Skin Temperature	Index of Minimum Surface (skin)Temperature at ground levels by estimated slope Quantiles		

1. The indicators shown above are extracted to incorporate demographics and climate data from the Bhubaneswar Municipal Corporation's (BMC) Disaster Management Plan report and the climate data from the ERA5 dataset to ensure a comprehensive understanding of climate and social vulnerability at the ward level.
2. Categorisation of indicators using Quantiles:
   To ensure comparison across each ward in Bhubaneswar, the indicator was converted into ranked categories using quantiles (percentiles).
   - Wards were divided into equal percentiles, such as 20%, 40%, 60%, 80%, and 100% and categorised as 1 (lowest) to 5 (highest).
   - In cases where parameters required simplification, 33%, 66%, and 100% were used and categorised as 1, 3, and 5.

   This standardisation ensures that each ward receives a comparable score for each variable for the identification of vulnerable wards in Bhubaneswar.
3. Index calculation:
   Once the indicators, including extreme weather events, climate trends, and demographics, were categorised for each ward, they were then summed to produce a Total Vulnerability score for each ward, as mentioned below.

$$\boldsymbol{Index} = \sum \boldsymbol{Extreme\ Weather\ Events} + \sum \boldsymbol{Climate\ Trend\ Index} + \sum \boldsymbol{Demograghics}$$

4. The Index or total vulnerability score will be used for identifying Vulnerable wards and will be categorised as follows:
   - Very Low Vulnerability (1st - 20th percentile) - 1
   - Low Vulnerability (20th - 40th percentile) - 2
   - Moderate Vulnerability (40th - 60th percentile) - 3
   - High Vulnerability (60th - 80th percentile) - 4
   - Very High Vulnerability (80th - 100th percentile) - 5
5. The final vulnerability scores were visualised using GIS (Geographic Information Systems) mapping. Each ward was mapped based on its vulnerability level. This identification of vulnerable wards, which addresses both climate and social vulnerability, identifies the vulnerable populations and livelihoods that are prevalent to conduct a livelihood survey to understand the vulnerability.

3.4 Vulnerable Index maps and interpretation

The GIS maps presented here are the outcome of a detailed ward-level analysis to address Bhubaneswar's climate risk and social vulnerabilities. These maps will reveal information on affected wards with slums that are more vulnerable to extreme weather events. The analysis covers a slum-index map, cyclone + flood, heatwaves maps, and other detailed maps, such as minimum air and land temperature analysis and the Total Vulnerability Index calculation table for all wards, which are attached in Annexure 1: GIS-based analysis. This also includes the heatwave map from the satellite, which validates the data from BMC.

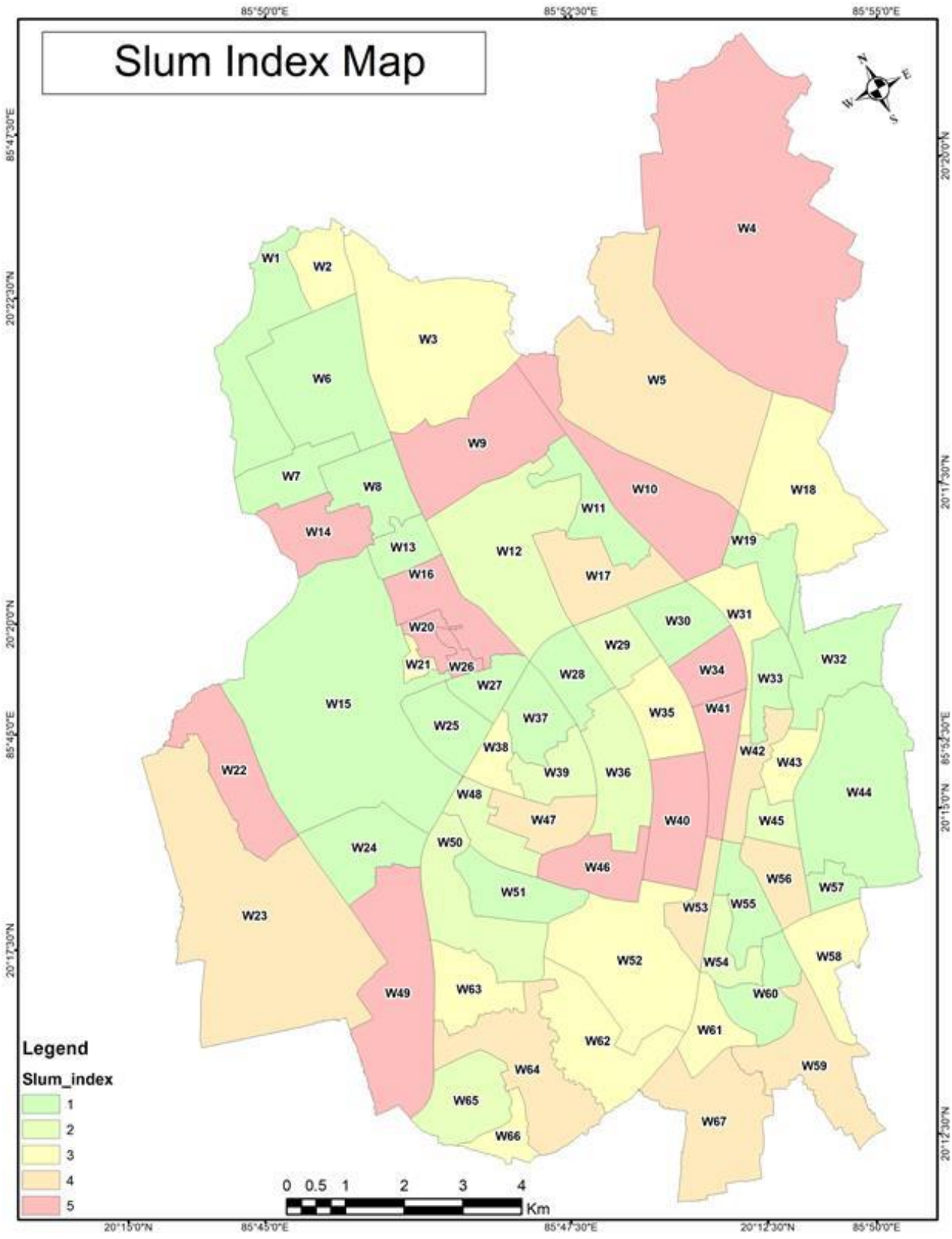


Figure 3. 1 Slum Index Map of Bhubaneswar

The above Slum index map shows wards with significantly very higher concentrations (index 4 and 5) and lower concentration of slum settlements (index 1 and 2), in which 23 wards have a very high number of slum settlements with a range starting from 7 and at the maximum, 29 slums present in Ward No: 22.

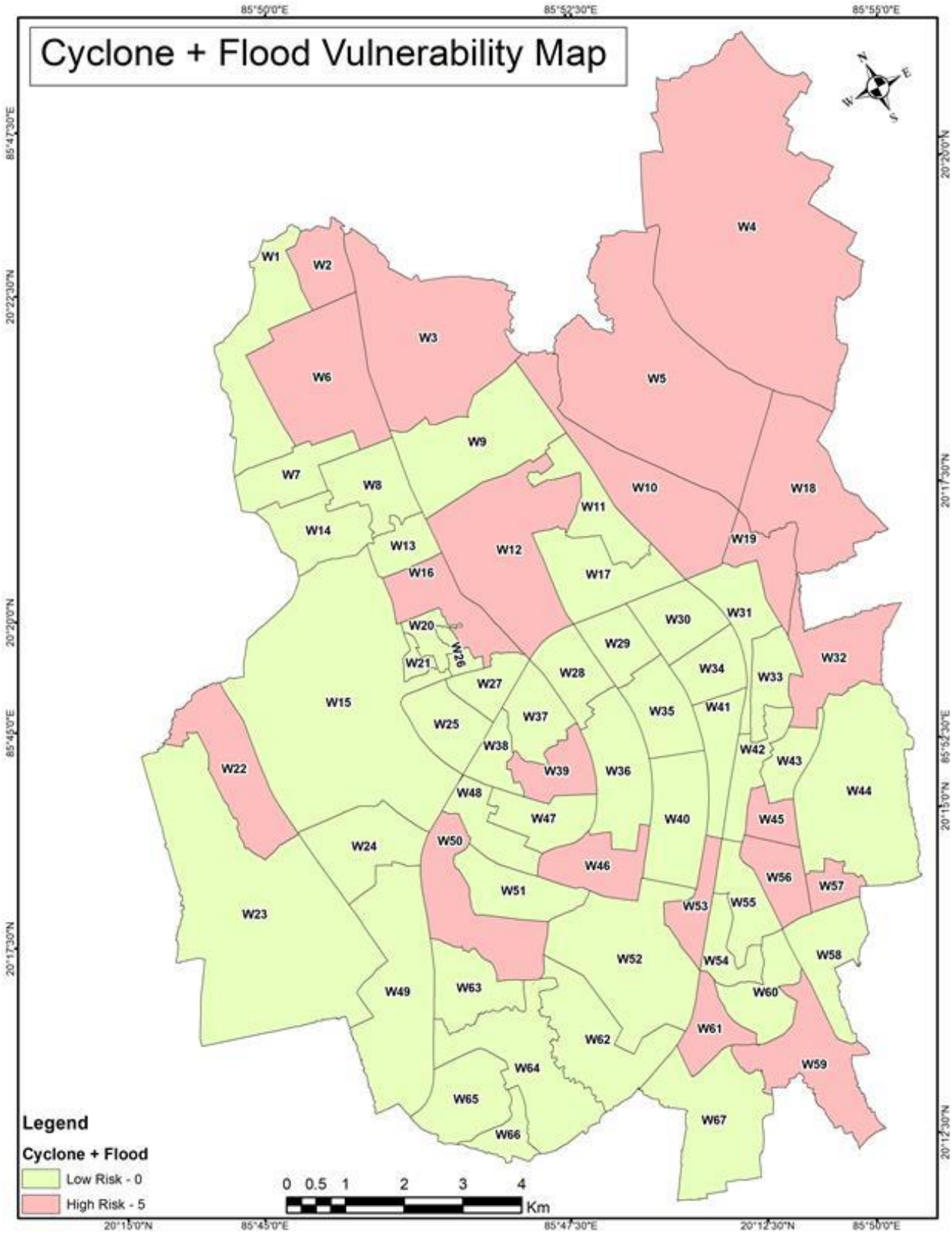


Figure 3. 2 Cyclone + Flood Vulnerability Index Map of Bhubaneswar

The Cyclone and Flood Vulnerability Index, sourced from the BMC, considers the history of cyclone and flood occurrences, area-specific occurrences of extreme weather events such as urban floods, waterlogging, and heavy rainfall, and other indicators. It revealed that 26 wards have been potentially impacted and identified as highly vulnerable to both cyclones and floods. The Index is given as High Risk (5) and Low Risk (0) in the Cyclone + Flood and Heatwave maps. The figure

below indicates a ward-wise heatwave map from BMC, and it has been validated with a satellite map along with the climate trend maps (Annexure 1).

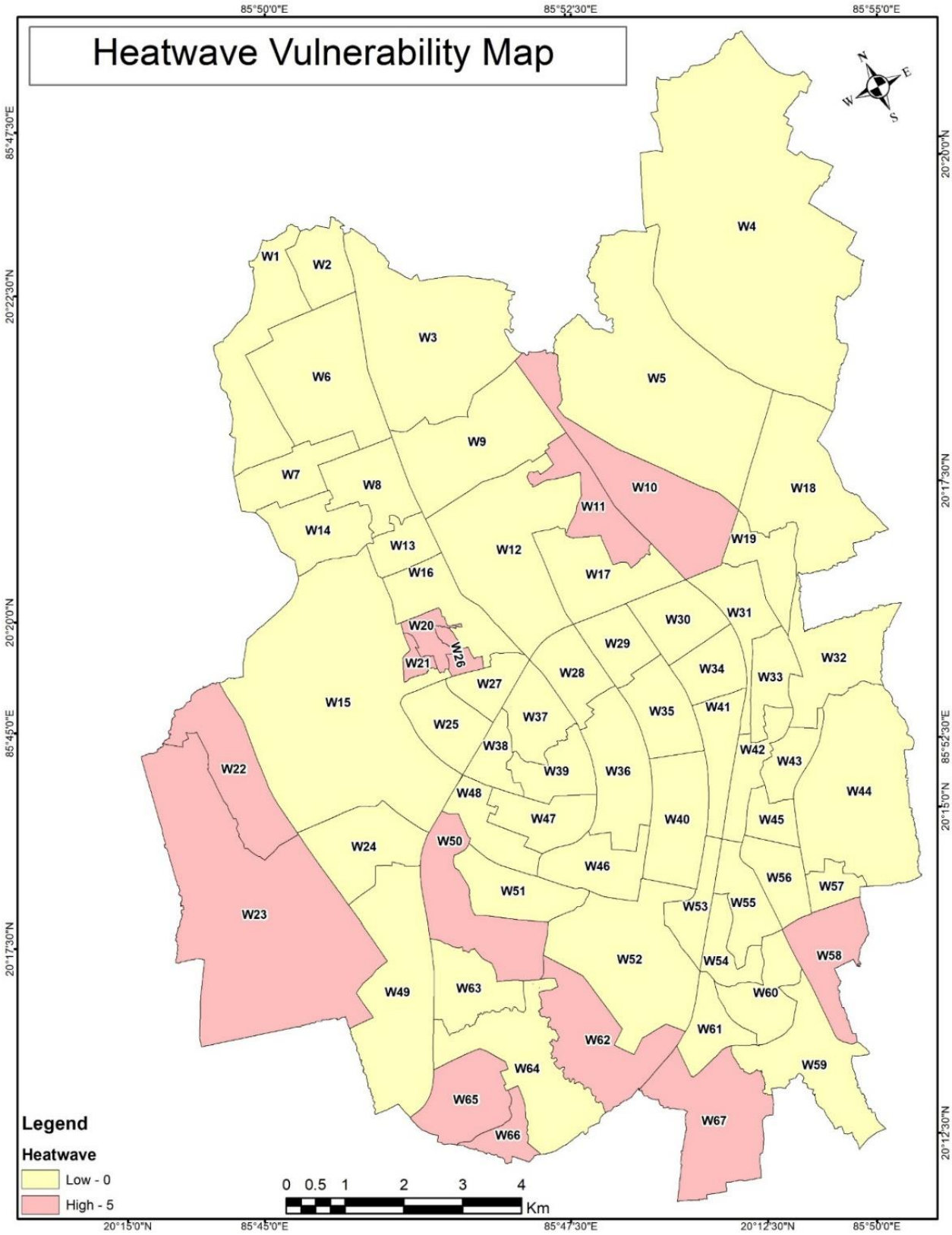


Figure 3. 3 Heatwave Vulnerability Index Map of Bhubaneswar

3.5 Results: Total Vulnerability Index and GIS Mapping

The GIS-based mapping of the Total Vulnerability Index for Bhubaneswar was developed by aggregating composite scores derived from multiple parameters, including observed climate trends, cyclone and flood risk maps, heatwave exposure maps, and demographic characteristics across individual wards. This analysis was conducted for notified and non-notified slum settlements, as illustrated in Figures 2.8 and 2.9 (BMC, 2016). The vulnerability index was categorised on a scale ranging from very high vulnerability (*5*) to very low vulnerability (**1**), providing a spatial representation of areas most at risk to climate-related impacts.

Total Vulnerability Index Map (Notified Slums):

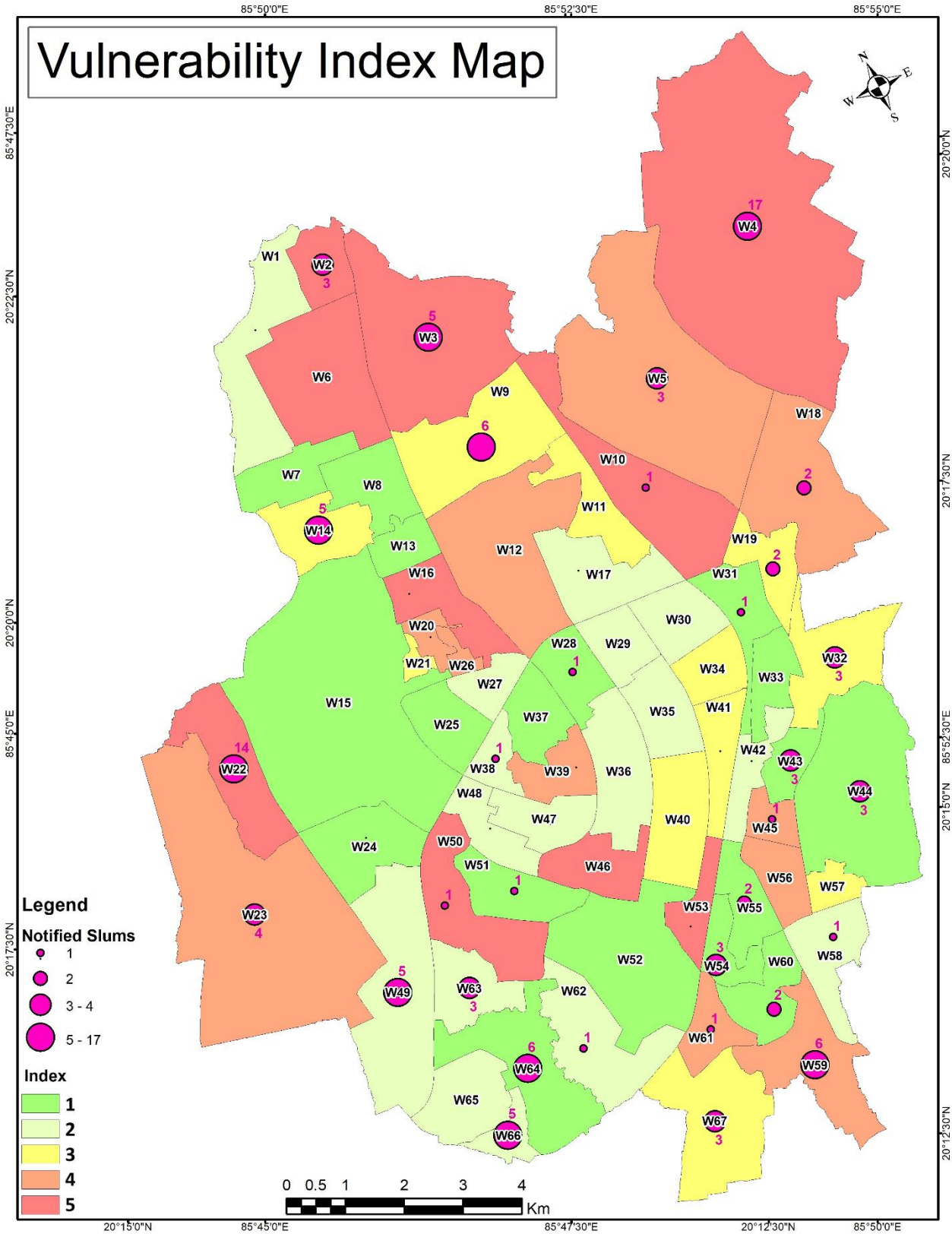


Figure 3. 4Total Vulnerability Index Map with Notified Slum Areas of Bhubaneswar

Total Vulnerability Index Map (Non-Notified Slums):

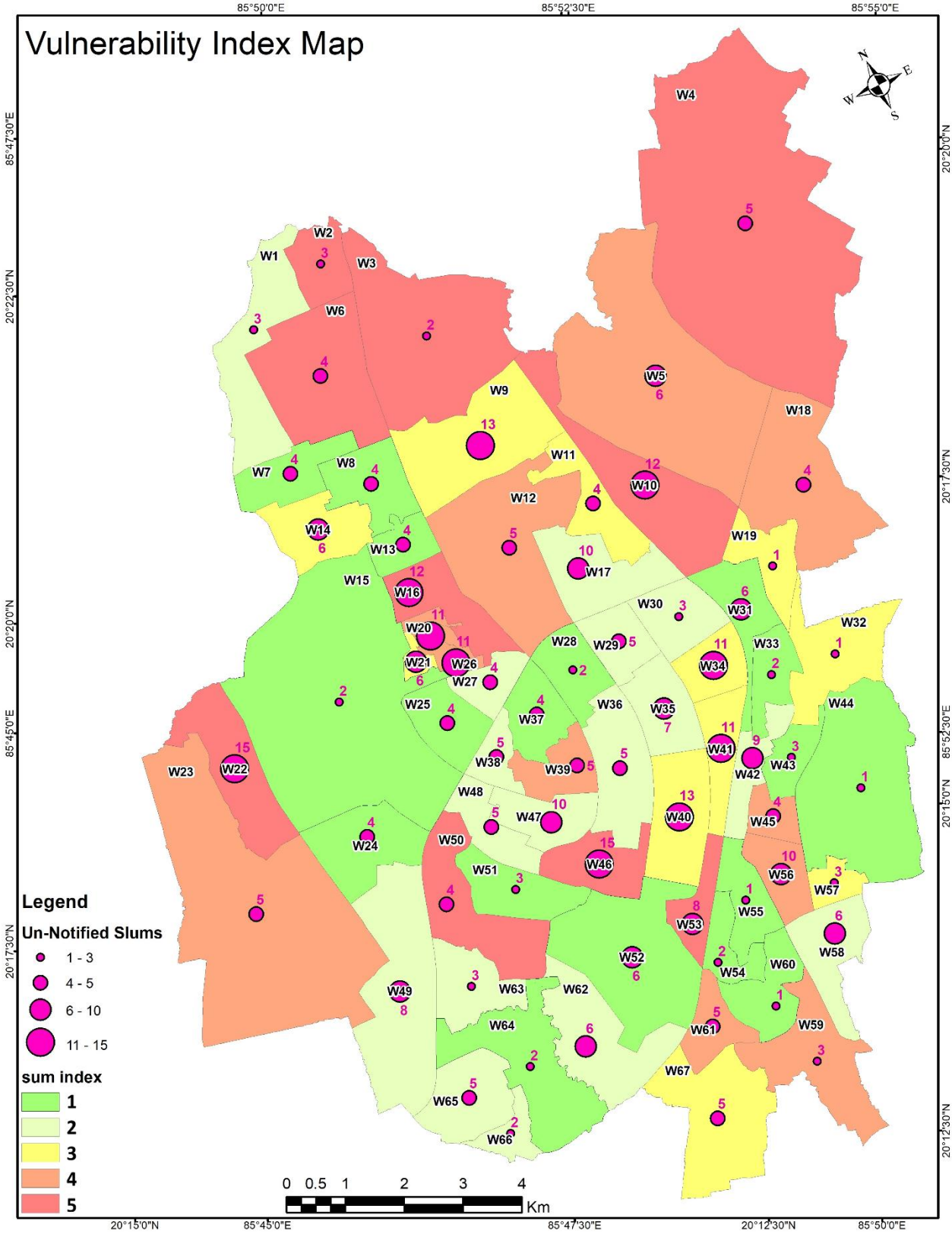


Figure 3. 5 Total Vulnerability Index Map with Non-Notified Slum Areas of Bhubaneswar

3.6 Selection criteria for Vulnerable Slums: Livelihood Survey

Building upon the GIS-based vulnerability mapping of ward-wise analysis in Bhubaneswar, vulnerable wards are identified by developing the vulnerability index that incorporates climate trends, socio-demographic exposure to climate vulnerability and ward-wise exposure of extreme weather events in Bhubaneswar. The next step is to select the slums for the urban poor livelihood survey; this has been identified based on the criteria as mentioned below:

1) Wards and slums with higher levels of vulnerability (Vulnerability Score - 5 and 4) to extreme weather events and increased trends are prioritised.
2) Shortlisted based on notified slums and non-notified slums to capture the urban poor's livelihood experiences in these settlements
3) Demographics with higher slum populations as per the BMC report.
4) Consider insights from the stakeholder consultation with allied departments and the on-ground field visits by the CCX Bhubaneswar team to refine the slum selection for the livelihood survey, using on-ground insights that may differ from the secondary analysis.

Table 3. 7 Results of GIS Mapping and Total Vulnerability Score

Categories	Description	Ward Numbers	Total wards	Wards with Notified Slum Areas (BMC, 2016)	Total Wards (Notified Slums)	Total Slums	Total Slums (Non-notified)	Total Slums
5	Very High Vulnerability	W56, W12, W16, W46, W39, W50, W45, W53, W22, W6, W4, W10, W3, W2	14	W2, W3, W4, W50, W45, W22, W10	7	42	104	146
4	High Vulnerability	W19, W5, W59, W57, W32, W18, W61, W11, W26, W21, W20, W41, W23	13	W18, W19, W23, W32, W5, W59, W61	7	21	71	92
3	Moderate Vulnerability	W66, W62, W58, W67, W9, W17, W34, W40, W42, W47, W14	11	W14, W58, W62, W66, W67, W9	6	21	91	112
2	Low Vulnerability	W49, W65, W29, W35, W36, W38, W63, W48, W27, W30, W1	11	W49, W38, W63	3	9	53	62
1	Very Low Vulnerability	W31, W33, W43, W54, W55, W44, W60, W64, W25, W51, W7, W13, W24, W28, W37, W52, W15, W8	18	W 28, W31, W43, W44, W51, W54, W55, W60, W64	9	22	55	77

Out of 67 wards in Bhubaneswar, 27 wards are under the highly vulnerable categories (14 in score 5 and 13 in score 4). Of these, 14 are notified slums as per BMC (2016). These wards make up 238 total slums, of which 63 are notified. The other categories, from very low to medium, comprise 40 wards, of which the notified slums are present in 18 wards.

3.7 Selection List and Rapid Survey of Slums:

Among these 63 highly vulnerable notified slums (in 14 wards), a livelihood survey has been planned by selecting the wards and slums based on the comprehensive structured selection criteria. The initial list of 12 slums, where 11 slums were selected based on highly vulnerable wards and slum wise population. Additionally, Ward No. 67 have been included as per the initial consultations with the BMC official in the Disaster Management Unit due to higher exposure and damage from extreme weather events.

A rapid survey had been conducted in selected slums of Bhubaneswar to verify the impact of climate on the urban poor, which began with a tentative list of slums prepared based on the analysis and criteria for selecting slums. If the slums are affected, FGDs and surveys were conducted in the selected slums. Otherwise, new slum areas within the vulnerable wards, were added, This step was taken to ensure the ground realities and to refine them with revised slums that are more vulnerable than the identified slum settlements for both quantitative and qualitative surveys. Besides the selected slums, other notified and non-notified slum visits to identify vulnerable wards are mentioned in Annexure 2: Initial Slum List and Rapid slum visit.

Once the rapid survey was completed, the livelihoods survey for 10% of the sample population, 175 respondents, was conducted using a revised list of 15 vulnerable slums (9 wards) identified from the field survey. Four slums were replaced and amended from the initial list, and two were non-notified (W-23 Laxminagar Subudhipur and W-5 Patadei Basti) slum settlements

Table 3. 8 List of Slums for Quantitative Survey

S. No	Ward No	Zone	Name of notified slums	Type of livelihoods
1	2	North	Shikarchandi cluster III	Construction worker, Daily wage labourer, Domestic worker, small business owner, Street vendor
2	3	North	CS Pur Sabar Sahi	Daily wage labourers
3	4	North	Bhoi Sahi	Daily wage labourer, Mason Worker
4	4	North	Jena sahi nakhara	Daily wage labourers
5	5	North	Maa Patadebi Basti	Small business owners, daily wage labourers, salaried factory workers, dry fish shop owners, betel shop owners, grocery shop owners, laundry workers, BMC municipal workers, tailors, beauty parlour workers, electronics repair technicians.
6	5	North	Bhot Pada	Domestic worker, Daily wage labourer, small business owner, Street vendor, Bhatta (Old age pension holder)
7	10	North	Bhot pada	Daily wage labourer, Domestic worker, Press, Small business owner, Street vendor
8	22	South - west	Shampur	Daily wage labour, street vending, auto driving, small shop ownership, hospital cleaning staff, Home-based tailoring, homemade snack preparation
9	22	South - west	Jhokalandi cluster 7	Daily wage labour, hawking and door-to-door product sales, small home-based shops, tailoring from home, hospital cleaning staff, drivers.
10	23	South-West	Laxminagar Subudhipur	Construction worker, Daily wage labourer, Small business owner, Street vendor
11	64	South-West	Dumduma Nua Bhoi Sahi	Daily wage labour, auto driver, Business, garage mechanic.
12	64	South-West	Jadupur Odia sahi	Daily wage labourer, Street vendor, Construction worker
13	67	South-west	Sunderpada Patna Sahi	Mansion workers, daily wage labourers, private company staff, BMC sanitation staff (tractor operators), auto-rickshaw drivers, taxi drivers, domestic help (maids), tailors, and small home-based grocery shop owners.
14	67	South-west	Kapilaprasada Bhata Bhoi Sahi	Construction worker, Daily wage labourer
15	67	South-west	Kapilaprasada Upper Bhoi Sahi	Construction worker, Daily wage labourer, Farmer, and Street vendors

Note: The light, green-highlighted slums denote the revised visits for the quantitative survey from the initial list of slums.

4 Section – II: Urban Poor Vulnerability Assessment

Based on the climate vulnerability Assessment findings and after the finalisation of vulnerable wards, a targeted qualitative and quantitative survey has been conducted to assess the impact of climate on the urban poor's livelihood.

4.1 Key Informant Interviews (KIIs)

Key Informant Interview (**KII**) was conducted with the relevant government organisations to understand the climate vulnerabilities prevalent in the vulnerable slums of Bhubaneswar. This includes the issues identified, initiatives implemented, formulation of plans and policies and focus areas, and future implementation in the vulnerable slum settlements.

Table 4. 1 List of KIIs

S. No	Organisation Name	Key Persons
1	Bhubaneswar Municipal Corporation (BMC), Odisha Disaster Management Authority	• Mr. Sachidananda Pati, Disaster Management Unit, BMC
2	Department of Health & Family Welfare, Ministry of Health & Family Welfare	• The Joint Director-cum-State Nodal Officer (SNO) of the Disaster Management Cell, Directorate of Health Services
3	Odisha Livelihood Mission, Department of Mission Shakti	• The Joint Secretary-cum-Addl. CEO, OLM • Manager, Mission Shakti Bazar

The Bhubaneswar Municipal Corporation (BMC) official mentioned the numerous challenges and impacts of climate hazards and recommended including ward No. 67 in the analysis, as it was highly affected by extreme weather events and their corresponding City Disaster Management Plan and Heat Wave action plan, among other BMC slum data.

The Odisha Health Mission has mentioned the challenges and initiatives to maintain basic and emergency healthcare services during climate-related extreme events. These include inventorying the medicine and instruments, implementing mobile health units with response teams, and providing solar-based systems for power backup to the hospitals and healthcare units.

The Joint Director from the Odisha Livelihood Mission and the Manager of Mission Shakthi mentioned the initiatives to enhance women's empowerment through handicrafts and other livelihoods to support income generation. These initiatives will positively impact and reduce the burden of financial conditions, especially during extreme weather events. The discussion is summarised into three categories: climate hazards and impacts, measures taken during hazards, and recommendations. Detailed KII is attached in the Annexure 3: Key Informant Interviews.

- **Climate Hazards & Impacts:**
  - Intense, short-duration rainfall leading to urban flooding.
  - Rising temperatures are causing heatstroke and heat-related illnesses.
  - Increased vector-borne, respiratory, and waterborne diseases, such as malaria, dengue, and other diseases, especially post-floods.
  - Poor housing and drainage systems in slums amplify vulnerability to floods and heat waves.
  - Pregnant women, infants, and children face increased health risks due to inadequate prenatal care and poor living conditions.
- **Measures taken during Hazards:**
  - Provision of shelters, food, and evacuation, and Early warning systems in place for timely evacuation.
  - 30 flood-prone areas identified; high-capacity pumps installed; Emergency dewatering by Fire Services.
  - In terms of access to water and transportation, "Drink from tap mission" helps in access to clean water, and the "MO BUS service" ensures mobility during emergencies
  - The Odisha Health Mission has implemented several measures to ensure healthcare continuity during climate emergencies, including stockpiling essential medical supplies, deploying mobile health units and emergency response teams, and equipping hospitals with solar energy systems and flood-resilient infrastructure.
  - Simultaneously, health resilience is strengthened through training on early disease recognition and hygiene practices, along with infrastructure measures like rainwater harvesting and telemedicine. Urban greening efforts, including the expansion of parks, green roofs, tree plantations, and heat-absorbing pavements, further enhance climate adaptation in vulnerable communities.
  - The Odisha Livelihood Mission (OLM) – Mission Shakti promotes women's empowerment and livelihood resilience through self-help groups that support income generation, skill development, credit access, and community services such as fair price shops and mid-day meal programs.
- **Recommendations:**
  - Focus on healthcare resilience by expanding solar installations, climate-proofing medical storage, establishing early disease warning systems, and encouraging community participation in climate-health initiatives.
  - Strengthening of energy infrastructure to prevent outages in poor communities, investing in resilient infrastructure using durable, low-carbon materials, and improving housing and drainage in informal settlements.

- Community awareness campaigns are essential to promote adaptive behaviours in slums, while integrating climate resilience into affordable housing schemes like RAY and Swarna Jayanti Shahari Rozgar Yojana is a key policy direction.
- Strengthen public-private partnerships and increase funding for disaster resilience.
- Policy support from SUDA and NULM to broaden employment programs and shelters, while continuing assistance to street vendors and BPL families through the Public Distribution System (PDS) and various livelihood promotion schemes.

4.2 Focus Group Discussions (FGDs)

The Focus Group Discussions (**FGDs**) were conducted on **5 slums,** of which **three are notified slums** and the other **two are non-notified slum** settlements as per the BMC (2016), although our focus of interventions is not on non-notified slums, to understand the on-ground and lived experiences and perspectives of the residents on their slum's climate vulnerability on its livelihoods, working conditions, health, financial challenges and the coping mechanisms and adaptation practices,

Table 4. 2 List of Slums: FGDs

S.No	Ward No	Zone	Name of the Notified Slums (2016)	Type of livelihoods	Type of institutions	Notified
1	5	North	Maa Patadebi Basti	Small business owners, daily wage labourers, salaried factory workers, dry fish shop owners, betel shop owners, grocery shop owners, laundry workers, BMC municipal workers, tailors, beauty parlour workers, electronics repair technicians.	Anganwadi Centre	No
2	22	South-West	Shampur	Daily wage labour, street vending, auto driving, small shop ownership, hospital cleaning staff, Home-based tailoring, homemade snack preparation	Shampur Anganwadi Centre	Yes
3	22	South-West	Jokalandi Cluster-7	Daily wage labour, hawking and door-to-door product sales, small home-based shops, tailoring from home, hospital cleaning staff, drivers.	Jokalandi Anganwadi Centre	Yes
4	23	South-West	Maa Laxmi Nagar Basti	Daily wage labourers, factory workers, drivers, grocery shop owners, tailoring unit owners, vegetable shop owners, and beauty parlor workers.	Parichaya Gruha, Laxmi nagar	No
5	67	South-East	Sunderpada Patna Sahi	Mansion workers, daily wage labourers, private company staff, BMC sanitation staff (tractor operators), auto-rickshaw drivers, taxi drivers, domestic help	Patna Sahi Anganwadi Centre	Yes

S.No	Ward No	Zone	Name of the Notified Slums (2016)	Type of livelihoods	Type of institutions	Notified
				(maids), tailors, and small home-based grocery shop owners.		
6	16	North	Tarini Nagar Salia Sahi	Mason workers, auto drivers, daily wage workers, and small business owners.	Anganwadi Centre	No

Of these slums, two FGDs were carried out along with the **Mahila Housing Trust** (**MHT**) at Maa Patadebi Basti (Ward No: 5) and Maa Laxmi Nagar (Ward No: 23) settlements, which are non-notified slums and falls under the highly vulnerable wards (Vulnerability index score: 5 and 4). Additionally, we have conducted a one-to-one discussion with households at Tarini Nagar, Salia Sahi (Ward No. 16), a non-notified slum settlement.

From these settlements, the FGDs were conducted with daily-wage workers, home-based businesses, market spaces, slum dweller associations (SDA), health workers, Anganwadi, etc., to identify the common livelihoods, challenges due to climate and financial vulnerability,

In summary, five FGDs conducted in both the notified and non-notified slums indicated that residents from these settlements were affected by major climate hazards such as cyclones, floods, heatwaves, and heavy rainfall, which impact their livelihoods. Daily wage labourers, home-based businesses, street vendors, and small shopkeepers are particularly vulnerable, as they frequently face income and revenue losses due to damaged goods or supplies, work disruptions, and operational shutdowns in small-scale workshops and businesses.

They do face numerous health issues such as dehydration, respiratory & waterborne diseases, sunstroke, and these are more intensified due to a lack of sanitation facilities in both the workplace and houses, with a lack of access to healthcare facilities as their workplaces and homes are built. Built-in asbestos and tin sheets are harmful to health due to poor ventilation and are more vulnerable or can be blown away when there is a heavy cyclone with high wind speed levels. Other challenges include waterlogging, cyclone shelters, drainage systems, frequent power cuts and water availability.

The responses and insights from the FGDs and discussions with grocery shops, home-based businesses, and market spaces are mentioned in the sections below. Detailed discussions with grocery shops, home-based businesses, market spaces, street vendors, and testimonials are attached in Annexure 4: Qualitative Interviews and Annexure 5: Testimonials.

Table 4. 3 Insights from the FGDs

S. No	Ward	Livelihood vulnerability	Health Vulnerability	Infrastructure vulnerability	Access to Energy/Water	Financial	Adaptation/Resilience measures
1	Maa Patadevi Basti, Ward-5	• Most affected livelihoods: Street vendors and small shopkeepers • Transportation of goods is difficult – loss of daily income and business • Business operations are halted for 3 to 4 hours during rainfall.	• Dehydration due to heat • Fatigue • Heatstroke	• Types of Roofing Used: Tin sheets, cement sheets, asbestos—often temporary and heat-conducting. • These setups are inadequate against heavy rain, strong winds, or intense heat- tarpaulin sheets, bamboo frames, or basic umbrellas. • Commuting to the workplace is difficult. • No space for business. There is a lack of proper ventilation and cooling systems for those working indoors. • Markets lack proper shade and ventilation. • Vendors wait an additional 2 to 3 hours for waterlogging to subside after heavy rain. • Rainwater entering stalls or shops causes spoilage of goods.	• Frequent and prolonged power outages during calamities and in summer. • No power backup for a small business	• Extreme weather causes both immediate and long-term financial losses. • Repairing or replacing structures - more financial stress. • Vendors with insufficient savings often seek financial support or short-term loans to restock and restart operations.	• Reduce the working hours from noon to late afternoon – daily wage workers and small vendors • Essential infrastructure is repaired first. • Overall, normal life and business activities usually take about 15-20 days to stabilise after such events.
2.	Maa Laxmi Nagar, Ward_23	• Daily wage labourers and home-based business owners lose workdays due to adverse conditions, • Dairy farmers struggle with livestock suffering from heat stress and inadequate shelter, especially during cyclones. • Stored goods and machinery are frequently damaged by water ingress. • Medical care is delayed due to the 2 km distance and transportation challenges.	• Sunstroke • Fatigue • Post-rain conditions lead to digestive infections, hepatitis, and fever due to poor sanitation.	• Infrastructure in informal workspaces is inadequate for withstanding climatic events. • Homes and workspaces are mostly built with asbestos or tin sheets, which are often damaged during cyclones. • Ventilation is poor, with makeshift cooling using straw or plastic sheets. • There is no proper drainage system, leading to rainwater entering homes and shops. • The community lacks formal disaster relief and financial support. • No cyclone shelters are available near the slum area	• Electricity and water services are disrupted during extreme weather, worsening living conditions. • Frequent power cuts (30 minutes to 1 hour daily) lower productivity for tailors and shopkeepers.	• Repairing cyclone damage often costs between ₹10,000 to ₹30,000, while stock losses during flooding can reach ₹1–2 lakh. • Rely on informal credit from SHGS or moneylenders at high interest rates • Small businesses suffer as they cannot afford backup power systems.	• Reduce the working hours from noon to late afternoon – daily wage workers and small vendors • Typical recovery takes around 2 weeks. • Essential infrastructure is repaired first. • Structural repairs take up to two months
3	Jokalandi Cluster 7, Ward 22	• Most vulnerable livelihoods include daily wage workers such as masons, painters, and cleaners.	• Sunstroke • Dehydration, • Discomfort, especially for children and the elderly.	• Tin-roofed or mud-walled structures cannot tolerate extreme heat with limited or no access to fans or ventilation.	• Reliability and quality of these services remain inconsistent during calamities.	• Women earn ₹200–₹250 per day; men earn ₹300–₹400, depending on work availability.	• Labourers adjust their schedules during summer to avoid peak heat, working from 6 AM to 12 PM and again from 3 PM to 6 PM.

S. No	Ward	Livelihood vulnerability	Health Vulnerability	Infrastructure vulnerability	Access to Energy/Water	Financial	Adaptation/Resilience measures
		• Cyclones and heavy rain halt work entirely for daily wage labourers and small shop owners. • Extreme weather lowers customer footfall, impacting earnings for small-scale entrepreneurs like tailors and shopkeepers. • Small business owners face challenges from irregular demand, power outages, and stock spoilage.	• Waterborne diseases and respiratory problems due to water contamination and damp living conditions. • Wood dust from a local furniture workshop contributes to respiratory health risks. • Limited medical support is available, with only basic aid like ORS packets distributed. • A government medical centre is 1 km away, but immediate healthcare within the slum is inadequate. • Regular health checkups are lacking.	• Vulnerable to leaks and minor flooding, disrupting both daily life and business operations.	• Water is sourced from a public tap, leading to long wait times and occasional shortages. • Sanitation is available, though most toilets were built with personal funds, without government support. • Electricity is frequently disrupted during cyclones and summers, worsening the impact of climate hazards, and is restored within 3–4 days post-disaster.	• Tailors earn only ₹50–₹100 per day and only when they receive orders. • Many rely on high-interest loans from local moneylenders for home repairs or to survive during business downtimes. • Contractor payment delays worsen financial instability for wage labourers. • Typical repair costs range from ₹20,000–₹25,000, paid out of pocket.	• If the worksite is nearby, labourers return home to rest during the midday break. • If the worksite is distant, they seek shelter on-site during the hottest hours. • 1-2 weeks recovery time.
4	Tarini Nagar, Ward no. 16 – unnotified slum	• Most vulnerable livelihoods include daily wage workers such as masons, painters, and cleaners. • Flooding: Though the slum has not faced a flood situation, it has faced heavy rains, leading to waterlogging for 2-3 hours.	• Sunstroke • Dehydration,	• Houses are typically made of temporary or Kacha (**Tin & Asbestos sheets**) materials, which get damaged during cyclones.	• Electricity is frequently disrupted during cyclones and summers. • Food shortages in climate events and disruptions last up to 10 days.	• People rely on high-interest loans. • 8 to 15 thousand for full damage due to climate events •	• Recovery time is usually 1 to 3 weeks. • During cyclones, they seek shelter at a nearby school but have to arrange food on their own. • Residents rebuild their homes using their own funds, without any financial support from the government. • Savings are used to fix infrastructure and cater to household needs.
5	Shampur Slum, Ward no. 22	• Men commonly work as daily wage labourers, street vendors, auto drivers, or run small shops. • Most women are housewives, but some run home-based businesses like tailoring or selling snack mixtures. • Street vendors and daily wage workers are highly vulnerable due to working in open spaces during heavy rains, heat waves, and cyclones.	• Heatstroke, • Waterborne diseases (e.g., cholera, dysentery) • Respiratory issues from mould and dust. • Food shortages during weather events cause nutritional challenges.	• Houses are typically made of temporary or kaccha materials, which get damaged during cyclones.	• Metered electricity connections: Power outages mostly occur during maintenance. • No alternative energy sources are available for households; only some businesses use battery-powered emergency lights.	• People spend their savings during climate hazards.	• The government provides food and essentials, but residents may need to collect them from nearby Anganwadi centres. • Shampur Slum has sufficient medicines and healthcare for common climate-related issues. • Emergency or critical cases are referred to government hospitals for advanced treatment. • Savings are used to fix infrastructure and cater to household needs. • No rent is charged for in-home businesses; Instead, residents contribute monthly funds for local development.

S. No	Ward	Livelihood vulnerability	Health Vulnerability	Infrastructure vulnerability	Access to Energy/Water	Financial	Adaptation/Resilience measures
6	Sunderpada Patni Sahi, Ward no. 67	• During extreme weather events, shops are closed, daily wage work stops, and transport is disrupted. • Reduced working hours by around 3 hours from the total working hours: 8 to 10 hours per day - labourers and street vendors. And days lost are due to irregular work, and illness during the summer & monsoon seasons • Most affected: Vegetable sellers, sweet shop owners, daily wage labourers, and home-based businesses like tailoring and grocery shops.	• Common issues include dehydration, heat exhaustion, waterborne diseases (during rains), • Lack of medical attention for the elderly and women due to cost and distance.	• Cyclone: Shops are shut due to fear of damage; loss of income for 1–2 weeks. • Heatwave: Small home-based shops and roadside vendors lack cooling, fans, or shade, making work difficult. • Heavy Rain: Waterlogging around shop entrances; no shelter for street vendors. Internal lanes get slippery and dangerous.	• Water supply - twice a day • Borewells are mostly dysfunctional. • No community toilets: people must go outside, which becomes harder during heavy rains. • No cold storage or proper lighting affects stock management in shops.	• Daily income is disrupted • No savings or insurance • Small businesses report low profit margins and cannot recover quickly from losses.	• Recovery time: 3–7 days to reopen after cyclones. • A limited number of solar lights have been installed at the household level, though street-level or lane lighting remains absent. • Some residents drink more water and avoid going out during extreme heat, but systematic health awareness, checkups, or access to ORS and basic medicines are limited. • Change in working hours to escape the extreme heatwaves. • Temporary shelters and makeshift structures are erected for shade and protection during heat waves and heavy rains.

Other issues:

- No access to government grants or insurance to cover disaster-related losses.
- Lack of financial support from the government during natural disasters like cyclones.
- Vulnerable groups like children, pregnant women, and lactating mothers are referred to government hospitals during severe weather.
- Women running home-based businesses are especially affected due to a lack of financial support and limited access to credit.

4.3 Market spaces, Street Vendors and Home-Based Business

1) Sada Behera, Vegetable Vendor

Name:	Sada Behera
Age:	38
Occupation	Vegetable Vendor
Contact Details	7991083196
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5

Mr. Sada Behera operates a roadside vegetable vending business near the market yard at Maa Patadevi Basti.

Store Setup and Operations

Mr. Sada Behera purchases fresh vegetables daily from the local Sabji Mandi at wholesale prices. He operates from a designated roadside spot, open from 6 AM to 10 PM. His primary customer base comprises residents of the local community. Although he does not own land at the market, he pays a fee to the market committee for usage rights. He lacks an electricity connection and relies on streetlights and portable charging lights during power emergencies.

Needs and Aspirations

Access to cold storage facilities reduces spoilage and improves profit margins. Provision of independent electricity connections to enhance operational efficiency. Temporary shelters or vending infrastructure to protect his setup from adverse weather conditions. Insurance or disaster relief schemes to support recovery during climate disruptions, as businesses typically shut down for 4–5 days during such events.

2) Mr. Satya Behera, Vegetable Seller

Name:	Mr. Satya Behera
Age:	30
Occupation	Vegetable Seller
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5

Mr. Satya Behera sells vegetables daily near the local market yard and serves residents of the area.

Store Setup and Operations

Mr. Satya Behera follows a two-shift schedule, from 6 AM to 12 PM and 2 PM to 9 PM. Buys vegetables from the nearby Sabji Mandi and sells them at retail prices. Similar to other vendors, he does not own a permanent space but uses a designated vending spot, paying a regular fee to the market committee. He lacks direct electricity access and depends on street lighting and portable rechargeable lights.

Needs and Aspirations

Cold storage access to reduce post-sale losses and maintain product freshness. Support with infrastructure development, such as a covered vending area to withstand weather-related disturbances. Formal electricity connections for improved lighting and safety. Inclusion in vendor insurance programs or government aid schemes for compensation during climate events, which typically cause 4–5 days of business shutdown.

3) Ms. Tunu Nayak, Small Business Owner (Variety Store)

Name:	Ms. Tunu Nayak
Age:	51
Occupation	Small Business Owner (Variety Store)
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5

Mr. Tunu Nayak operates a small variety store that is attached to his residence and caters primarily to the local slum community. The store plays an essential role in providing daily-use and seasonal items to the neighbourhood. The shop's electric supply is drawn from the house's main line, reflecting its modest setup and integration with the owner's household infrastructure.

Store Setup and Operations

The shop does not have a refrigerator, which restricts the ability to stock perishable items. Sales are highest during the winter season, likely due to increased demand for seasonal goods and comfort products. Mrs Nayak procures inventory from a wholesale market in Chakeisiani, ensuring a regular supply of essential commodities for her customers.

Needs and Aspirations

During natural disasters such as cyclones or heavy rains, the owner relocates shop stock to the house for protection. Despite these precautions, product damage still occurs, resulting in financial setbacks. It generally takes at least one week for Ms. Nayak to restore her store and recover her livelihood post-disaster.

4) Ms. Arati Pradhan, Tailor / Owner of a Small Tailoring Shop

Name:	Ms. Arati Pradhan
Age:	30
Occupation:	Tailor / Owner of a Small Tailoring Shop
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Ms. Arati Pradhan is a self-employed tailor operates a small tailoring shop in Jokalandi Cluster 7. Her business caters to the clothing needs of the local community and provides an essential service, particularly for residents seeking affordable and customised tailoring.

Store Setup and Operations

Ms. Arati Pradhan runs a small tailoring shop from a rented structure with an asbestos roof in Jokalandi Cluster 7. The shop caters primarily to the local community and serves as an essential service for residents seeking custom and affordable tailoring. Although the shop has a metered electricity connection with regular bill payments, power outages frequently disrupt her ability to complete orders on time, resulting in reduced daily income.

To cope with high temperatures during heatwaves, she modifies her working hours by operating only in the morning and evening and resting during the hot afternoon hours. Inside the shop, she manages the heat using a fan and natural ventilation.

Needs and Aspirations

Arati expressed a strong need for a reliable backup power solution, such as solar panels or inverters, to help her maintain consistent business operations during outages. She also highlighted the economic strain caused by climate-related events like floods and storms, which force her to shut down for one to two weeks at a time. Support in the form of financial aid or recovery assistance during such periods would help her stay afloat.

Additionally, Arati is eager to upgrade her skills by participating in training programs focused on advanced tailoring techniques and modern design trends. She believes that upskilling would expand her customer base and improve her earnings. Moreover, she is open to the idea of home-based tailoring during adverse weather, provided she receives support in setting up a functional workspace at home.

4.4 Anganwadi

The adaptation measures and requirements of nine Anganwadis were identified from the one-to-one discussions conducted with Anganwadi workers. The detailed information is attached in Annexure 6: Discussion with Anganwadis.

4.4.1 Maa Patadevi Basti, Ward no. 5

Adaptation / Resilience measures:

- Recovery time usually ranges from 4 to 7 days.
- ASHA and Anganwadi workers inform families door-to-door and coordinate evacuations, especially for children and pregnant women, and manage collection and distribution within communities.
- Awareness drives focused on health, hygiene, and climate-related disaster preparedness are regularly conducted.
- The workers provide ORS and drinking water, provide first aid and refer severe cases to the government health centre in Naharkanta (~6 km away). Dry food rations and medicines are provided.

Requirements:

- A permanent, well-constructed building that is safe and all-weather resistant.
- Access to clean drinking water to ensure the health of children.
- Backup electricity systems to maintain lighting, fans, and refrigeration for medicines if needed.

4.4.2 Jokalandi Cluster 7, Ward 22

Adaptation / Resilience measures:

- Recovery takes 3 to 4 days for people to return to their homes and 1 –2 weeks to resume work.
- Rely on their own efforts and community support to rebuild, as government assistance is minimal after the initial relief phase.
- Anganwadi distributes ORS packets and raises awareness about preventive care.
- Conducted health and safety awareness sessions, especially around heatstroke prevention and hygiene.

Requirements:

- More consistent and long-term support is needed.

- Need for training in disaster response and health emergencies, as current knowledge is limited to basic practices.
- Need for durable housing, emergency health kits, backup power, and regular health check-ups within the slum.
- Demand for job opportunities with fixed income, financial aid for house repairs, and skill training for women, to sustain livelihoods during and after climate events.

4.4.3 Shampur Slum, Ward No. 22

Adaptation / Resilience measures:

- Anganwadi staff focus on evacuating children and mothers to safer locations and referring them to government hospitals for medical assistance.
- Early warnings from the government are communicated by Anganwadi staff to each household within the slum.
- The community receives food provisions and evacuation support to shelter houses from the government.
- Some local businesses use battery-operated emergency lights during short-term outages.

Requirements:

- Need for improved facilities to ensure better protection for vulnerable populations
- Need for stronger climate resilience measures, improved infrastructure
- Need for support systems to help families cope with climate change's economic and health impacts.
- More reliable and sustainable energy options are needed to support the community, especially during extreme weather events.

4.4.4 Sunderpada Patni Sahi, Ward No. 67

Adaptation/Resilience Measures:

- The center often shuts down during extreme weather.
- There is no contingency plan, emergency kit, or alternative arrangement for childcare or food distribution.
- Some solar lights were installed, and housing schemes under Jaga Mission and PMAY have improved roof quality for a few families. However, these programs haven't reached all residents.

Requirements:

- The centre needs heat-resistant infrastructure (e.g., better roofing, ceiling fans), solar backup, clean drinking water, emergency kits, and shaded outdoor space.
- Training for staff and parents on disaster readiness and child protection during hazards is also urgently needed.

4.4.5 Naharkanta Near to Banguari Slum, Ward no.4

Adaptation/Resilience Measures:

- No proper drainage or water facilities; water currently sourced from a nearby school.
- During flooding, 2–3 feet of water accumulate on roads; BMC pumps it out, but it takes 8–10 days to return to normal.
- Wealthier households use air conditioning, while others rely on fans or experience frequent power cuts.
- The government provides early relief support (food, medicine) and sends alerts before disasters.
- Primary treatment is provided locally; Serious cases are referred to the government hospital or the CHC.
- Community receives basic disaster alerts, but recovery and preparedness remain weak among daily wage groups.

Requirements:

- Install drainage and water facilities for better hygiene and sanitation.
- Establish a permanent electricity connection to support children and workers during heat waves.
- Set up a dedicated water supply—potentially a tank or direct connection from nearby sources.
- Improve road and drainage infrastructure to prevent long-term flooding.
- Create community cooling shelters or install fans in common spaces for heatwave response.
- Run awareness campaigns on sunstroke prevention, hydration, and hygiene.
- Explore solar energy or other backup power solutions for Anganwadi and vulnerable homes.
- Conduct regular health awareness drives and check-ups focused on climate-sensitive illnesses.
- Build linkages with mobile health services or schedule regular visits by health professionals to the Anganwadi.

4.5 NGO Activities

A few NGO's are actively working towards slum development, enhancing the livelihood of the residents in slums, providing them with healthcare facilities, and training them for community-based disaster preparedness and capacity building in vulnerable areas, particularly due to the region's exposure to cyclones, floods, and other climate-related risks. Details of NGOs are given in Annexure 3: Table A 2. 3 NGO List.

4.6 Quantitative Analysis

Quantitative survey was conducted in 9 wards – 15 slums, covering about 175 respondents from 22nd April 2025 to 5th May 2025, understanding the impact of climate hazards on livelihoods, infrastructure vulnerability, health vulnerability, and access to resources such as energy and water. The questionnaire also covered sections regarding support from the government, community and individual resilience. The questionnaire is presented in Annexure 7. The summary of results is presented in the following sections.

4.6.1 Demographic Characteristics:

The demographic characteristics comprised about 50.29% (88 respondents) male respondents, and the others were female. Regarding occupation, about 70.29% (123 respondents) are daily wage labourers working in small-scale industries, workshops, and municipal services. Some respondents work daily loading and unloading goods and items, and hotel assistance work. About 9.14% (16 respondents) of the respondents are street vendors, mainly selling fruits and vegetables in the slums. The other respondents were auto drivers, construction workers, domestic workers, old age pension holders, small business owners, and private sector employees etc.

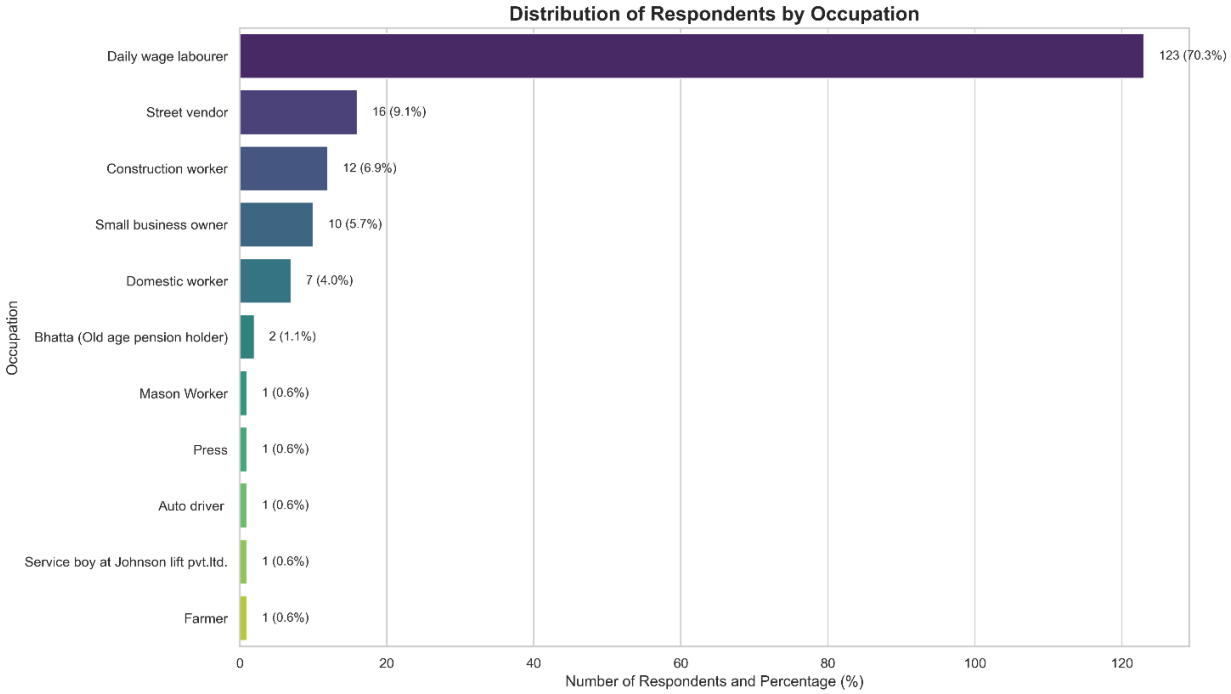


Figure 4. 1 Occupation of respondents

4.6.2 Income and Living Conditions:

Out of 175 respondents, about 46.2% (81 respondents) earn around ₹5001–10,000 per month, and around 42.8% (75 respondents) earn around ₹10,001–20,000 per month. Out of 123 respondents

who are daily wage labourers, about 51.2% (63 respondents) earn around ₹5001–10,000 per month, and about 42.2% (52 respondents) earn around ₹10,001–20,000 per month.

Out of 16 respondents who are street vendors, about 56.2% (9 respondents) earn a monthly income around ₹10,001–20,000, and 37.5% (6 respondents) earn a monthly income around ₹5001–10,000.

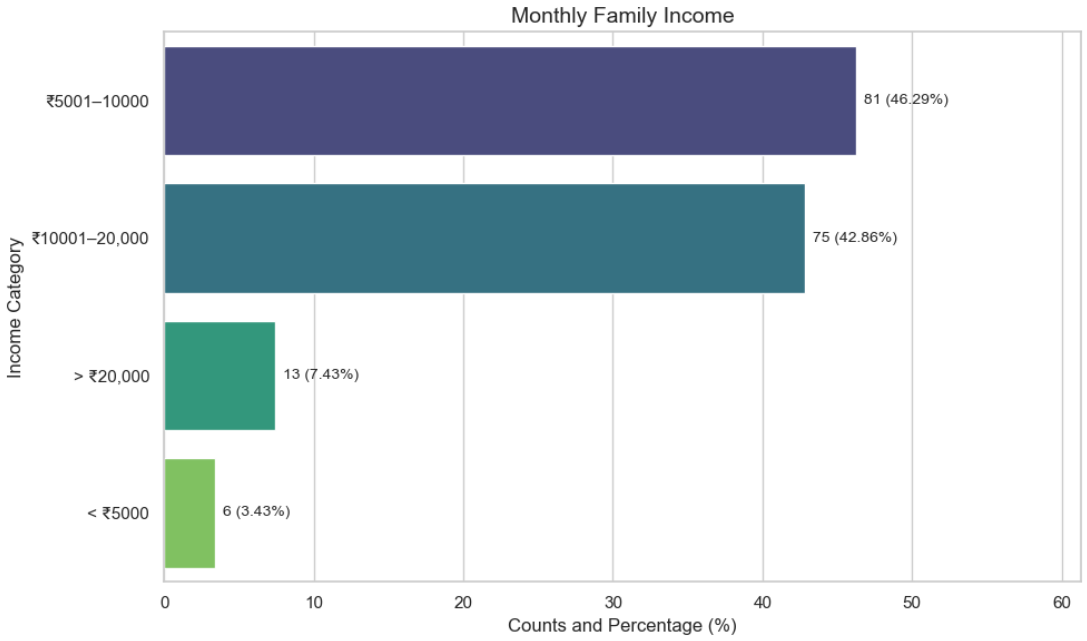


Figure 4. 2 Monthly Family Income

Out of 175 respondents, 93% (162 respondents) live in their own houses and only 7% in rental houses. Most of these respondents live in Semi-pucca (concrete structure with thatched roof or asbestos sheet) houses compared to pucca (Full concrete) and Kaccha (mud house or thatched houses), where own-house respondents are 79.6% (129 respondents), and 12 respondents live in Semi-Pucca Rental houses.

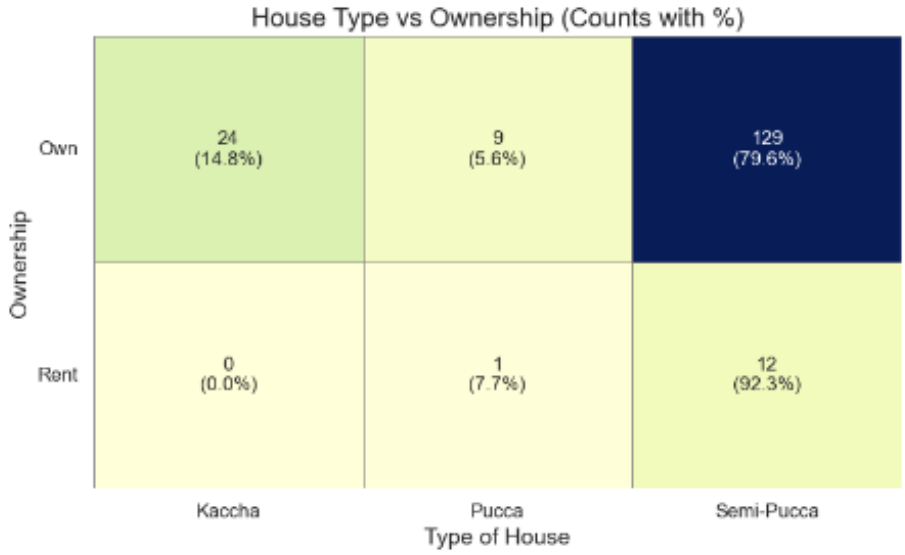


Figure 4. 3 Ownership and Living Conditions

Table 4. 4 Occupation and Living Conditions

1.4 Occupation	Kaccha	Pucca	Semi-Pucca	Total
Own	**24**	**9**	**129**	**162**
Auto driver			1	1
Bhatta (Old age pension holder)	1		1	2
Construction worker	2		9	11
Daily wage labourer	19	3	92	114
Domestic worker			5	5
Farmer	1			1
Mason Worker	1			1
Press		1		1
Service boy at Johnson Lift Pvt. Ltd.			1	1
Small business owner		1	8	9
Street vendor		4	12	16
Rent		**1**	**12**	**13**
Construction worker			1	1
Daily wage labourer			9	9
Domestic worker			2	2
Small business owner		1		1
Total	**24**	**10**	**141**	**175**

The majority of the respondents live in owned houses rather than rental spaces. The 92 daily wage labourers, along with 12 street vendors, nine construction workers, small business owners, and others, live in semi-pucca houses rather than pucca and kaccha houses.

4.6.3 Climate Hazards

Over the past five years, respondents have reported experiencing a range of climate events, with the most frequent being a combination of heavy rains, heatwaves, and cyclones, accounting for 36.5% (64 respondents). Floods alone were reported by 23.4% of respondents, followed closely by a combination of floods and heavy rains (22.3%). Less commonly reported events included heatwaves and cyclones (6.3%) and instances combining multiple hazards, such as water shortages, though these represented a smaller proportion of responses.

21% of the respondents reported that their houses or streets had been flooded in the last five years. Nine of the respondents have experienced an occurrence that takes more than 3 days to recede, and 2% experience 1-2 days. 46% of the respondents experience waterlogging issues that take a few hours to recede.

About 82.86% (145 respondents) mentioned that they face a lot of impact due to extreme heatwave, which in return affects their productivity and ability to work. Majority of them (90% of respondents) use fans and coolers to withstand the extreme temperatures whenever there are no power cuts.

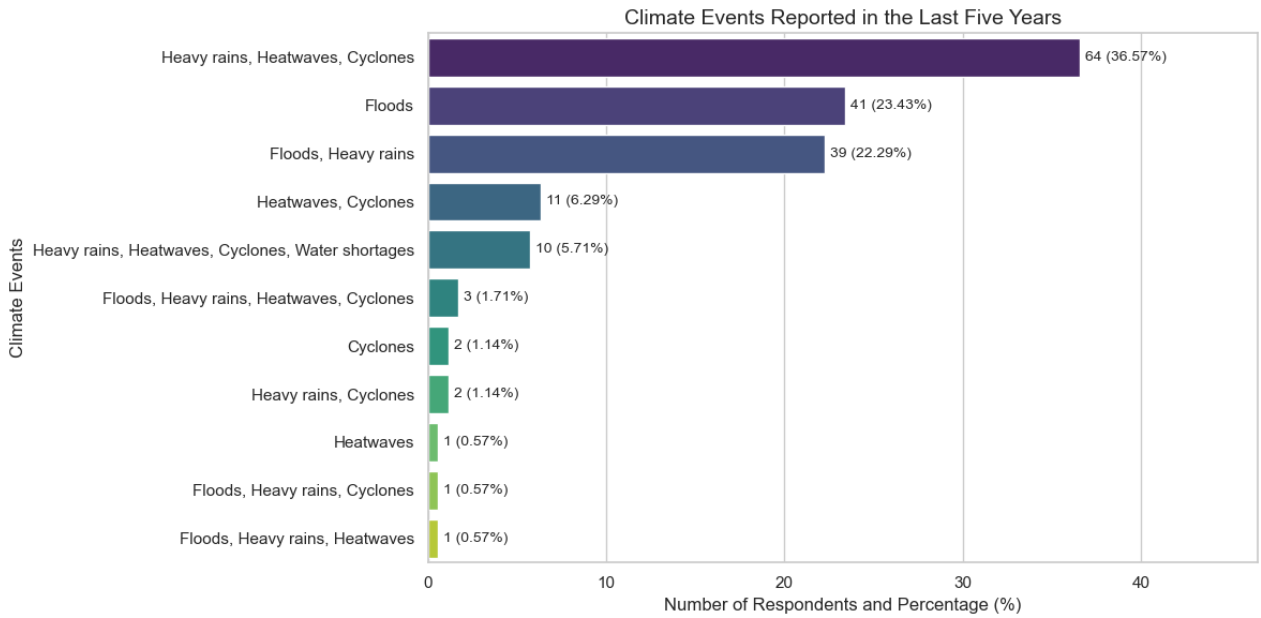


Figure 4. 4 Climate Events reported in the last 5 years

Majority of the respondents (49.14%) have mentioned they face a lot of difficulty in working during heatwave conditions. Loss of stored food/water and difficulty in working are the combined factors mentioned by 43.43% (76 respondents) as the damages occurred due to heat stress. Also, 97.14% (170 respondents) have stated that their working conditions are poor.

Upon analysis of the survey results, it was observed that approximately 98.9% of respondents (96 individuals) reported inadequate working conditions during flood events. Common challenges cited include water entering workplaces, damage of stored food and water supplies, and damage to roofing structures.

Similarly, around 97.2% of respondents (170 individuals) indicated that heatwaves significantly impact working conditions in the area. The respondents reported spoilage of stored food and water, frequent power outages, and various health-related problems.

4.6.4 Livelihood Impact

The respondents mentioned that they work 8 to 10 hours per day. About 30.29% (53 respondents) have stated that there is a job loss due to extreme weather events, as most of the respondents are daily wage workers and face immediate and severe impacts on their livelihoods. Also, about 20.57% (36 respondents) mentioned a loss of jobs, and to withstand extreme weather events, they change their working hours as a resilience measure, which in turn impacts their income. This adjustment, often involving avoiding work during peak summer hours (12–3 PM) and rainy seasons based on the occurrence of rainfall, results in a notable decline in income, as they lose out on customers and business during this time.

Other factors affecting livelihoods during climate hazard events include job loss, reduced working hours, damage to goods or tools, temporary forced relocation, increased cost of raw materials, and loss of agricultural productivity.

In the context of income loss due to health issues, many families rely on their personal savings to recover both from illness and the resulting livelihood disruptions. On a monthly basis, approximately 35.4% of respondents (62 individuals) reported spending between ₹1001 and ₹3000 on healthcare related to climate hazard events. Additionally, 12.6% (22 respondents) spent between ₹3001 and ₹5000, while 11.4% (20 respondents) incurred expenses exceeding ₹5000 to address health issues caused by such events.

4.6.5 Infrastructure impact

Along with livelihood impacts, built infrastructure faces damage, such as the respondents' houses, workplaces, and other infrastructure facilities. About 44.57% (78 respondents) mentioned poor drainage as the sole reason for an increase in the infrastructure vulnerability in the area. Respondents have noted that during heavy rain, there are cases of waterlogging on roads and water entering houses and workplaces, causing multiple issues. About 16% (28 respondents) have mentioned poor drainage, overcrowding, and lack of green spaces as the main reasons for increased infrastructure vulnerability in the areas. Other reasons cited are poor access to healthcare, frequent power cuts, and no safe drinking water.

As climate hazard events impact infrastructure, people's incomes, including their homes and workplaces, are significantly impacted. About 39.4% (69 respondents) face an annual loss of income of more than > ₹5000, and about 37.7% (66 respondents) face an annual loss of income in the range of ₹1001–3000. There are also cases where people spend their savings on recovering from the damage to infrastructure, which usually takes 7- 10 days on average. The graph below illustrates the loss of income due to health illnesses (monthly) and health expenses arising from extreme weather events such as cyclones, floods, and heatwaves (seasonal) in summer and the monsoon season. Lastly, it addresses the infrastructural damages caused by extreme weather events (annual).

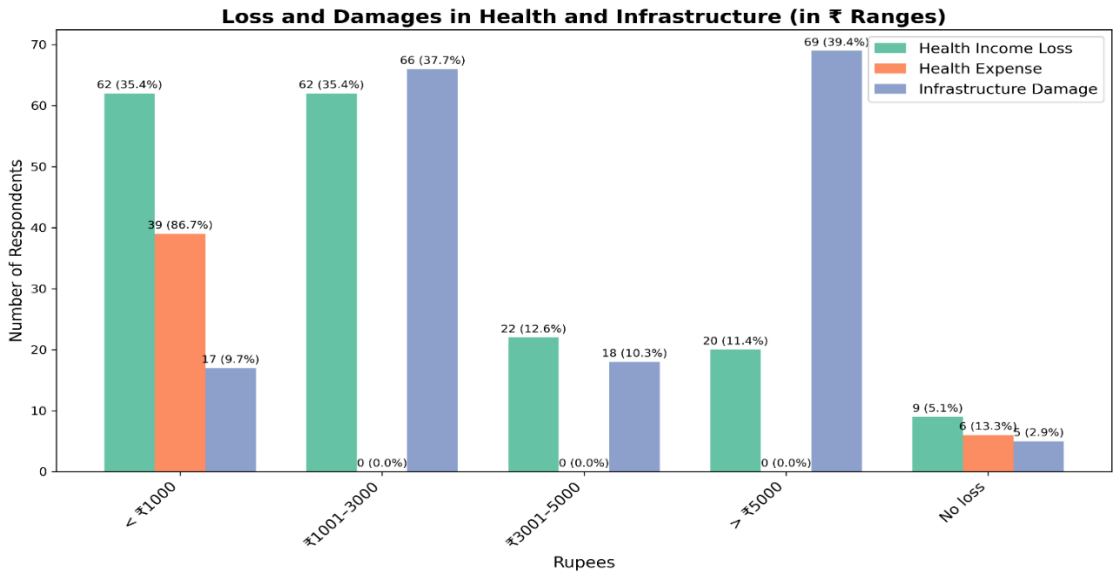


Figure 4. 5 Health and Infrastructure expenses and loss

4.6.6 Health Vulnerability

Heatwaves, heavy rains, and cyclones significantly harm public health. About 45.71% (80 respondents) stated that they face major heat-related illnesses, such as dehydration, weakness, etc. About 16% (28 respondents) have stated clearly that heat-related illnesses, waterborne diseases, and increased stress or anxiety are key health impacts resulting from climate-related events. There are also vector-borne diseases and respiratory issues caused by heavy rains and heat waves.

During climate hazard events, 48% of respondents (84 respondents) mentioned that they could not go to work for more than 3 days. Also, in addressing the health impacts, about 53.71% (94 respondents) have mentioned that they have to spend around ₹1001 - ₹3000, and about 14.86% (26 respondents) have to spend around ₹3001-₹5000.

4.6.7 Access to Energy and Water

While understanding the status of access to energy and water, about 40.5% (71 respondents) reported that they face frequent power cuts, and 5% (9 respondents) reported that they don't have electricity connections. Apart from that, 44.57% (78 respondents) mentioned loss of income as a major issue caused by frequent power cuts. Disruption in communication, interruption of essential services, and improper refrigeration/storage of food and medicines are other issues caused by power cuts. About 77.14% (135 respondents) have mentioned that power cuts usually last for less than 3 hours.

4.6.8 Resilience

Regarding resilience and coping mechanisms, out of 175 respondents, about 80.6% (141 respondents) have no knowledge of climate change's impacts, but all receive early warning messages during extreme weather events. About 47.4% (83 respondents) receive messages through neighbours, 21.1% (37 respondents) through SMS, TV/Radio, 11.4% (20 respondents) through TV/Radio and local government. It was observed that about 89.1% (156 respondents) do not keep a stock of emergency supplies such as food, water and medicines during disasters.

About 50% (87 respondents) use only energy-efficient appliances as a resilience measure. About 23% (40 respondents) use energy-efficient appliances and strengthen house structure as resilience measures to overcome the impact of weather.

About 5% (9 respondents) do not follow any resilience measures during climate hazard events. Other resilience measures usually adopted by livelihoods are relocating to a safer area, planting trees for shade, and raising floor levels.

Food and water are shared with communities, along with the provision of temporary shelter, which is carried out during climate hazards to help one another. It was understood that there was minimal support (about 87%) from government or NGO programs with climate adaptation, as per the responses. 13% (23 respondents) answered that there is support from government and NGO

programs, and they mentioned that they got training in housing, water & sanitation, disaster preparedness training, livelihood programs, etc.

4.6.9 Requirements

Regarding requirements, out of 175 respondents, about 37.1% (65 respondents) mentioned the need for a good heat-resistant roof, whereas 29.1% (51 respondents) mentioned the need for both a good heat-resistant roof and good cyclone shelters. About 20.6% (36 respondents) mentioned the need for the above requirements and good health facilities. Other respondents also mentioned the need for access to water and electricity to overcome extreme weather events.

5 Climate Change Adaptation Measures

The City of Bhubaneswar and the state of Odisha have developed robust programmes and schemes to address climate risk arising from extreme weather events. These are implemented at the settlement, city, and state levels, emphasising adaptation and resilience.

5.1 State level Policies

5.1.1 Heat Action Plan

The **Heat Action Plan** (**HAP**)[3] This plan provides a structured framework for implementing, coordinating, and monitoring response activities to reduce the adverse impacts of extreme heat events in urban and rural areas. The plan's primary goal is to raise awareness in regions where extreme heat conditions are prevalent or anticipated and ensure timely alerts reach vulnerable populations, enabling them to take appropriate preventive measures against heat-related illnesses.

The Plan also seeks to strengthen the capacity of **early warning systems and media platforms** to disseminate critical information promptly and effectively. Furthermore, it promotes multi-stakeholder engagement—mobilizing government departments, community organisations, and civil society—to collectively safeguard public health and livestock during heatwave conditions.

In coordination with the **India Meteorological Department** (**IMD**), the Odisha State Disaster Management Authority (OSDMA) issues heat alerts and warnings to concerned authorities, institutions, and the general public. Enhancing this effort, OSDMA has partnered with the **Regional Integrated Multi-Hazard Early Warning System** (**RIMES**) to develop the *Satark* mobile application, which facilitates the **real-time dissemination of localized heatwave alerts** to identified focal points at district and block levels.

As part of its awareness-building initiatives, OSDMA, in collaboration with media partners, annually disseminates short video messages and heatwave awareness posters. These materials are distributed across villages to educate communities about the risks associated with extreme heat and the preventive actions that can be taken at the household and community levels.

As part of prevention, preparedness and mitigation measures, cool roofs are proposed as an affordable and effective adaptation measure to mitigate the effects of extreme heat in slum areas. The key adaptation aspects include:

- **Thermal Comfort Through Cool Roofs**: Cool roofs are white reflective surfaces that reduce heat absorption and reflect solar radiation, making homes significantly cooler—up to 30°C less than conventional roofs and reducing indoor temperatures by 3–5°C.

[3] http://www.indiaenvironmentportal.org.in/files/file/heat%20wave%20odisha.pdf

- **Reduction of Urban Heat Island Effect**: When widely adopted, cool roofs can mitigate the Urban Heat Island (UHI) effect in cities, improving overall urban thermal comfort.
- **Materials and Coatings**: These roofs can be created using low-cost materials like lime-based whitewash, white tarp, white chins mosaic tiles, or acrylic resin coating.
- **Targeting Vulnerabilities**: The intervention addresses multiple vulnerabilities of slum residents, such as high exposure to heat, limited adaptation options, and poor health infrastructure, by offering a simple, scalable cooling solution.

5.1.2 Odisha Renewable Energy Policy, 2022

The **Renewable Energy Policy of Odisha (2022)**[4] envisions the establishment of a robust and inclusive framework to facilitate the state's transition to a low-carbon energy future. This framework seeks to significantly increase renewable energy (RE) share in Odisha's power system while promoting broader decarbonisation across sectors such as electric mobility, green buildings, agriculture, and industrial and mining activities.

Policy Objectives

The key objectives of the Renewable Energy Policy are as follows:

a) **Accelerate Clean Energy Adoption:** To promote the adoption of clean energy alternatives and facilitate the decarbonization of both grid-connected electricity consumption and captive power use, particularly in the industrial sector.
b) **Utilize Renewable Energy Potential:** To harness the state's renewable energy resources efficiently by supporting the development of green energy projects across Odisha.
c) **Promote Investment and Economic Development:** To attract investments in the clean energy sector, foster job creation, and contribute to the sustainable economic development of the state.
d) **Encourage Innovation and Emerging Technologies:** To support research and development (R&D) and promote new initiatives and emerging renewable energy technologies within the state.

Strategic Interventions and Implementation Approach

Promotion of Solar Energy Projects: The policy encourages the development of both utility-scale and distributed **solar energy** applications. Notably, solar parks with a minimum capacity of 25 MW will be promoted to optimize generation costs and reduce infrastructure expenses.

Grid-Connected Rooftop Solar PV: The Government of Odisha shall promote rooftop solar photovoltaic (PV) systems across public, residential, commercial, and industrial buildings. All government buildings with suitable roof space will be encouraged to install solar PV systems. The

[4] https://energy.odisha.gov.in/sites/default/files/2022-12/3354-Energy%20dept._1.pdf

Odisha Renewable Energy Development Agency (OREDA) will facilitate project development under net metering or gross metering mechanisms, primarily through the Renewable Energy Service Company (RESCO) model.

Distributed Solar Generation: The policy emphasises the deployment of distributed solar systems to ensure energy access in remote and inaccessible areas through sustainable means.

5.1.3 Odisha SAPCC (2021-2030)

Odisha's State Action plan on climate change outlines a Rs. 2.45 Lakh Investment over 10 years (2021-2030)[5]. Ninety-four strategies have been proposed, out of which 49 are strongly linked to adaptation, 31 linked to mitigation, and 14 have linkages to both adaptation and mitigation. The action focused on urban development, water, health, energy access, etc. The key allocations and activities that Odisha State departments carried out are below.[6].

Table 5. 1 Activities and Implementing Departments, Odisha SAPCC (2021-2030)

Code	Activity	Implementing Department
Health		
H/KP/1	Capacity building of the health sector on climate change adaptation and mitigation	DoHFW
H/KP/2	Integrating climate change considerations in the State Health Policy	DoHFW
H/KP/3	Strengthening approaches to manage vector-borne diseases that have worsened due to climate change impact	DoHFW
H/KP/4	Strengthening approaches to deal with heat wave conditions exacerbated by climate change	DoHFW
H/KP/5	Undertaking measures to manage waterborne diseases that have worsened due to climate change impacts	DoHFW
Coastal and Disaster Risk Management		
CD/KP/10	Developing a techno-legal regime for disaster-resilient public infrastructure (Approach Road to MCS, ODRP housing projects)	OSDMA
CD/KP/12	Setting up integrated capacity building protocols for shelters, SHGs, CBDRFs, college/school volunteers, and officials at state and district levels	OSDMA
Energy		
Energy/CAP/23	Develop state-level energy efficiency standards through ECBC, PAT, etc., via SDA	Energy Department
Energy/KP/2	Institutional development (capacity building, restructuring, GEDCOL formation, capacity development of OREDA, RPO operationalisation, clean tech feasibility)	Energy Department, OREDA
Energy/CAP/29	Implementation of Odisha Energy Conservation Building Code (OECBC)	Energy Department

[5] https://www.newindianexpress.com/states/odisha/2022/Sep/04/odisha-pegs-rs-245-lakh-crore-climate-spend-in-10-years-2494753.html

[6] https://climatechangecellodisha.org/pdf/Odisha_SAPCC_2021-30..pdf

Code	Activity	Implementing Department
Urban Development		
HUD/CAP/2a	Augmentation of integrated sewerage project for Bhubaneswar and Cuttack municipalities	H&UD
HUD/CAP/N4a	Update building by-laws and development control regulations to incorporate climate change (CC) and disaster risk reduction (DRR) considerations	H&UD
HUD/CAP/N4b	Incorporate risk-sensitive land use planning in city's Master Plan	H&UD
HUD/CAP/10a	Energy efficiency in street lighting	H&UD, Energy Department
HUD/KP/9	Developing urban storm water drainage systems based on climate change impacts	H&UD
HUD/CAP/N1	Housing for all – In-situ slum development and relocation	H&UD
HUD/CAP/N2a	Development of green space and parks in 105 ULBs	H&UD
HUD/CAP/N2b	Development of green space and parks in 9 AMRUT cities	H&UD
HUD/CAP/N3a	Smart City Bhubaneswar initiative	H&UD
HUD/KP/3	Ensuring tap water for all	WR, H&UD
HUD/CAP/2b	Making urban Odisha open defecation free; management of sewerage, faecal sludge, and sewage	H&UD

5.1.4 City Level Programs

Bhubaneswar has implemented several targeted measures to improve slum livelihoods and enhance their resilience to climate vulnerabilities. The JAGA Mission (Odisha Livable Habitat Mission)[7], led by the Housing and Urban Development Department of the Government of Odisha, empowers Slum Dweller Associations (SDAs) to lead in-situ upgradation plans and provides land tenure under the Odisha Land Rights to Slum Dwellers Act, 2017. This initiative ensures essential infrastructure like stormwater drainage, paved roads, and community drinking water.

Additionally, affordable housing projects in Subhudipur, Satyanagar, and Gandakana will deliver 2662 dwelling units for Economically Weaker Sections (EWS)[8]. These units have basic infrastructure, shops, health centres, and primary education facilities, among other improvements for slum settlements from the Bhubaneswar Development Authority (BDA)[9]. Other initiatives at the Bhubaneswar level regarding climate vulnerabilities and respective departmental actions and their recommendations are mentioned in Annexure 3: Key Informant Interviews.

[7] https://world-habitat.org/wp-content/uploads/2019/11/Odisha-Liveable-Habitats_India_FULL-Project-Summary.pdf

[8] http://www.ouidf.in/slum_development_rehabilitation.php

[9] https://cms.bhubaneswarone.in/uploadDocuments/Directory/Annual%20Report/Directory20211004_165703.pdf

5.2 National Policies on Solar Roof Top and Cool Roof Policies

India, one of the world's fastest-growing economies, is confronted with escalating energy demands, accelerated urbanisation, and heightened climate vulnerabilities. In response, the Government of India has positioned sustainable energy and climate-resilient infrastructure as the foundation of its development strategy. Rooftop solar power and cool roof technologies have emerged as critical, scalable solutions to reduce energy consumption, lower greenhouse gas emissions, and improve urban climate resilience.

The Government has initiated a series of national-level initiatives, including the PM Surya Ghar: Muft Bijli Yojana, to expedite the adoption of rooftop solar systems in one crore households. Subsidies, concessional loans, and digital facilitation mechanisms support these initiatives. The Grid-Connected Rooftop Solar Programme Phase II, which is being led by the Ministry of New and Renewable Energy (MNRE) and the Solar Energy Corporation of India (SECI), is designed to achieve a 40 GW rooftop capacity across the country by utilising a combination of viability gap funding and net metering provisions. This initiative serves as a complement to the previous one. The table below addresses the key areas of selected policies at national level and state level for roof top solar and cool roof policy.

Policy / Scheme	Scope & Launch	Key Features	Targets & Impact	References
PM Surya Ghar: Muft Bijli Yojana	National; approved 29 Feb 2024	Subsidy ₹30 k–78 k for 1–3 kW rooftop solar, collateral-free loans (~7%), online platform, net-metering	1 crore households by Mar 2027; ~3 GW installed to date; Gujarat ~336 k installs	https://pmsuryaghar.gov.in/#/ https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2025/04/20250416715431493.pdf
Grid-Connected RTS Programme Phase II	National (SECI–VGF)	40 GW rooftop target, net-metering, funding support	~16 GW rooftop capacity installed by Jan 2025; top states include Gujarat, Maharashtra, Rajasthan, Kerala, TN	https://mnre.gov.in/en/grid-connected-solar-rooftop-programme/
Telangana Cool-Roof Policy	State; effective 1 Apr 2023	Mandatory for govt/commercial; residential ≥600 sq yd; reflective coatings; compliance via occupancy certificates	300 km^2 by Mar 2028 (200 km^2 Hyderabad +100 rest); 2.1–4.3 °C indoor cooling; ~20% energy savings	https://www.nrdc.org/sites/default/files/2023-04/telengana-cool-roof-policy-booklet.pdf

Policy / Scheme	Scope & Launch	Key Features	Targets & Impact	References
Tamil Nadu Cool-Roof Initiative	State; UNEP-supported from Mar 2023; piloting in Chennai	Urban Cooling Programme includes cool roofs, passive cooling, nature-based & district cooling; signed with UNEP, NIUA, RMI, CEPT University	Pilot projects in Chennai; aims to integrate into city masterplan, reduce heat exposure	http://unep.org/news-and-stories/story/amid-scorching-temperatures-india-turns-ideas-both-old-and-new-beat-heat https://coolcoalition.org/beating-extreme-heat-in-tamil-nadu/
Kerala Cool-Roof Policy (Draft)	State; drafted 2025 under "Kulirma"	Local self-government driven; reflective paint campaigns, local enforcement	~500 million sq ft (~46 km^2) target	https://keralaenergy.gov.in/?p=3745 https://keralaenergy.gov.in/wp-content/uploads/2025/03/Guidelines-for-empanelment-of-vendors-of-cool-roof-technologies.pdf
India Cooling Action Plan (ICAP) 2019 & NAPCC	National strategy	Encourages reflective, cool roofs in building codes; part of sustainable habitat mission	Cooling-sector load reduction by ~20–25% by 2037–38	https://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf

5.3 Existing Policy Gaps

Through its Renewable Energy Policy, 2022, Odisha has established a comprehensive policy framework to encourage rooftop solar energy. Institutional mechanisms and streamlined regulations reinforce this framework. To motivate both private and public investments in solar energy, the state offers attractive fiscal incentives, including exemptions from electricity duty, transportation charges, and land conversion fees. The approval process has been further simplified by regulatory reforms, such as the Odisha Electricity Regulatory Commission's (OERC) directive to waive technical feasibility studies for rooftop systems with a capacity of up to 10 kW.

City-level initiatives in Bhubaneswar and Cuttack demonstrate the state's commitment to expanding urban rooftop solar deployment, while implementation agencies such as OREDA and GRIDCO provide comprehensive services, from approval to grid integration. The PM Surya Ghar Yojana provides national subsidies to consumers, while local DISCOMs provide streamlined net-metering services. Nevertheless, Odisha has not yet implemented a specialised cool-roof policy. Such a policy could complement the state's solar strategy and further enhance urban thermal resilience, given its climate and increasing urbanisation. The policy can be developed from the experiences of Telangana, Tamil Nadu and other states which has developed cool roof top policy.

In the absence of a cool roof policy focusing on slum settlements with respective typologies (Kaccha, pucca, and Semi-pucca), a notable gap exists in urban climate adaptation. Introducing a similar policy or initiative in the Odisha State, with a focus on slum settlements, could mitigate climate stress, such as heatwave situations, reduce energy needs, and enhance the livelihoods of vulnerable communities.

5.4 Slum-specific Recommendations:

Based on the feedback and insights from both the quantitative and qualitative surveys, the table below presents the number of interventions required in each slum area surveyed, predominantly for heatwave action plans; specific cyclone-related measures have been proposed based on the requirements of the slum dwellers.

Of the 16 slums, most infrastructure is expected to have asbestos roofs, with Tarini Nagar Salia Sahi having approximately 2500-2800 households with asbestos sheets. Based on all KII, FGDS, and One-to-One Discussions, the potential adaptation measures that the community requires include rooftop solar, community drinking water, cyclone shelters, Pucca Anganwadi, etc.

The subsequent sections detail the implementable adaptation measures for improving climate resilience among slum dwellers.

Anganwadi:

From 16 slums, 14 Anganwadis are present, with a distribution of 9 owned and five in rental spaces. Out of nine owned Anganwadis, seven have a Pucca roof structure and two have an Asbestos roof structure. Regarding the present condition of Anganwadi, community requirements vary from ownership to the roof structures. They are:

- If the Anganwadi is pucca owned, the community requires solar rooftops in the Anganwadi.
- If the Anganwadi is owned with an asbestos roof, the community requires a pucca roof and solar rooftops in the Anganwadi.
- If no Anganwadi is present in the slum or the Anganwadi is rented with an asbestos sheet, the community requires a pucca Anganwadi, a cyclone shelter, and solar rooftops in the Anganwadi.

Table 5. 2 Potential Adaptation Measures

S. No	Slum Name	Ward. No	Roof-top Solar	Community Water drinking	Roof (Mostly Asbestos) *	Community	Anganwadi	Infrastructure	House Type
1	Shikarchandi cluster III	2	3	1	50	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Rented
2	CS Pur Sabar Sahi	3		1	65	Solar roofing	Available	Pucca	Own
3	Naharkanta Near to Banguari	4	7	1 for Anganwadi		Solar roofing	Available	Pucca	Own
4	W-4 Bhoi Sahi	4		1	45	Solar roofing	Available	Pucca	Own
5	W-4 jena sahi nakhara	4		1	10	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Not Available		
6	Bhot Pada	5	3	1	150	Pucca Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Own
7	Maa Patadebi Basti	5	6	1	218	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Rented
8	Bhot pada	10	2	1	45	Solar roofing	Available	Pucca	Own
9	Tarini Nagar Salia Sahi	16	7	3	2500-2800	Pucca Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Own

S. No	Slum Name	Ward. No	Roof-top Solar	Community Water drinking	Roof (Mostly Asbestos) *	Community	Anganwadi	Infrastructure	House Type
10	Jhokalandi cluster 7	22	7	1	150	Solar roofing	Available	Pucca	Own
11	Shampur	22	8	3	1700	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Rented
12	W-23 Laxminagar Subudhipur	23	8	1	500	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Not Available		
13	Dumduma Nua Bhoi Sahi	64	4	1	85	Solar roofing	Available	Pucca	Own
14	Sunderpada Patna Sahi	67	6	1	200 - 225	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Rented
15	W-67 Kapilaprasada Bhata Bhoi Sahi	67	4	1	55	Pucca-Own Anganwadi, Cyclone shelter, solar rooftop	Available	Asbestos	Rented
16	W-67 Kapilaprasada Upper Bhoi Sahi	67	2	1	20	Solar roofing	Available	Pucca	Own

5.5 Solutions

5.5.1 Solar Cart

The study found that vendors face difficulties maintaining the freshness of fruits and vegetables during extreme heat and adverse weather conditions. They often use wet gunny bags and sprinkle water to keep their produce cool. However, this method frequently leads to spoilage, especially for items with a short shelf life like leafy greens, tomatoes, and cucumbers. As a result, the produce often rots, leading to vendor income loss when customers refuse to purchase spoiled goods.

To support low-income vegetable vendors, the Ministry of Food Processing Industries has introduced a solar-powered vending cart, developed by the Indian Agricultural Research Institute (IARI). This cart, known as the "Rehri"[10]It is designed to reduce the spoilage of fruits and vegetables by maintaining their freshness for up to five days, thereby minimising vendors' losses.

The cart is priced at Rs. 30,000 and is currently available through the Division of Agricultural Engineering at IARI. Plans are underway to license the technology for broader adoption. The solar cart can reduce the temperature of the storage chamber by 5- 8 °c and increase relative humidity by 15 to 30 percentage points. Thus, it enhances the storage life of fresh fruits and vegetables up to five days as it reduces evaporative losses vis-à-vis consumers' satisfaction.

The solar-powered cart addresses this challenge by maintaining the produce's colour, texture, and appearance for longer, even in dry winter conditions. As a result, vendors can reduce waste, attract more customers, and increase their overall earnings.

[10] https://www.mofpi.gov.in/sites/default/files/SolarpoweredVendingcartdevelopedbyIARI.pdf.pdf

5.5.2 Cool Cart

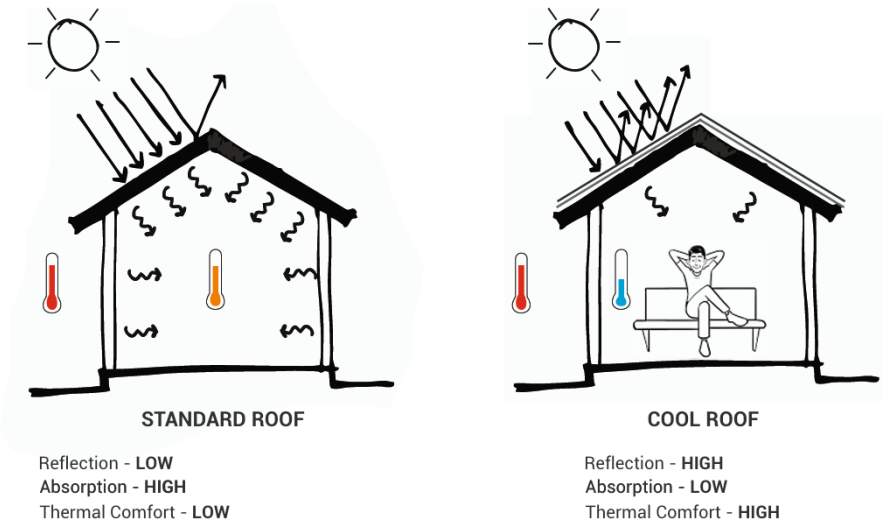
A new cart prototype developed by Trane Technologies, in collaboration with students from the Cambridge Institute of Technology under the 'Operation Possible' program, aims to address food wastage among street vendors in developing countries like India. The "Cooling Cart" is equipped with a canopy covered in a thin film that reflects sunlight, reducing the temperature inside by 6–8°C without using energy. This passive cooling helps preserve vegetables and fruits for longer durations.

The cart is designed to be lightweight and affordable, prioritising ease of use in challenging terrain. The canopy also serves as a storage container when lowered, addressing practical vendor needs.

5.5.3 Cool Roofs

Housing conditions significantly affect heat buildup, especially during the summer. Poor ventilation, tin roofs, and using solid fuels for cooking can trap heat inside homes, making them even hotter. Additionally, small areas' overcrowding and high population density further contribute to rising indoor temperatures.[11] As the summer temperature in Odisha ranges between 35 °C to 40 °C, cool roofs absorb less heat and make living conditions more comfortable.

A cool roof is designed to reflect most sunlight and release some of the heat it absorbs, rather than passing it down into the building. This helps keep the roof surface cooler and maintains a more stable, comfortable indoor temperature. The term "cool roof" refers to the outermost layer of the roof—the part that does the



[11] Swain, S., Bhattacharya, S., Dutta, A., Pati, S., & Nanda, L. (2019). Vulnerability and adaptation to extreme heat in Odisha, India: a community based comparative study. International Journal of Environmental Research and Public Health, 16(24), 5065. https://doi.org/10.3390/ijerph16245065

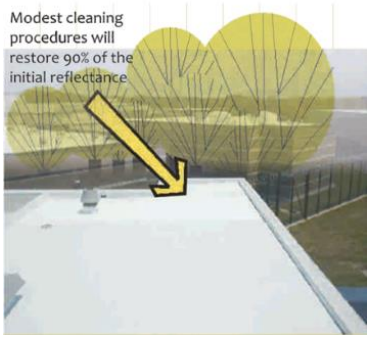
reflecting. These roofs come in many types, colours, textures, coatings, and designs, but what they all have in common is a higher ability to reflect sunlight compared to standard roofs [12].

Benefits of a cool roof:

1) Cool roofs conserve energy and enhance thermal comfort – they help in mitigating the urban heat island effect.
2) Cool roofs effectively reduce electricity usage with minimal impact on winter heating.
3) Cool roofs reduce ambient air temperatures and improve air quality by curtailing or eliminating smog formation.
4) [13]Cool roofs, especially those coated with solar reflective white paint, can reduce indoor temperatures by 2°C to 5°C, making homes much more liveable during hot seasons.[14]

Some of the cool roof solutions are presented below:

5.5.4 Membrane Cool Roofs:



These use pre-made sheets or membranes (like PVC or bitumen-based materials) that are laid over the roof to reflect sunlight and reduce heat absorption but require regular maintenance.

5.5.5 Tiled Cool Roofs:

These roofs use tiles, such as ceramic mosaic tiles, that naturally reflect sunlight due to their high SRI and albedo. Like coated roofs, tiled roofs are relatively easy to install and can be used for both existing and new buildings.

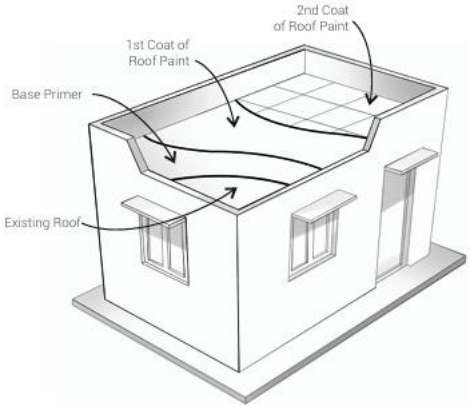
[12] GOVT. OF NATIONAL CAPITAL TERRITORY OF DELHI, Mathur, A., Environmental Design Solutions Team, Prasad, A., Tathagat, T., Jain, K. D., Khan, M., Goyal, A., Lawrence Berkeley National Laboratory, Garg, V., Building Science Research Centre, IIIT, Prakash, S., Dhamija, P., Gogia, C., & Mazumdar, M. (n.d.). Cool Roofs for Cool Delhi: design manual. https://shaktifoundation.in/wp-content/uploads/2014/02/cool-roofs%20manual.pdf

[13] https://ndma.gov.in/sites/default/files/PDF/Guidelines/Cool-Roof-Handbook.pdf

[14] https://www.bbc.com/future/article/20230628-the-white-roofs-cooling-womens-homes-in-indian-slums

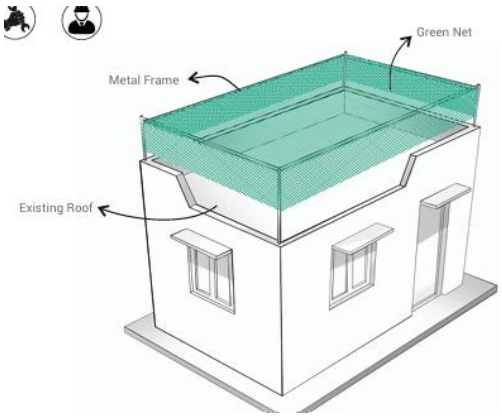
5.5.6 Cool Roof Painting

Cool roof coatings are applied to steep as well as low sloped roofs in good condition. Coatings can be field applied to both new roofs and existing roofs. Cool roofs or solar reflective roofs have surfaces that reflect sunlight and emit heat more efficiently than hot or dark roofs, and therefore keeping them cooler in the Sun.



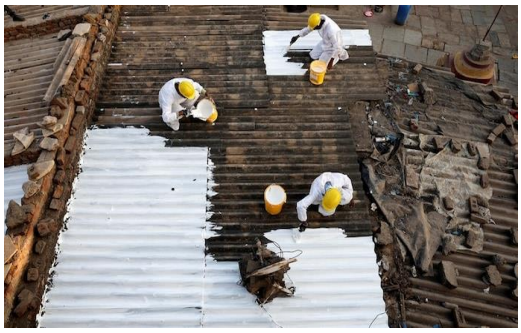
Applying white paint or using white materials such as vinyl can increase the roof's reflectivity to approximately 60%, compared to the 10–20% reflectivity of conventional asphalt roofs. This significantly helps in lowering indoor temperatures. At the community level, establishing shared cooling centers or applying cool roof techniques to community buildings can help mitigate heat stress, particularly for vulnerable populations. These spaces can serve as safe environments for rest, work, or study during periods of extreme heat.[12][15]

5.5.7 Cool Roof – Green Net Shading



Green net shading, also known as shade netting, is an emerging cool roof technology used to combat extreme heat in slum areas across India. This approach involves installing a green-coloured net above roofs-typically made of tin, asbestos, or concrete-to provide a barrier that reduces direct solar radiation and lowers indoor temperatures.[13]

Green net shading functions as a simple and effective method to reduce indoor heat. It acts as a physical barrier that blocks direct sunlight from reaching the roof, thereby lowering heat absorption. The installation typically includes a gap between the net and the roof, allowing air to circulate and further dissipate heat. This results in a cooler roof surface and improved indoor thermal comfort. As a low-cost and low-technology solution, green net shading is easy to install and can be adapted to a variety of roof types and settlement conditions[16].

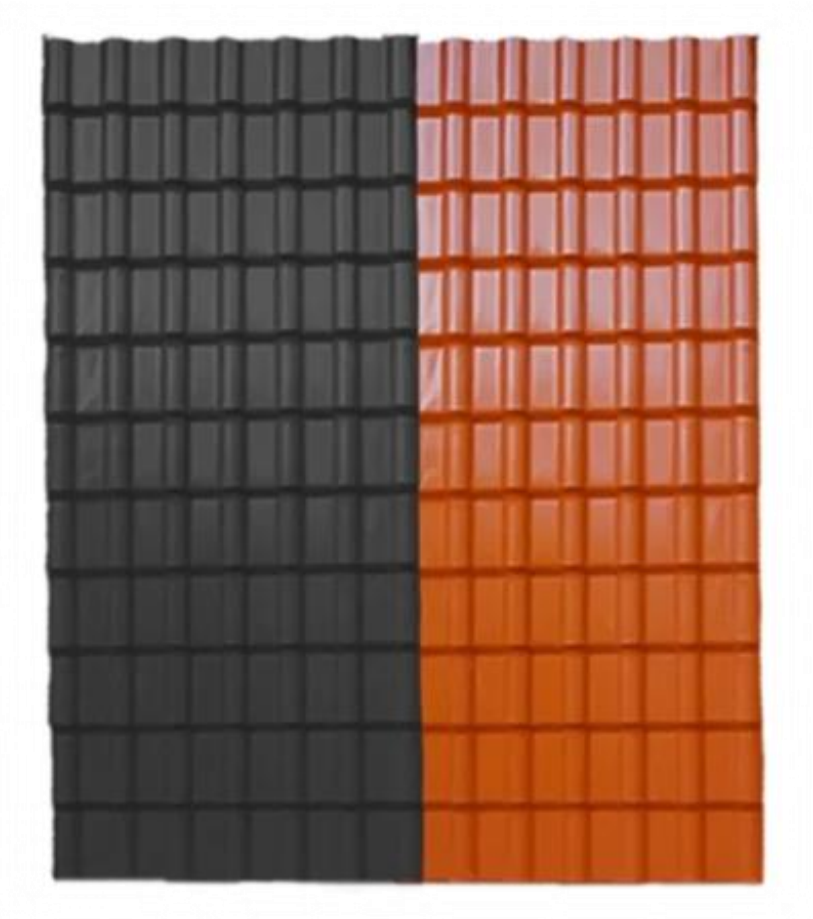


[15] https://www.reuters.com/world/india/indian-slums-get-cool-roofs-combat-extreme-heat-2025-03-10/

[16] https://vjmaterialsmart.com/blog/construction-shade-net/

5.5.8 Unplasticized Polyvinyl Chloride (UPVC)

UPVC roofing sheets have become a robust option for these situations, providing exceptional protection and longevity.



- UPVC sheets are designed to withstand extreme weather conditions, making them ideal for regions frequently impacted by cyclones and hailstorms.
- Hailstorms can cause severe damage to roofs, often leading to costly repairs. UPVC sheets are engineered with high-impact resistance, which allows them to endure the force of hailstones without sustaining significant damage.
- Despite their robustness, UPVC sheets are lightweight.
- UV stabilisation, corrosion and chemical resistance
- In addition to their disaster-resilience properties, UPVC roofing sheets offer energy-efficient benefits. Their thermal insulation properties help regulate indoor temperatures, reducing reliance on heating or cooling systems.

5.5.9 Community-based Water Purifier

Community-based water purification facilities can be established to improve water security and generate income for the urban slums of Bhubaneswar. Such facilities can function as decentralised, secure sources of potable water, particularly in regions where municipal supply is inconsistent or of poor quality. SHG groups or youth can be trained and operate the water purifier while serving the community. These water purifier plants can be integrated with

cyclone shelters, schools or Anganwadi centres, which can be used during peak climatic events. These water purifier units may also provide jobs and earn modest revenue, promoting local ownership and sustainability. This also serves as a source of clean water. Generally, RO-based water purifiers are suitable for removing viruses from water. However, RO reject should be managed, and the use of RO reject for flushing toilets and mineralisation of water after RO purification should be considered.

5.5.10 Solar Street Lights

Solar streetlights are a sustainable solution for improving urban neighbourhoods' safety and mobility. They provide reliable lighting during power outages, which are prevalent in vulnerable locations. One of the key issues that needs to be addressed is battery security and maintenance to ensure longevity and community ownership. The battery secured enclosures, proper maintenance, and community-based monitoring can reduce theft and damage.

5.5.11 Information, Education and Communication (IEC) Activities

A recent study by the Mahila Housing Trust (MHT) in Jodhpur, Rajasthan, identified a significant gap in access to heat early warning systems. Existing communication methods, mainly print media, are ineffective for many residents of poor urban communities, especially those who are not literate. There is a lack of understanding about how to protect themselves and others from extreme heat at home and in the workplace among literate people. [17]

In collaboration with women-led community action groups, MHT is taking an innovative and community-based approach to ensuring the last-mile delivery of heat early warnings in informal settlements. This includes installing hoardings with colour-coded heat warnings in key locations and engaging local women leaders to conduct awareness activities. These leaders hold group meetings and visit households to share important information and practical guidance.

A similar approach can be exercised in Bhubaneswar by targeting the settlements and collaborating with the government and local NGOs to increase awareness of climate hazards and early warning systems. Hoardings and boards in Odia can be printed for broader accessibility, and slum development associations can organise regular meetings to train the communities.

---

[17] https://bracupgi.org/wp-content/uploads/2024/02/Climate-Adaptation-of-Inclusive-Livelihood-Programmes.pdf

5.5.12 Solar roof panels – Anganwadi

The Anganwadis, serving as rural childcare centres, help children in the age group of 0-5 years and their mothers and expecting mothers with a nutritious diet to combat hunger and malnutrition. Most of the slums face electricity issues during climate hazards, installation of a solar rooftop will solve the problem by reducing the dependency on grid connection. They provide reliable access to energy to remote areas and require less maintenance by occupying bare minimum space.[18]

Source: https://www.villagesquare.in/manyachiwadi-becomes-maharashtras-first-solar-powered-village/

The provision of electricity empowers Anganwadi workers to use digital learning tools, helping children understand concepts more effectively. With the addition of reliable energy solutions, Anganwadis can be further strengthened, making them ideal hubs for community development. Women can gather, form self-help groups, engage in economically productive activities, and participate in decision-making that affects their lives. The extended battery life ensures essential services like lighting and fans remain functional throughout the day, enhancing the overall utility of these centers.[19]

[18] https://hartek.com/post/advantages-of-rooftop-solar-installation/

[19] https://ngobox.org/detail_impax_UN-Women-is-transforming-simple-Anganwadis-to-%E2%80%98Smart-Anganwadi%E2%80%99-to-deliver-high-quality-services_186

5.5.13 Mobile Health Centres

Many people in the slums and Anganwadis highlighted their limited access to health facilities and health issues they faced during extreme weather events. The slum dwellers have requested that mobile health centres visit the slum areas on a regular basis for health checkups.

Many people in the slums and Anganwadis highlighted their limited access to health facilities and health issues they faced during extreme weather events. The slum dwellers have requested that mobile health centres visit the slum areas on a regular basis for health checkups. Mobile health vans (MHV) can be proposed as a proactive pathway to providing outreach healthcare.

During extreme weather events, people have mentioned that access to hospitals ranges between 2km and 5km, depending on the slum. A mobile health van can help provide basic medication during such events, and in case of serious health issues, patients can be taken to hospitals.

6 Conclusion and Way Forward

The study of climate vulnerability and urban poverty reveals that Bhubaneswar is most impacted by heatwaves, with floods and cyclones often occurring thereafter. Cyclones exert a more acute immediate impact, especially on impoverished and vulnerable communities who frequently endure damage to their residences and loss of livelihoods; conversely, heatwaves are more prevalent and extended, generally persisting for 2 to 3 months.

The next steps can start with piloting the implementation of cool carts and cool roofs in the identified small businesses and Anganwadi and monitoring the impact of these interventions. Once the impact is experienced, the implementation can be replicated and scaled in other parts of the notified slum areas.

Annexure 1: GIS-based analysis

In addition to the slum dwellers, cyclone + flood, and heatwave maps mentioned in section 3.4, we have used the minimum air temperature and land surface temperature index to calculate the vulnerability index. The minimum air temperature and the minimum land surface (skin) temperature index, calculated from the slope, represent the rate and direction of change over time for each ward from 1990 to 2024. These climate parameters indicate the increase in warming trends over the past 30 years, and a higher concentration of wards falls under the higher vulnerability (Index 3 and 5).

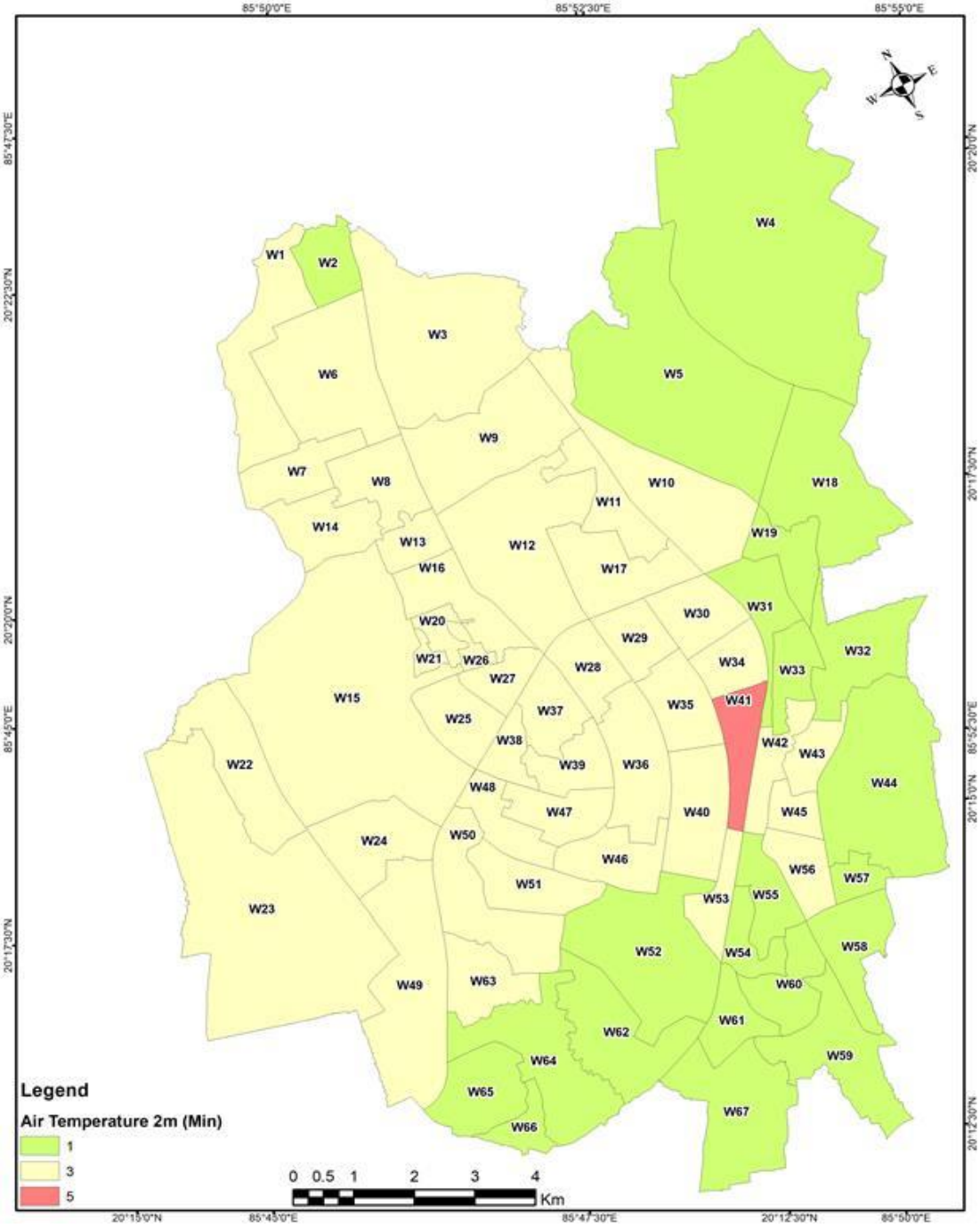


Figure A1. 1 Minimum Air Temperature (2m) Index Map of Bhubaneswar

The increase in minimum air temperature is likely lower in low-elevation zones. There has been a gradual increase in medium and high-elevation zones among the wards of Bhubaneswar. Ward 41 recorded the highest minimum temperature increase of 1.470 °C, followed by a recorded 1.46 °C increase in 44 wards. The difference is minimal as the temperature changes are regional phenomena that show minimal variations in temperature trends among the wards.

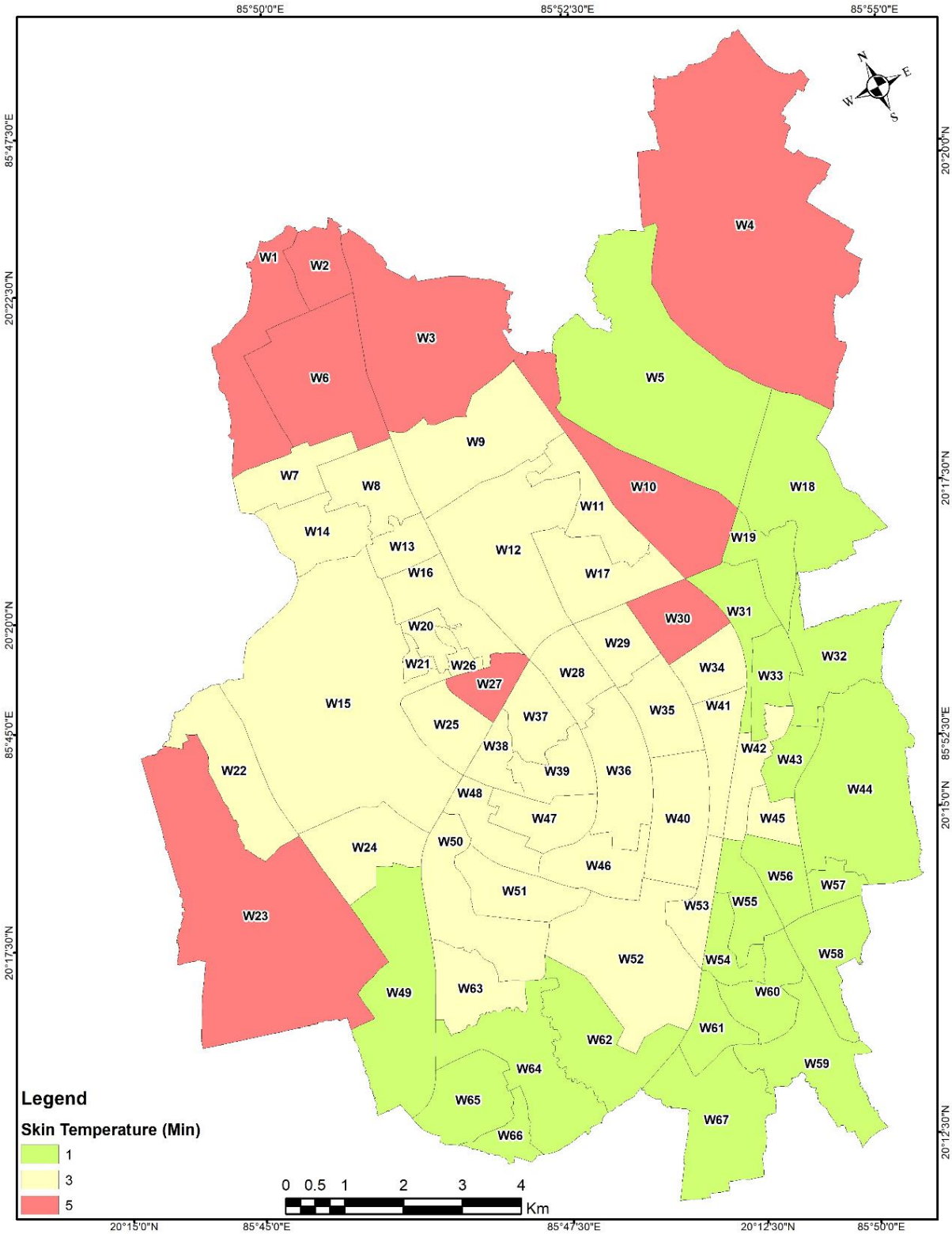


Figure A1. 2 Minimum Land Surface (Skin) Temperature Index Map of Bhubaneswar

The minimum Land surface (skin) temperature index of Bhubaneswar indicates that the 9 wards have an increasing trend of surface temperature of 0.015 °C per year from 1990 to 2024 due to reduced green cover with more concrete structures and paved surfaces increasing the minimum land surface temperature over time which can lead to prolonged heat exposures specifically to informal settlements and outdoor workers etc.,

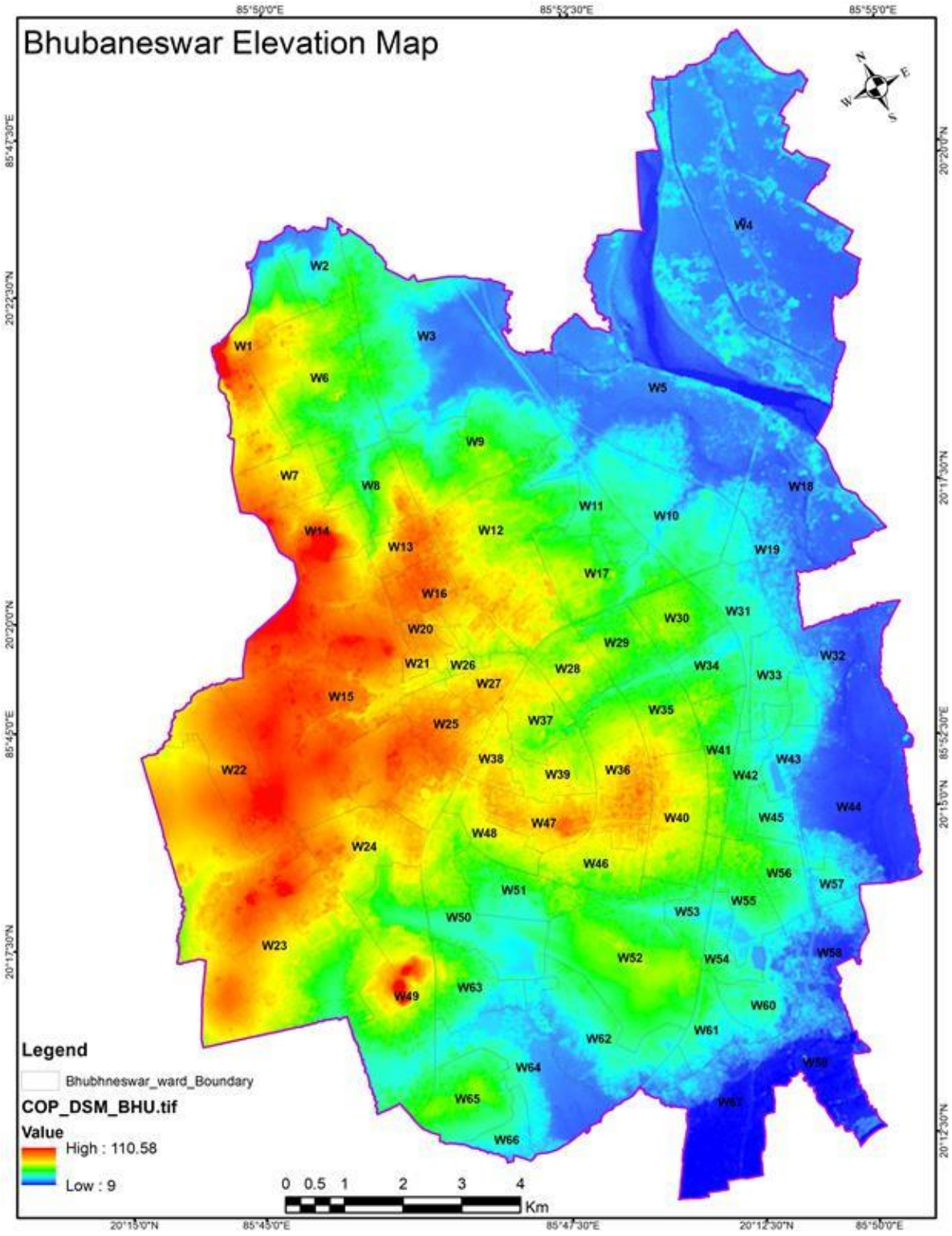


Figure A1. 3 Elevation Map of Bhubaneswar

The above elevation map of Bhubaneswar shows that the high-elevation areas (in red and orange) are located in central and western parts of Bhubaneswar and around 7 wards, such as ward numbers 14, 15, 22, 23, 24, 25, and 49. The low-elevated areas (in blue) are located towards the North, North-East and South-Eastern parts of Bhubaneswar, where the waterbodies like Barghavi and Kuakhai River pass. However, this is a low-resolution map, where local elevation changes and low-lying areas cannot be mapped out.

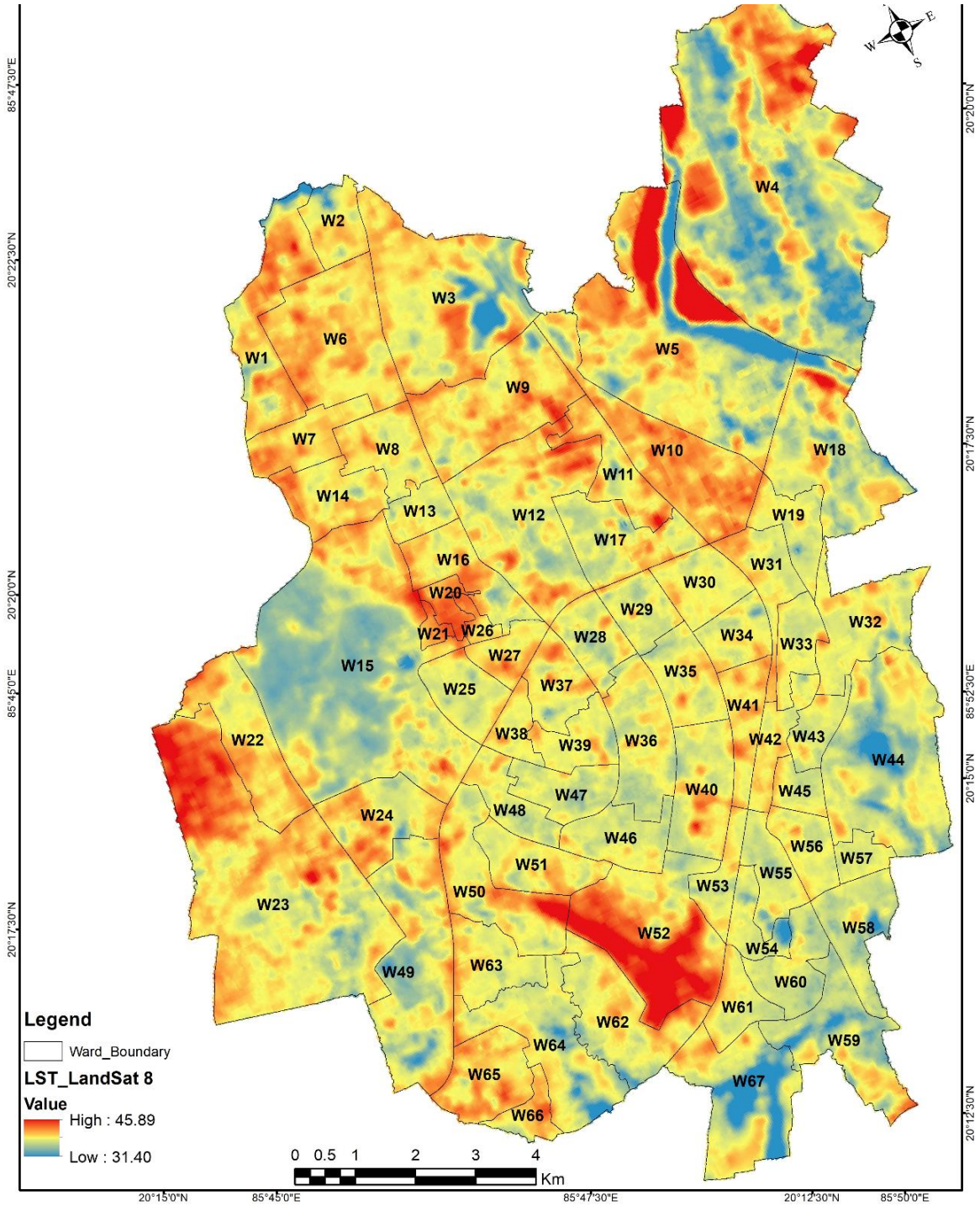


Figure A1. 4 Land Surface Temperature Map of Bhubaneswar

The average maximum land surface temperature of Bhubaneswar in May 2024, indicates heatwave conditions. The red-coloured areas represent zones with extremely high surface temperatures, typically the most urbanised areas characterised by more concrete buildings and paved structures with minimal green cover. Notably, the hotspot wards include 10, 20, 22, 23, and others, while Bhubaneswar Airport is in Ward 52. In contrast, the blue-coloured regions indicate water bodies and green cover, which consists of moderate to low surface temperatures.

Ward-Wise Vulnerability Score Table:

The table below provides a comprehensive overview of the index values associated with extreme weather events and the corresponding slum counts observed in each ward, sourced from the Bhubaneshwar Municipal Corporation (BMC), ensuring its relevance and accuracy. The climate trends index, calculated using the Mann-Kendall trend analysis methodology, was also sourced from the ERA5 weather dataset.

Table A 1. 1 Ward Wise Vulnerability Score Calculation

Ward No	Cyclone	Floods	Heatwaves	Air Temp (Min)	Skin Temp (Min)	Slum count	Slum count Index	Total Vulnerability Score	Vulnerable category
16	5	5	0	3	3	12	5	21	5
22	5	5	5	3	3	29	5	26	5
2	5	5	0	1	5	6	3	19	5
4	5	5	0	1	5	22	5	21	5
3	5	5	0	3	5	7	3	21	5
56	5	5	0	3	1	10	4	18	5
46	5	5	0	3	3	15	5	21	5
10	5	5	5	3	5	13	5	28	5
53	5	5	0	3	3	8	4	20	5
45	5	5	0	3	3	5	2	18	5
50	5	5	5	3	3	5	2	23	5
12	5	5	0	3	3	5	2	18	5
39	5	5	0	3	3	5	2	18	5
6	5	5	0	3	5	4	1	19	5
26	0	0	5	3	3	11	5	16	4
21	0	0	5	3	3	6	3	14	4
41	0	0	0	5	3	11	5	13	4
32	5	5	0	1	1	4	1	13	4
59	5	5	0	1	1	9	4	16	4
20	0	0	5	3	3	11	5	16	4
5	5	5	0	1	1	9	4	16	4
23	0	0	5	3	5	9	4	17	4
19	5	5	0	1	1	3	1	13	4
18	5	5	0	1	1	6	3	15	4
61	5	5	0	1	1	6	3	15	4
11	0	0	5	3	3	4	1	12	4

Ward No	Cyclone	Floods	Heatwaves	Air Temp (Min)	Skin Temp (Min)	Slum count	Slum count Index	Total Vulnerability Score	Vulnerable category
57	5	5	0	1	1	3	1	13	4
34	0	0	0	3	3	11	5	11	3
17	0	0	0	3	3	10	4	10	3
14	0	0	0	3	3	11	5	11	3
47	0	0	0	3	3	10	4	10	3
62	0	0	5	1	1	7	3	10	3
9	0	0	0	3	3	19	5	11	3
66	0	0	5	1	1	7	3	10	3
42	0	0	0	3	3	9	4	10	3
67	0	0	5	1	1	8	4	11	3
58	0	0	5	1	1	7	3	10	3
40	0	0	0	3	3	13	5	11	3
27	0	0	0	3	5	4	1	9	2
1	0	0	0	3	5	3	1	9	2
35	0	0	0	3	3	7	3	9	2
65	0	0	5	1	1	5	2	9	2
48	0	0	0	3	3	5	2	8	2
36	0	0	0	3	3	5	2	8	2
29	0	0	0	3	3	5	2	8	2
49	0	0	0	3	1	13	5	9	2
63	0	0	0	3	3	6	3	9	2
38	0	0	0	3	3	6	3	9	2
30	0	0	0	3	5	3	1	9	2
13	0	0	0	3	3	4	1	7	1
24	0	0	0	3	3	4	1	7	1
25	0	0	0	3	3	4	1	7	1
52	0	0	0	1	3	6	3	7	1
64	0	0	0	1	1	8	4	6	1
8	0	0	0	3	3	4	1	7	1
51	0	0	0	3	3	4	1	7	1
28	0	0	0	3	3	3	1	7	1
31	0	0	0	1	1	7	3	5	1
33	0	0	0	1	1	2	1	3	1
7	0	0	0	3	3	4	1	7	1
54	0	0	0	1	1	5	2	4	1
55	0	0	0	1	1	3	1	3	1
43	0	0	0	3	1	6	3	7	1
37	0	0	0	3	3	4	1	7	1
44	0	0	0	1	1	4	1	3	1
15	0	0	0	3	3	2	1	7	1
60	0	0	0	1	1	3	1	3	1

Although the extreme weather events have already been ranked as 5, the climate trend parameters are ranked as 1,3, and 5 among wards, and the slum counts from each ward will be ranked from 1 to 5 using the percentile method. After summing up all the indicators into the Total Vulnerability score, the score will be the basis for ranking the wards. A higher score corresponds to a higher index, like 5 or 4, while a lower index reflects lower scores, such as 1 or 2. The indices for each ward will be ranked from 5 to 1 using the percentile method and the short description of percentile calculation is given below.

Ward-wise Index		
Score	**Percentile Calculation**	**Vulnerability Description**
1	If Ward Value ≤ 20th Percentile of All Ward Values	Very Low Vulnerability
2	If 20th Percentile < Ward Value ≤ 40th Percentile	Low Vulnerability
3	If 40th Percentile < Ward Value ≤ 60th Percentile	Moderate Vulnerability
4	If 60th Percentile < Ward Value ≤ 80th Percentile	High Vulnerability
5	If Ward Value > 80th Percentile	Very High Vulnerability

Using the score, the selection of slums for the quantitative survey was refined based on selection criteria, alongside stakeholder consultation and a rapid field assessment. The final list of slums was mapped out, and the quantitative survey was conducted.

Annexure 2: Initial Slum list, Rapid slum visit, List of NGOs

Table A 2. 1 Initial list of slums from vulnerable wards (Notified Slums)

S.No	Wd No	Zone	Name of the Notified Slums (2016)	Approx Household	Approx. Population
1	2	North	Sikharchandi Cluster III	1500	5700
2	3	North	CS Pur Sabar Sahi	70	266
3	4	North	Banguari	209	795
4	4	North	Haridaspur Muslim Basti	130	494
5	5	North	Bhot Pada	202	768
6	10	North	Bhot Pada	202	768
7	19	North	Rasulgarh Canal Road Bhoi Sahi	100	380
8	22	South-West	Jokalandi Cluster-7	350	1330
9	23	South-West	Ghatikia Baramana Sahi	68	259
10	32	South-East	Muslim Basti	500	1900
11	59	South-East	Nuagaon Upper Sahi	150	570
12	67	South-East	Sunderpada Patna Sahi	50	190

Note: From the initial list of slums, four have been replaced and four more have been added based on a rapid field assessment survey.

Table A 2. 2 Initial list of slums from vulnerable wards (Notified Slums)

Ward No	Zone	Name of notified slums	Visit Date	Type of livelihoods	Type of institutions
64	South-West	Allia Maa Sahi Jadupur	16-Apr-25	Daily wage labourers, tailors, drivers, auto driver, business (Mutton shop), mutton shop helper.	Raghunatha Nagar Anganwadi Centre
64	South-West	Begunia Sahi Jadupur	16-Apr-25	Daily wage labourers, tailors, drivers, auto drivers, business, mutton shop helper.	Raghunatha Nagar Anganwadi Centre
64	South-West	Dumduma Bhoi Sahi	16-Apr-25	Daily wage labour, an auto driver, and a Business.	Dumduma Anganwadi Centre
64	South-West	Dumduma Nua Bhoi Sahi	16-Apr-25	Daily wage labour, auto driver, Business, garage mechanic.	Dumduma Anganwadi Centre
64	South-West	Jadupur Odia Sahi	16-Apr-25	Daily wage labour, an auto driver, and a Business.	Raghunatha Nagar Anganwadi Centre
32	South-East	Bhoi Sahi Jharapada	16-Apr-25	Daily wage labour, an auto driver, and a Business.	Nua sahi Anganwadi Centre
32	South-East	Harijan Sahi Jharpada	16-Apr-25	Daily wage labourers, drivers, auto drivers, business, grocery shop owners, and vegetable shop owners.	Dolamandap Anganwadi Centre

Ward No	Zone	Name of notified slums	Visit Date	Type of livelihoods	Type of institutions
32	South-East	Muslim Basti Jharpada	16-Apr-25	Daily wage labourers, drivers, auto drivers, business, mutton shop helper, grocery shop owners.	Raza Jama Masjid Anganwadi center
9	North	Rangamatia Bhoi Sahi	17-Apr-25	Daily wage labour, driver, Business.	Rangamatia Anganwadi center
9	North	Rangamatia Upper Sahi	17-Apr-25	Taxi Owner, Businessman, Taxi driver, grocery shop owners, Daily wage labourer	Rangamatia Anganwadi center
9	North	Gadakan Sabar Sahi	17-Apr-25	Daily wage labour	Gadakan Anganwadi center

Apart from the revised list, the above table consists of a rapid field survey conducted in other notified slums across selected zones to identify potentially vulnerable slum pockets for further qualitative research through FGDs and KIIs.

Table A 2. 3 NGO List

S.No	Name	Description
1	Orissa State Volunteers and Social Workers Association (OSVSWA)	With the twin concepts of 'Development through Participation' and 'Development through Sustainability'. OSVSWA works in Agriculture & Agricultural Livelihoods, Green Energy, and WASH, Emergency Disaster Response
2	Service for Rural Development (SRD)	SRD was involved in E shakti, project, supported by NABARD Bhubaneswar in Rayagada and Kolnara blocks of Rayagada district, working majorly on tracking status and functioning of SHGs.

Annexure 3: Key Informant Interviews

1. **Bhubaneswar Municipal Corporation (BMC):** A discussion with the BMC Disaster Management Unit outlines the wards that are majorly affected by extreme weather events, issues and challenges that the residents and the corporation are facing due to climate hazards, and their intervention through government initiatives.

   Below is an expanded version of the points discussed:

   - He has highlighted that the city has experienced a shift in rainfall patterns, leading to heavy precipitation over short periods. Consequently, urban flooding has become a common challenge.
   - He has mentioned that heatstroke is one of the most common climate-induced health issues in Bhubaneswar. Additionally, vector-borne diseases, respiratory illnesses, and waterborne diseases pose significant health risks, particularly in informal settlements with inadequate sanitation.
   - Non-governmental organizations (NGOs) and community-based organizations contribute to capacity-building and livelihood support programs. These initiatives enhance the resilience of urban poor populations by equipping them with necessary skills and resources.
   - Measures taken by BMC during hazards:
     - Protect residents by preparing shelters with essentials; evacuating people from unsafe areas, deploying road clearance teams, distributing relief and cooked food; ensuring strong interdepartmental coordination for effective disaster response.
     - Identified 30 flood-prone locations and installed high-capacity pumps.
     - During the monsoon season, emergency dewatering pumps from the Fire Service are deployed to manage excess water accumulation.
     - Under the "Drink from Tap Mission" launched by WATCO, the Odisha government ensures the availability of clean drinking water in urban areas, significantly improving water security during extreme weather conditions.
     - To provide reliable transportation for urban-poor communities during climate events, BMC operates the "MO BUS" service under the Capital Region Urban Transport initiative, ensuring mobility even during adverse conditions.
     - Additionally, increased afforestation efforts in open spaces and parks aim to reduce heat intensity during summers.
     - Early Warning Systems are placed which help in ensuring timely evacuation and preparedness during extreme weather events. Timely alerts and coordinated responses have significantly reduced casualties and damages from extreme weather events.
     - BMC engages vulnerable communities through participatory planning to ensure their needs and perspectives are integrated into climate resilience strategies.
   - Government initiatives: The municipal corporation supports climate-resilient urban planning through various government-sponsored initiatives such as:
     - Swarna Jayanti Sahari Rozgar Yojana

    - Rajiv Awas Yojana (RAY)
    - Urban Self-Employment Program (USEP)
    - Urban Wage Employment Program (UWEP)
    - Urban Women Self-Help Program (UWSP)

- The Odisha State Action Plan on Climate Change (SAPCC) 2021-30 outlines strategies and actions to mitigate climate change impacts and integrate adaptation measures into urban development planning.

- BMC has received financial and technical support for climate adaptation projects from various sources, including:
    - Odisha State Budget
    - Green Climate Fund
    - Orissa Mining Corporation
    - Jawaharlal Nehru National Urban Renewal Mission (JnNURM)
    - Japan International Cooperation Agency (JAICA)

- BMC collaborates with multiple stakeholders, including:
    - Odisha State Disaster Management Authority (OSDMA)
    - Community Consulting India Private Limited
    - International Council for Local Environmental Initiatives (ICLEI)
    - United Nations Development Programme (UNDP)

- Requirements mentioned by BMC:
    - Need for enhanced energy infrastructure that can withstand climate shocks and ensure uninterrupted electricity access to urban poor communities.
    - Need for systematic planning and better infrastructural investments to address these issues effectively.
    - Improved resilience strategies are needed to ensure uninterrupted services during climate emergencies.
    - Informal housing settlements require significant improvements in resilience to combat extreme heat, flooding, and cyclones.
    - BMC highlights the necessity of a multi-pronged approach for sustainable urban development.
    - To enhance housing resilience in informal settlements, durable and low-carbon building materials should be utilised in infrastructure development.
    - Awareness about climate change impacts among urban poor communities must be carried out, highlighting the issues and possible measures to combat the same.
- In terms of policy, recommendations are: To strengthen climate resilience among urban poor communities, policy measures should focus on:
    - Expanding affordable housing programs under Swarna Jayanti Sahari Rozgar Yojana and RAY as climate-resilient infrastructure is costly.

- Enhancing community capacities to manage climate risks through awareness and training initiatives.

- Suggestions:
  - Improved resilience strategies are needed to ensure uninterrupted services during climate emergencies.
  - Informal housing settlements require significant improvements in resilience to combat extreme heat, flooding, and cyclones.

2. **Odisha Health Mission:** Discussion with Joint Director-cum-State Nodal Officer (SNO) of the Disaster Management Cell, Directorate of Health Services, identified the prevalence of diseases, and the health risks due to climate-induced events, public health trends, healthcare service disruptions, maternal and child health vulnerabilities, infrastructure preparedness, and policy measures for adaptation and resilience

   Below is an expanded version of the points discussed with Joint Director-cum-State Nodal Officer (SNO) of the Disaster Management Cell, Directorate of Health Services:

   - Extreme weather events such as floods, cyclones, and heat waves have led to an increase in climate-induced health issues, including heat exhaustion, heatstroke, cardiovascular diseases, and respiratory conditions.
   - Health challenges:
     - **Heat-related illnesses**: Increased temperatures contribute to dehydration, heatstroke, and exhaustion, particularly among outdoor workers and slum dwellers.
     - **Vector-borne diseases**: Stagnant water from urban flooding increases malaria, dengue, and chikungunya cases.
     - **Waterborne diseases**: Poor sanitation and flooding contribute to diarrhoea, cholera, and gastrointestinal diseases.
     - **Respiratory illnesses**: Air pollution and temperature fluctuations exacerbate asthma and other respiratory conditions.
     - Pregnant women, infants, and children face climate-induced health hazards, including Pregnancy complications from heat stress and inadequate prenatal care; Increased child morbidity and mortality from waterborne and vector-borne diseases.
   - Government initiatives:
     - Pre-positioning medical supplies: Stockpiling vaccines, essential medicines, and ORS before extreme weather events.
     - Strengthening healthcare infrastructure: Ensuring hospitals remain operational using renewable energy and backup power.
     - Deploying emergency response teams: Medical teams provide care in flood-affected and cyclone-hit areas.
     - Mobile health units: These teams provide medical assistance in disaster-prone regions.
     - Upgrading health centres with solar panels and energy-efficient equipment.

- Developing flood-resistant healthcare facilities.
- Strengthening climate-responsive hospital design.

- In terms of policy, government initiatives are:
  - The Health Department actively contributes to the State Disaster Action Plan through: Monitoring the State Disaster Preparedness and Response Plan; Collaborating with national and international agencies; Engaging in public-private partnerships; Advocating for increased disaster resilience funding.
- Initiatives taken in terms of capacity building and public awareness:
  - Training programs and awareness campaigns include:
  - Early recognition of heat-related illnesses.
  - Preventive measures for vector-borne and waterborne diseases.
  - Safe food and water practices.
  - Community-based emergency preparedness.
- Measures to ensure uninterrupted health services:
  - Equipping health centers with renewable energy solutions.
  - Implementing rainwater harvesting systems.
  - Enhancing emergency transport services.
  - Strengthening telemedicine services.
  - Future Strategies for Strengthening Climate-Resilient Healthcare Expanding solar energy installations in healthcare centers; Strengthening climate-proof medical storage facilities; Enhancing early warning systems for disease outbreaks; Promoting community participation in health resilience programs.

3. **Odisha Livelihood Mission (OLM)-Mission Shakthi:** Discussion with Joint Secretary-cum-Addl. CEO, Odisha Livelihood Mission and Manager, Mission Shakti Bazar, to understand common livelihood practices, income sources, and the challenges faced by extreme weather events, etc.

   Below is an expanded version of the points discussed with the Joint Secretary-cum-Addl. CEO, OLM, and Manager, Mission Shakti Bazar:

   - Daily wage labourers, street vendors, and domestic workers are vulnerable to climate hazards; they lack job security, social safety nets, and often cannot work during extreme weather conditions.
   - Mission Shakti plays a crucial role in empowering women through self-help groups (WSHGs), promoting income-generating activities such as:
     - Empowering women through gainful activities by providing credit and market linkage.
     - Implementation of interest subvention scheme & Livelihood, Skill Development.
     - Supply of pre-school uniforms and mid-day meals.
     - Operation of fair price shops and community service centers.
     - Agri-based income-generating activities (mushroom cultivation, beekeeping, poultry farming, etc.).

- Challenges faced by livelihoods:
    - **Slum Dwellers & Low-Income Communities:** Poor housing conditions, often living in informal settlements, increase vulnerability to floods and heat waves; Lack of proper drainage, and sanitation systems; Limited access to resources slows post-disaster recovery.
    - **Women & Children:** Women face additional burdens in household management; Climate-induced disruptions affect children's education and well-being.
- Government initiatives:
    - Swarna Jayanti Shahari Rozgar Yojana
    - Rajiv Awas Yojana (RAY)
    - Urban Self-Employment Program (USEP)
    - Urban Wage Employment Program (UWEP)
    - Urban Women Self-Help Program (UWSP)
- Urban Green Initiatives:
    - Expansion of parks, green roofs, and community gardens to reduce heat stress.
    - Tree plantation programs along roads and in public spaces.
    - Promotion of cool roofs and heat-absorbing pavements.
- In terms of policy, government initiatives are the State **Urban Development Agency** (**SUDA**) **& National Urban Livelihoods Mission** (**NULM**) aim to:
    - Strengthen urban self-employment and skill development programs.
    - Provide shelter for urban homeless communities.
    - Support street vendors and vulnerable groups through livelihood promotion initiatives.
    - Supervision & Monitoring of PDS of BPL families.

Annexure 4: Qualitative Interviews

Jokalandi Cluster 7, Ward No. 22

1) Kamini Prusty, Tailoring and Boutique Product Seller

Name:	Kamini Prusty
Age:	35
Occupation	Tailoring and Boutique Product Seller
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Kamini Prusty is a home-based entrepreneur who manages a tailoring business and sells boutique items. Her small-scale operation plays a key role in meeting the clothing and accessory needs of the residents. She travels 4–5 kilometres regularly to procure stock, which adds to her workload and operational costs.

Store Setup and Operations

Kamini's tailoring unit is run from her home and primarily serves local women. She is not affiliated with any Self-Help Group (SHG) and has no access to institutional credit or small business loans. Boutique sales are done manually with no digital presence. During extreme heat, she adjusts working hours to mornings and evenings.

Needs and Aspirations

Kamini aspires to expand her business by investing in better sewing machines and stock. She seeks financial assistance and is open to joining an SHG to access loans.

2) Annapurna Mohanty, Grocery Shop Owner

Name:	Annpurna Mohanty
Age:	54
Occupation	Grocery Shop Owner
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Annapurna has been running a small grocery shop from her home for the past two years. The shop is an important source of daily essentials for residents. However, her business is vulnerable to climate conditions and infrastructure limitations.

Store Setup and Operations

The shop is modestly equipped and depends on regular electricity for cooling and lighting. However, frequent power cuts lead to the spoilage of perishable goods. The extreme heat in summer limits her operating hours, and climate disasters disrupt her ability to stay open.

Needs and Aspirations

Annpurna hopes to install alternative power sources like solar panels to protect her stock. She wants access to small business loans or emergency funds to better cope with climate-induced challenges.
Additional cooling infrastructure and proper storage solutions are also high on her wishlist.

3) Srikanta Sahu, Grocery Shop Owner

Name:	Srikanta Sahu
Age:	46
Occupation	Grocery Shop Owner
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Mr. Srikanta Sahu operates a grocery shop out of a rented house in Jokalandi Cluster 7. The shop serves local residents and a few outside customers, providing regular supplies of food and daily necessities.

Store Setup and Operations

The shop has a metered electricity connection, but operations are frequently disrupted due to weather-related power cuts. During cyclones, he must move stock to safer locations, causing weeks of business interruption. Recovery is slow, often taking up to two weeks after the disaster.

Needs and Aspirations

Srikanta wishes to install a generator or an inverter to deal with power outages. He seeks disaster insurance or financial assistance for loss recovery. He is open to learning about disaster planning and coordinating with authorities to reduce disruptions.

4) Srinibas Sahoo, Furniture Workshop Owner

Name:	Srinibas Sahoo
Age:	42
Occupation	Furniture Workshop Owner
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Mr. Srinibas Sahoo is a local entrepreneur who runs *Khusi Furniture*, a small-scale furniture and woodwork unit located within a slum area of Jokalandi Cluster 7. The workshop employs four individuals, including Mr. Sahoo himself. Despite operating under infrastructural constraints, the unit continues to cater to local furniture demands using basic tools and a metered electricity connection.

Store Setup and Operations

The workshop lacks formal land documentation but has access to metered electricity, which ensures a sable power supply for machinery.

Operations are affected by extreme weather, particularly in summer when productivity drops due to heat. A major concern at the workshop is the large volume of wood dust generated during furniture cutting and processing. This dust poses health risks to workers and affects the nearby slum residents.

The Bhubaneswar Municipal Corporation (BMC) currently does not collect this type of industrial waste, leading to dust accumulation around the premises.

Needs and Aspirations

Chimney Exhaust System: Mr. Sahoo has requested support for installing a chimney exhaust system to effectively control and manage wood dust. He is open to purchasing it through government subsidy schemes or on an EMI basis if financing support is available.

Financial Support: He is interested in exploring EMI-based machinery financing or small-scale industry assistance programs.

Waste Disposal Coordination: Mr. Sahoo seeks regular waste collection services from BMC and is willing to discuss dust disposal solutions.

Workplace Safety: He aspires to maintain a cleaner and safer work environment by implementing localised dust containment tools such as dust collectors or vacuum systems.

5) Mr. Subash Das, Furniture Variety Shop Owner

Name:	Mr. Subash Das
Age:	48
Occupation	Furniture Variety Shop Owner
Ward Name and Number:	Jokalandi Cluster 7, Ward 22

Mr. Subash Das is a local shopkeeper who runs a small variety shop attached to his residence in Jokalandi Cluster 7. His shop plays a vital role in serving the local community, offering essential daily-use items. Throughout our discussion, he highlighted several socioeconomic and environmental challenges that significantly impact his business and the broader community.

Store Setup and Operations

Subash operates his shop independently and manages all procurement and sales himself. His stock is sourced from the only wholesale market, located about 8 km from his shop. Transportation becomes difficult during adverse weather, affecting product availability. During extreme summers, especially heatwaves, the shop is open only during mornings and evenings, which directly reduces sales volume and income. The shop functions year-round but is vulnerable to seasonal disruptions and climate-related emergencies.

Needs and Aspirations

Government Assistance: Subash shared that while he and others in the community are enrolled under the JAGA Mission and Rajiv Awas Yojana (RAY), they have not yet received any actual benefits. He hopes for quicker and more visible implementation of these schemes.

Climate Disaster Recovery Support: The area often suffers from climate disasters like floods and storms. Subash estimated that about ₹20,000–₹25,000 is needed each time for repairs and recovery—an amount difficult to manage without external support. He emphasised the need for a disaster relief fund for immediate post-disaster recovery.

Improved Supply Chain Access: He aspires to have better connectivity and transportation facilities to reduce the burden of travelling for stock during challenging times.

Support for Seasonal Business Disruption: Subash believes that financial support or policy interventions during seasonal slowdowns (e.g., heat waves) would help maintain livelihood stability for small businesses.

Maa Laxmi Nagar Slum, Ward No. 23

6) Ms. Guni Sabu, Grocery Shop Owner

Name:	Guni Sahu
Age:	54
Occupation	Grocery Shop Owner
Ward Name and Number:	Maa Laxmi Nagar Slum, Ward No. 23
Contact Details:	9937722156

Ms. Guni Sahu is a home-based woman entrepreneur who runs a small grocery store attached to her residence in Maa Laxmi Nagar slum. Since 2018, her shop has served the local community by providing daily essentials. The store is managed primarily by her, with support from her husband.

Store Setup and Operations

The shop is set up within their home and is powered through the residential electricity connection. Products are sourced from wholesale markets in Dumduma, and her customers are mainly slum residents. Guni uses a table fan for cooling, and the shop operates daily from morning till night.

Despite stable electricity most of the time, occasional transformer issues lead to milk spoilage due to lack of refrigeration. During heavy rains, water enters the shop, damaging stock like rice packets stored at floor level. The asbestos sheet roof was once damaged during a cyclone, and it took a week for her to resume normal operations.

Her average daily sales are around ₹500. However, due to age restrictions, she is not eligible for many microfinance schemes that could support business expansion or improvements.

Needs and Aspirations

Guni wishes to invest in raised shelving or waterproof storage solutions to minimise product damage during monsoons. She also aspires to reinforce her shop's roof to withstand cyclones and improve storage space to ensure better protection of goods in adverse weather conditions.

7) Pramila Pradhan, Owner of Variety Store; President of Mahila Samiti

Name:	Pramila Pradhan
Age:	45
Occupation	Owner of Variety Store; President of Mahila Samiti
Ward Name and Number:	Maa Laxmi Nagar Slum, Ward No. 23
Contact Details:	8018066217

Ms. Pramila Pradhan is a senior woman entrepreneur and community leader who runs a variety store attached to her home in Maa Laxmi Nagar slum. Apart from managing her business, she actively leads the Mahila Samiti and advocates for community needs and entitlements.

Store Setup and Operations

The shop is physically integrated with her house. An asbestos roof and a tin sheet extension partially cover it. The store is equipped with a ceiling fan, table fan, and a deep freezer to stock perishable items like cold drinks and dairy products. Her electricity expenses rise to around ₹1600 in the summer months and stay between ₹800–₹900 in other seasons.

Her customer base primarily consists of residents. However, she experiences operational hurdles, especially during the monsoon due to waterlogging. Lack of proper drainage causes rainwater to enter the shop, which once resulted in damages worth around ₹2,00,000. Despite lodging complaints with BMC and the local corporator, no compensation has been received to date.

Adaptation Measures

To cope with increasing summer heat, Pramila has undertaken various initiatives. These include:

- Lining the roof with paper cartons to reduce heat
- Planting trees near the store for shade. She has also received heatwave coping training and actively uses available cooling appliances.

Community Insights

As the Mahila Samiti President, Pramila is vocal about the shortcomings in government support systems. She believes that many schemes are poorly targeted and recommends

8) Sangeeta Das, Dairy Farmer

Name:	Sangeeta Das
Age:	45
Occupation	Dairy Farmer
Ward Name and Number:	Maa Laxmi Nagar Slum, Ward No. 23

Ms. Sangeeta Das runs a family-based dairy business in Maa Laxmi Nagar Slum, a livelihood established over three decades ago by her father-in-law. The dairy serves as the sole source of income for the family, and involves three members in daily operations and animal care. Sangeeta's dairy farm currently operates with 15 cows, yielding around 60 litres of milk every day. Milk is sold locally, supporting household expenses and reinvestment into livestock care.

Operations & Expenses:

The farm requires a consistent supply of fodder, and Sangeeta purchases around 60 packets of cow feed each month at the rate of ₹1,000 per packet, in addition to procuring paddy straw. The cows are housed in a shed with asbestos roofing and a separate metered electric connection. A pump set is used for bathing the cows, while a ceiling fan is installed for ventilation inside the shed. Electricity expenses are notably higher during the summer months, reaching ₹1,200, while in other seasons the bill ranges from ₹600–₹700. Veterinary services are not readily available from government institutions, so the family relies on private veterinarians and bears the treatment costs themselves.

Needs and Aspirations

Despite decades of operation, the dairy has not received any formal government support, such as training, financial aid, or scheme benefits specific to livestock care or dairy entrepreneurship. Natural disasters pose a major threat—during cyclones, the cows are left exposed while the family takes shelter, resulting in the death of two cows in a past event. The farm also lacks the infrastructure and equipment to produce value-added products like curd, ghee, or cheese, limiting opportunities for income diversification. Furthermore, Sangeeta recently invested heavily in high milk-yielding cows, each costing between ₹50,000–₹70,000, highlighting the financial risks associated with livestock ownership in the absence of insurance or institutional support.

Maa Patadebi Basti, Ward No. 5

9) Ms. Bhagyashree Sahoo, Small Business Owner (Variety Store)

Name:	Ms. Bhagyashree Sahoo
Age:	25
Occupation	Small Business Owner (Variety Store)
Contact Details	9861435311
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5

Ms. Bhagyashree Sahoo is a young woman entrepreneur who operates a small variety store located within a slum area. Her establishment plays a vital role in serving the daily needs of the local community, offering essential goods and household items to nearby residents.

Store Setup and Operations

The shop is equipped with a closed-circuit television (CCTV) system, which she has installed as a proactive security measure. The store operates with a metered electricity connection, ensuring an uninterrupted power supply for regular business functions.

Ms. Sahoo does not possess legal landownership documents for the location where her store is situated. This lack of formal ownership limits her eligibility for institutional financial assistance and government welfare schemes.

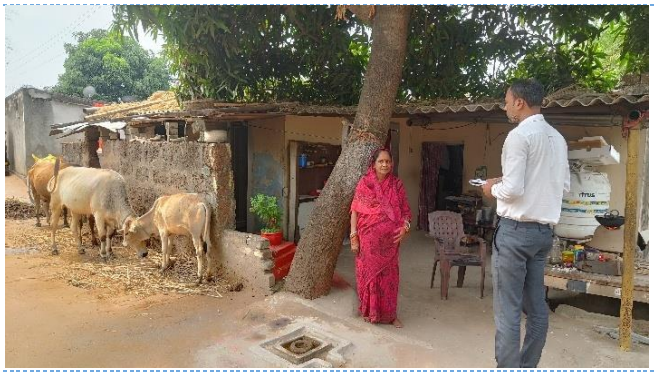
Her primary customer base consists of local slum residents, and she reports that her sales peak during the rainy season, likely due to increased demand for accessible local services during periods of limited mobility. She sources her inventory from a wholesale market in VSS Nagar, maintaining a consistent supply chain to meet customer demands.

Needs and Aspirations

Access to financial assistance, preferably in the form of low-interest loans or government grants, for strengthening of her enterprise. Skill development opportunities, particularly in areas such as business management, inventory control, and digital marketing, to enhance her entrepreneurial skills and ensure long-term business sustainability.

10) Ms. Kamala Behera, Dairy-Based Livelihood (Cattle Rearing and Dairy Product Preparation)

Name:	Ms. Kamala Behera
Age:	48
Occupation	Dairy-Based Livelihood (Cattle Rearing and Dairy Product Preparation)
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5



Ms. Kamala Behera is a committed resident of the slum who has built a sustainable livelihood through cattle rearing and dairy-based production from her home. Her entrepreneurial initiative and self-reliant approach have enabled her to contribute meaningfully to her household income and local food systems.

Livelihood Activities:

Began her dairy venture two years ago with a single cow; she currently owns 2 adult cows and 2 calves. A dedicated cow shed, attached to her residence, provides shelter for the animals. Spends 4 to 5 hours daily on cattle care, including feeding, cleaning, and preparing milk products.

Production and Income:

Cows yield 10–12 liters of milk daily for about 6–7 months each year. Instead of selling raw milk to dairies, she produces and sells curd, paneer, and ghee directly from her home to local customers. Cow dung is collected regularly and sold as organic compost to farmers in nearby areas. Monthly expenditure on feed and maintenance is approximately ₹1,000.

Challenges:

Lack of nearby veterinary services leads to difficulty in accessing timely care for her cattle. Veterinary visits are costly and must be arranged personally, increasing both her financial and emotional burden.

Support Requirements

Regular and affordable veterinary services or mobile vet units in or near the slum. Access to subsidized cattle feed and periodic health camps for livestock.

Training programs in animal husbandry and advanced dairy product processing.

Financial aid for expanding production and acquiring hygienic packaging equipment to enhance product quality and market reach.

11) Ms. Pramila Samal, Home-Based Small Grocery Shop Owner

Name:	Ms. Pramila Samal
Age:	52
Occupation	Home-Based Small Grocery Shop Owner
Ward Name and Number:	Maa Patadebi Basti, Ward No. 5

Ms. Pramila Samal is a resilient woman entrepreneur operating a small grocery business from her home in the slum. Despite facing physical challenges and limited resources, she remains determined and self-reliant, sustaining her livelihood through dedication and hard work.

Store Setup and Operations

She stocks essential household groceries to cater to the daily needs of nearby residents.Goods are sourced regularly from the wholesale market in Chakeisiani to maintain inventory. The shop relies on a metered electricity connection and has access to a household water supply. Pramila manages her business independently despite having a physical disability that limits her mobility. She lacks land ownership documentation, which hinders her access to government financial support or formal schemes.

Needs and Aspirations

Financial assistance or micro-loan support will help expand her business. Skill development programs focused on entrepreneurship, tailored to home-based and differently abled individuals. Assistance with land documentation and business recognition to qualify for relevant schemes and subsidies.

Annexure 5: Testimonials

Maa Laxmi Nagar Slum, Ward No. 23

Sangeeta Das, Dairy Farmer, Maa Laxmi Nagar Slum	This dairy has been our family's only source of income for many years. We take care of 15 cows and produce around 60 litres of milk every day. We haven't received any help or training from the government. We've spent a lot on good-quality cows and feed, but we still can't make curd, ghee, or other products because we don't have the space or equipment. If there were some support for small dairy farmers like us, it would help us grow and keep our animals safe.

Running my shop here in Maa Laxmi Nagar is challenging, especially when the rainwater floods the store and damages my products. Last time, I lost about ₹2,00,000 worth of goods, and despite complaining to the authorities, I never received any help. Power cuts are another issue during the summer. The government schemes don't always reach those of us who need them the most, and I believe there should be better financial help for people like me who are genuinely struggling.	Pramila Pradhan, Owner of Pramila Variety Store President, Mahila Samiti (Slum Community Group)

Guni Sahu, Owner of Maa Laxmi Store	Running my shop here in Maa Laxmi Nagar is not easy. The rain often damages the products, especially the rice bags, when the water comes in. Sometimes, power cuts cause the milk to spoil. The roof was damaged in a cyclone, and it took a while to get things back to normal. If I could get some help with fixing the roof and raising the shelves, it would help protect the stock from the rain. Small changes like these could make a big difference to my business.

Sundarpada Patnasahi, Ward No. 67

Anupama Behera, Owner, Grocery Shop	I run a small grocery shop beside my house, and while it helps the local community, I face challenges like low profits and the lack of proper storage for cold items. My income is around ₹10,000 a month, but sometimes it's hard to manage with the limited space and resources. If I had help to upgrade my shop, like a fridge and better shelves, it would make a huge difference in my business. A low-interest loan would also help me expand and serve my customers better.

I run a small vegetable shop in Sundarpada–Patna Sahi Slum. I buy fresh vegetables from the local market and sell them twice a day. But without electricity in my shop, I rely on streetlights at night and candles during power cuts. It's very hard to manage in summer and the rainy season without a fan or proper lighting. If I could get solar light or a small battery light, and some help to keep the vegetables fresh, it would make my work much easier and help my business grow.	Manguli Samal, Owner, Vegetable Shop

Harihar Sahoo, Owner, Sweets Shop	I run a small sweets shop near the Sundarpada–Patna Sahi Slum, and my family depends on this business for our livelihood. But during cyclones, my shop has to close for up to two weeks, which causes severe financial strain. The income stops completely during bad weather or lockdowns. I really need support for my small business and assistance to manage my family during such emergency times."

Joklandi Cluster 7, Ward No. 22

Srinibas Sahoo, Owner, Khusi Furniture	I run Khusi Furniture with a small team, and while we do our best, managing wood dust has become a huge challenge. The dust affects our health and creates problems for people living nearby. It's hard to stay efficient, especially in the summer when the heat slows things down. I've been thinking about installing a chimney exhaust system to control the dust, but it's a big investment. If there was a way to get support, like a subsidy or an EMI option, it would make a huge difference for us to keep working safely and improve our operations.
Subash Das, Owner, Variety Shop	I run my variety shop from home in Joklandi Cluster 7. While we're enrolled in the JAGA Mission and Rajiv Awas Yojana, we haven't received any real help yet. The worst part is the climate disasters—they damage our homes and businesses, and it takes weeks to recover. For small business owners like me, it's hard to keep up, especially with the distance to the wholesale market and extreme heat in summer. We need better support from the government and quicker disaster relief."
Arati Pradhan, Owner, Tailoring Shop	I've been running my tailoring shop in Joklandi Cluster 7, but the constant power outages really affect my work. When storms or floods hit, my shop stays closed for up to two weeks, and it's tough to recover financially. I love what I do, but I'd really benefit from some training in new techniques to expand my business. If I had better power solutions and help to bounce back from disasters, it would make a huge difference."
Kamini Prusty, Tailor & Boutique Seller	I run my tailoring business from home and also sell some boutique items to support my income. But without any financial help, it's really hard to grow. I'm not part of any SHG, so I can't get loans easily. Every few days I have to travel 4–5 km just to buy stock, which takes time and money. In the summer, it's even tougher—we can't work in the heat, so we shift to mornings or even nighttime. Most of my customers are from nearby, and I'd love to reach more people, maybe through WhatsApp or online. If I could get a small loan and some training, it would help me buy better equipment, manage stock better, and run the business more smoothly."
Annpurna Mohanty, Grocery Shop Owner	I've been running my grocery shop from home for the last two years. Most of my customers are from the neighbourhood, and I try my best to keep everything they need. But during heavy rains or other disasters, it becomes very hard to keep the shop open. We have to depend on our savings to manage during those times. Also, when the power goes out, food in the fridge gets spoiled, and that's a big loss. In the summer, it's too hot to work comfortably, even with a fan. If I could get some help with backup power or better cooling, it would make it easier to run the shop without so many problems."
Srikanta Sahu, Grocery Shop Owner	I run my grocery shop from a rented house. Power cuts are a big problem, especially during rain or heat waves. Cyclones make things worse—I have to move all the stock, and it takes weeks to get back to normal. Some support with power backup or disaster help would make a big difference."

Maa Patadebi Basti, Ward No. 5

Tunu Nayak, Owner of a Small Variety Store	My shop is small and part of my house, and most of my customers are from the slum nearby. I don't have a fridge, so I can't keep items that spoil quickly. During cyclones or heavy rains, I try to move everything inside the house, but still, some things get damaged. It always takes at least a week before I can open the shop properly again. The losses hurt, especially because I work hard to keep the shop running and serve the people here.
Bhagyashree Sahoo, Variety Store Owner, Maa Laxmi Nagar Slum	I've been running my small shop here in the slum, and it means a lot to me and the people around. I even installed CCTV to keep the shop safe, and I make sure to always have daily items in stock. But since I don't have land papers for the place, I can't get any government help or loans. I want to grow my business, but without financial support or proper training, it's hard. If I could get a small loan or learn more about managing the shop better, like using digital tools or handling inventory, it would help me take the next step."
Kamala Behera, Dairy Entrepreneur	I started with just one cow, and now I have two cows and two calves. Every day I take care of them—feeding, bathing, and cleaning—then I prepare curd, paneer, and ghee to sell from my home. People from the area come to buy directly from me. I also sell cow dung as compost. This work helps me support my family, but it's not always easy. When the cows fall sick, I have to find a vet on my own and pay for everything. It would really help if there were regular vet visits or some support for feed and medicines. I also wish I could get some training and better tools to make and pack my products properly."

Annexure 6: Discussion with Anganwadi's

Table A 6. 1 Discussion with Anganwadi's

S. No	Ward	Major Hazards	Livelihood vulnerability	Health Vulnerability	Infrastructure vulnerability	Access to Energy/Water	Financial
1	Maa Patadevi Basti, Ward-5	• Cyclones, • Heatwaves • Heavy rainfall	• Pregnant women face limited mobility, higher infection risk, and reduced access to prenatal care. • Children are more vulnerable to illness due to poor hygiene and high temperatures. • Daily-wage-dependent work makes them highly vulnerable to weather disruptions – loss in business affects daily needs. • Poor Road connectivity, making it difficult to access medical help or emergency supplies during floods or storms.	• Diarrhea, Skin infections, Fever, Dehydration - more prevalent in children, lasts for several days. • The nearest government health centre is located in Naharkanta, approximately 6 kilometres from the slum.	• Non resilient structures. • Poor ventilation and lack of cooling make indoor spaces uncomfortable and potentially harmful. • Water enters the premises during heavy rains, damaging materials and creating unsafe conditions for children.	• Lack of access to basic needs, such as water, sanitation, and nutrition during disasters. • Power outages, which affect cooling, lighting, and medicine storage.	• A significant portion of the population is engaged in small-scale businesses, with limited access to formal financial systems such as bank loans or government schemes. • Most residents do not possess land ownership documents, which restricts their eligibility for financial assistance.
2	Jokalandi Cluster 7, Ward 22	• Cyclones, • Heatwaves • Floods	• Public taps cause long waits; water quality is occasionally poor.	• Frequent dehydration and sunstroke • Basic first aid is available, but no regular medical services exist within the slum. • Serious medical cases are referred to Bharatpur Medical Centre, 1 km away. • Children often fall sick due to poor ventilation and hygiene, and a lack of immediate healthcare access makes recovery difficult.	• Strong, well-built structure that doubles as a safe shelter during cyclones. • Residents live in kachha houses made of tin, plastic, and mud - leak during rains and become extremely hot in summer, making them unsuitable for rest or home-based work.	• Power cuts and heavy rains limit access to electricity and water.	• Rely on daily earnings for essentials. • No post – disaster financial support. • Take high interest loans to repair homes and cater to basic needs.
3	Shampur Slum, Ward no. 22	• Cyclones, • Heatwaves • Heavy Rains	• Most affected - street vendors and daily wage workers • Operate in open spaces - vulnerable to extreme weather conditions such as heavy rains, heatwaves, and cyclones. • Ability to work is severely disrupted, leading to income losses.		• The Anganwadi buildings in Shampur are not equipped to withstand the impact of extreme weather – asbestos roof, poorly maintained concrete roofs • Waterlogging for 1hour, road access is mostly functional.	• Power outages are still a challenge; there are no backup energy sources like solar power, generators, or inverters.	• Financial burden for those who rely on daily incomes.

S. No	Ward	Major Hazards	Livelihood vulnerability	Health Vulnerability	Infrastructure vulnerability	Access to Energy/Water	Financial
4	Sunderpada Patni Sahi, Ward No.67	• Cyclones, • Heatwaves • Heavy Rains	• Inadequate infrastructure and poor climate resilience of Anganwadi centers force mothers to keep children at home during extreme weather. • This limits their ability to work full-time or pursue better-paying jobs, reducing household income and financial stability.	• Children face risks of dehydration, skin rashes, and respiratory issues • Cleanliness is difficult to maintain in humid or rainy seasons, increasing vulnerability to infections.	• The Anganwadi operates from a rented room with poor ventilation, no insulation from heat, and inadequate space for children. • There is no cooling system or proper furniture, making it unsafe during summers. • The lack of weather-resistant infrastructure disrupts services during cyclones and heavy rains.	• Limited access to basic resources like drinking water, fans, or emergency supplies. • Food is provided occasionally, but storage and distribution are disrupted during climate events due to lack of refrigeration or space.	• The financial capacity of the Anganwadi is low, not able to maintain consistent service delivery. • Government support is limited and often delayed, and there is no dedicated budget for climate resilience improvements.
5	Naharkanta Near to Banguari Slum – Ward no.4	• Cyclones, • Heatwaves • Heavy Rains	• 55% of the population are daily wage workers, who are highly vulnerable during disasters such as floods and heatwaves. • Extreme weather limits the ability of working mothers to leave children at the Anganwadi center, restricting their work hours and income opportunities. • Small business owners and informal sector workers also face disruptions during weather events.	• Basic treatment is available locally, but more serious cases must be referred to a CHC or government hospital. • Elderly individuals are particularly vulnerable to sunstrokes during heatwaves.	• Flooding in the area leads to water accumulation of 2–3 feet, taking 8–10 days to drain out. • Lack of proper drainage in the Anganwadi center. • No dedicated water facilities; water is sourced from a nearby school. • Inadequate disaster-resilient infrastructure such as raised roads or protective barriers.	• The Anganwadi centre has no electricity, affecting service delivery, especially during heatwaves. • Daily power cuts are common, affecting comfort and safety during extreme heat. • Wealthier families use ACs, while poorer households depend on fans or go without. • Water supply to the Anganwadi is insufficient; • Poor sanitation due to inadequate drainage facilities.	• Inability of working mothers to utilize childcare facilities affects employment and household income. • Daily wage workers' income is disrupted during heatwaves and floods. • Delayed return to normalcy (8–10 days post-flooding) further impacts earning potential. • Limited ability to invest in alternatives like private healthcare or power backups due to financial constraints.

Annexure 7: Questionnaire for Quantitative Analysis

Climate Vulnerability & Livelihood Impact Perception Survey

(A structured approach to assess exposure, vulnerability, and adaptive capacity to climate risks.)

Section 1: General Information

(Demographic and socio-economic background of the respondent.)

1.1 Name (Optional):
1.2 Age:
1.3 Gender: ☐ Male ☐ Female ☐ Other
1.4 Occupation (Check one): ☐ Daily wage labourer ☐ Street vendor ☐ Construction worker ☐ Domestic worker ☐ Small business owner ☐ Other (Specify)_____
1.5 Number of family members:
1.6 Number of earning members:
1.7 Type of employment: ☐ Daily wage ☐ Informal sector ☐ Self-employed ☐ Other
1.8 Monthly family income: ☐ < ₹2000 ☐ ₹2001–5000 ☐ ₹5001–10,000 ☐ > ₹10,000
1.9 Do you live in a notified slum area? ☐ Yes ☐ No
1.10 Type of House: ☐ Kuccha ☐ Semi-Pucca ☐ Pucca
1.11 Do you own or rent your house? ☐ Own ☐ Rent
1.12 How long have you lived in this area? ☐ Less than 1 year ☐ 1-5 years ☐ 6-10 years ☐ More than 10 years
1.13 Have you had to relocate due to climate events? ☐ Yes ☐ No

Section 2: Exposure to Climate Hazards

(Understanding the frequency, intensity, and direct impact of climate hazards.)

A. Types of Climate Hazards Experienced

1.1 Which climate events have affected you in the last five years? (Check all that apply)
☐ Floods
☐ Heavy rainfall
☐ Heatwaves
☐ Cyclones
☐ Water shortages
☐ Drought ☐ Landslides
☐ Other (Specify)_____

1.2 How frequently do these events occur?
☐ Every year
☐ Every 2-3 years
☐ Rarely

1.3 Which months are most difficult due to climate hazards?
☐ Summer (March–June)

☐ Monsoon (July–September)
☐ Post-monsoon (October–December)
☐ Winter (January–February)

B. Flooding and Waterlogging

1.4 Has your house or street been flooded in the past 5 years? ☐ Yes ☐ No

i. If yes, how often? ☐ Every year ☐ Every 2-3 years ☐ Rarely

1.5 How long does it take for floodwater to recede?

☐ A few hours
☐ 1-2 days
☐ More than 3 days

1.6 What damage do floods cause in your area? (Check all that apply)

☐ Damage to houses
☐ Loss of stored food/water
☐ Destruction of roads/transport routes
☐ Contaminated drinking water
☐ Increased disease outbreak
☐ Other (Specify)_____

1.7 How are working conditions during floods? ☐ Good ☐ Poor ☐ Very poor

C. Heatwaves and Extreme Temperatures

1.8 Does extreme heat impact you? ☐ Yes ☐ No

If yes, how often? ☐ Every year ☐ Every 2-3 years ☐ Rarely

1.9 During heatwaves, how do you manage extreme heat?

☐ Use fans/coolers (if electricity is available)
☐ Stay indoors during peak hours
☐ Use community water taps or cooling spaces
☐ No option but to work outside

1.10 Have extreme temperatures affected your productivity or ability to work? ☐ Yes ☐ No

1.11 What damages do heat stress in your area? Choose all that apply

☐ Damage to houses ☐ Loss of stored food/water ☐ Improved Roof ☐ Water Availability ☐Electricity Availability ☐ Difficulty in Working

1.12 How are working conditions during summer season?

☐ Good ☐ Poor ☐ Very Poor

D. Cyclones and Strong Winds

1.13 Has your house or workplace been damaged by storms or cyclones in the past five years?

☐ Yes ☐ No

i. If yes, what was the impact?

☐ Roof damage
☐ House collapse
☐ Injury to family members
☐ Loss of livestock
☐ Other (Specify) _____

1.14 How are working conditions during cyclone impact?

☐ Good ☐ Poor ☐ Very Poor

Section 3: Vulnerability (Livelihood, Health, Energy, and Infrastructure)

(Assessing the effects of climate events on work, income, health, energy access, and infrastructure conditions.)

A. Livelihood Impact

3.1 How have climate events affected your ability to earn a living? (Check all that apply)

☐ Job loss
☐ Reduced working hours
☐ Damage to tools, equipment, or goods
☐ Temporary relocation due to climate-related events
☐ Increased cost of raw materials or production
☐ Decline in agricultural productivity
☐ Other (Specify) _____

B. Health

3.2 What is the loss of income due to health in the family?

❑ None
❑< ₹1000
❑₹1000 - ₹2500
❑₹2500-₹5000
❑>5000

3.3 How have climate-related factors affected your health and, in turn, your work or income? (Check all that apply)

☐ Heat-related illnesses impacting work capacity
☐ Waterborne diseases leading to medical expenses and lost workdays
☐ Vector-borne diseases affecting productivity
☐ Respiratory issues reducing work efficiency
☐ Increased stress or anxiety impacting job performance
☐ No impact

3.4 How many workdays have you missed due to climate-related health issues?

❑ No
❑ <1 days
❑ 1-3 days
❑ 3-6 days
❑ >7 days

3.5 How much has your household spent on health expenses due to climate-related factors?

❑None
❑< ₹1000
❑₹1000 - ₹2500
❑₹2500-₹5000
❑>5000

C. Energy/Power

3.6 Do extreme weather conditions lead to frequent power outages in your area?
☐Yes
☐ No

3.7 How do power failures impact your ability to work or earn an income?
☐ Loss of income due to disrupted work
☐ Communication breakdown affecting job-related activities
☐ Disruptions to essential services required for work
☐ Inability to store perishable goods or medicines needed for work productivity
☐ No impact

3.8 How long do these power outages typically last?

❑None
❑< 1h
❑1h-3h
❑3h-24h
❑>24h

D. Infrastructure

3.9 What infrastructure issues increase climate vulnerability in your area?
☐ Poor drainage
☐ Overcrowding
☐ Lack of green spaces
☐ No safe drinking water
☐ Frequent power cuts
☐ Difficult access to healthcare

3.10 What is the loss of income due to infrastructure damage?

☐ No loss
☐ < ₹1000
☐ ₹1001–3000
☐ ₹3001–5000
☐ > ₹5000

Section 4: Adaptive Capacity (Risk Awareness, Preparedness, and Response)

A. Individual Response & Adaptation

4.1 How much awareness do you have about climate impacts?
☐ No knowledge
☐ Good knowledge
☐ High knowledge

4.2 Have you received any early warning messages about extreme weather events? ☐ Yes ☐ No

4.2.1 If yes, how do you receive them?
☐ SMS ☐ TV/Radio ☐ Local government ☐ Neighbors

4.3 Do you store emergency supplies such as food, water, and medicine for disasters?
☐ Yes ☐ No

4.4 What measures have you taken to overcome the impact of weather

☐ Using energy-efficient appliances
☐ Raising flood levels
☐ Planting trees for shade
☐ Relocating to a safer area
☐ Strengthening house structure
☐ Using alternative livelihoods
☐ No adaptation
☐ Other (Specify)

B. Community Response & Adaptation

4.5 How does your community help each other during disasters?

☐ Share food and water
☐ Provide temporary shelter
☐ Work together to clean up damage
☐ No organised support available

4.6 Have any government or NGO programs helped your community with climate adaptation?

☐ Yes ☐ No

4.6.1 If yes, what kind of support? ☐ Housing ☐ Water & sanitation ☐ Livelihood programs ☐ Disaster preparedness training

4.7 What kind of support would help you better cope with climate disasters?

☐ Improved drainage
☐ More trees and shaded areas
☐ Affordable housing improvements
☐ More health services
☐ Financial support
☐ Better early warning system

C. Requirements

5. What are the key requirements to overcome Heat Stress, Floods or Cyclones

Annexure 8: Details of Personnel as per Requirement

Table A 8. 1 List of Cool Cart required personnels

Name	Ward No.	Slum Name	Business Type	Cool Cart
Sada Behera	5	Maa Patadebi Basti	Vegetable Seller	Required
Satya Behera	5	Maa Patadebi Basti	Vegetable Seller	Required
Manguli Samal	67	Sunderpada Patna Sahi	Vegetable Seller	Required
Chuni Pal	5	Maa Patadebi Basti	Vegetable Seller	Required
Sanjukta Nayak	23	W-23 Laxminagar Subudhipur	Vegetable Seller	Required
Sankuntala Sahoo	23	W-23 Laxminagar Subudhipur	Vegetable Seller	Required
Jhuni Dei	23	W-23 Laxminagar Subudhipur	Vegetable Seller	Required
Balakrushna Behera	16	Tarini Nagar	Vegetable Shop	Required
Shiva majhi	22	Shampur	Food Halker	Required
Gitanjali Mishra	64	Jadupur Odia Sahi	Vegetable Seller	Required

Table A 8. 2 List of small business owners

Name	Ward No.	Slum Name	Business Type	Ownership
Anupama Behera	67	Sundarpada Patna Sahi	Grocery Shop	Own
Harihar Sahoo	67	Sundarpada Patna Sahi	Sweets Shop	Own
Swarnalata Behera	16	Tarini Nagar	Grocery Shop	Own
Kamini Prusty	22	Joklandi Cluster 7	Tailoring Shop	Rent
Annpurna Mohanty	22	Joklandi Cluster 7	Grocery Shop	Own
Srikanta Sahu	22	Joklandi Cluster 7	Grocery Shop	Own
Srinibas Sahoo	22	Joklandi Cluster 7	Furniture Workshop	Rent
Subash Das	22	Joklandi Cluster 7	Variety Store	Own
Arati pradhan	22	Joklandi Cluster 7	Tailoring Shop	Rent
Tunu Nayak	5	Maa Patadebi Basti	Grocery Shop	Own
Bhagyashree Sahoo	5	Maa Patadebi Basti	Variety Store	Own
Kamala Behera	5	Maa Patadebi Basti	Dairy Farm	Own
Pramila Samal	5	Maa Patadebi Basti	Grocery Shop	Own
Guni Sahu	23	Maa Laxmi Nagar	Grocery Shop	Own
Pramila Pradhan	23	Maa Laxmi Nagar	Variety Store	Own
Sangeeta Das	23	Maa Laxmi Nagar	Dairy Farm	Own
Ramesh Prusty	10	Bhotpada	Brick Factory	Own
Pramod Behera	22	Shampur	Variety Store	Own
Puspita Swain	5	Bhotpada	Variety Store	Own
Pilaka Padma	22	Joklandi Cluster 7	Tailoring Shop	Own
Sunita mandal	2	Sikharchandi Cluste III	Tea Shop	Rent
Saraswati Panigrahi	23	Maa Laxmi Nagar	Variety Store	Own