The Urban Unit
Urban Sector Planning & Management Services Unit (Pvt.) Ltd.

SPACE TECH
IN SOCIO-ECONOMIC DEVELOPMENT

Heatwave Management Plan of Lahore

(2022 – 2025)




Heatwave Management Plan of Lahore (2022-2025)

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Abbreviations

CRI	Climate Risk Index
DC	Deputy Commissioner
EPD	Environment Protection Department
GLOF	Glacier Lake Outburst Floods
IPCC	Intergovernmental Panel on Climate Change
MC	Municipal Corporations
MCDA	Multicriteria Decision Analysis
MODIS	Moderate Resolution Imaging Spectroradiometer
NCCP	National Climate Change Policy
NDMA	National Disaster Management Authority
NDBI	Normalized Difference Built up Index
NDVI	Normalized Difference Vegetation Index
NGOs	Non-governmental Organizations
PCCA	Pakistan Climate Change Council
PCCC	Pakistan Climate Change Council
PDMA	Provincial Disaster Management Authority
PMD	Pakistan Meteorological Department
RO Filtration Plant	Reverse Osmosis Filtration Plants
UHI	Urban Heat Islands
WASA	Water and Sanitation Authority
WHO	World Health Organization
WMO	World Meteorological Organization

Executive Summary

Climate change is increasing the risk of being exposed to extreme heat. The prospect of more and or longer and more severe summer heatwaves is concerning for densely populated, built-up cities that keep the environment hotter due to the "urban heat island effect."

Swathes of Pakistan have been smothered by high temperatures since late April, in extreme weather, the World Meteorological Organization (WMO) has warned is consistent with climate change. According to the Global Climate Risk Index published by the non-profit group Germanwatch, Pakistan is one of the most vulnerable nations in the world when it comes to the effects of climate change over the past two decades.

Lahore city experienced heatwaves with temperatures reaching 49°C between April 20 and May 20, 2022. The city has seen an outbreak of Cholera and Diarrhea as a result of the heatwave 2022. On March 15, March 30, May 6, and May 14, 2022, the National Weather Forecasting Center Islamabad issued a series of heatwave warnings. The 2022 heatwave is thought to be the worst in Lahore's climatic history. Therefore, a systematic heatwave management plan is prepared by Urban Unit Environment Team to address the issue. The Urban Unit now has developed a heatwave management plan which is advised to manage and mitigate climatic extreme events like heatwaves.

The plan is prepared after conducting a comprehensive survey related to the community perception survey, and risk assessment of the related water supply assets. The hotspot areas for survey and planning were identified through remote sensing data analysis for vegetation index, maximum temperature, population, and land cover. Overall, this heatwave plan outlines the state of existing infrastructure in the hotspot areas along with what should happen before, during, and after the periods of heatwaves. It also sets out strategies and actions that government and other key stakeholders could take together to prevent the impacts of extreme heat events. This heatwave management plan will be implemented for three years (2022-2025) and contains the cost of key interventions which is 20.15 million PKR.

Overview

The increasing instability of the global climate system is potentially intensifying the climate variability and the frequency and intensity of extreme climatic events have been significantly increased. Deadly heatwaves are one of them!

1.1. Defining the heatwaves

A heatwave (HW) is typically defined as a prolonged period (usually several consecutive days) when the temperature exceeds predetermined thresholds. Its precise definition varies greatly across different regions.

Pakistan follows World Meteorological Organization (WMO) definition of heatwave, that describes it as a **'Climatic event which occurs when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5 °C'** [1].

The Intergovernmental Panel on Climate Change (IPCC) recent special report on '1.5 Degrees Celsius Global Warming' reported that human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate [2]. This climatic change has been substantially observed in Pakistan, specifically in southern and central regions, where the frequency and intensity of heatwaves are accelerated for the past few years, potentially impacting the local and regional environment, particularly in the health and economic sector.

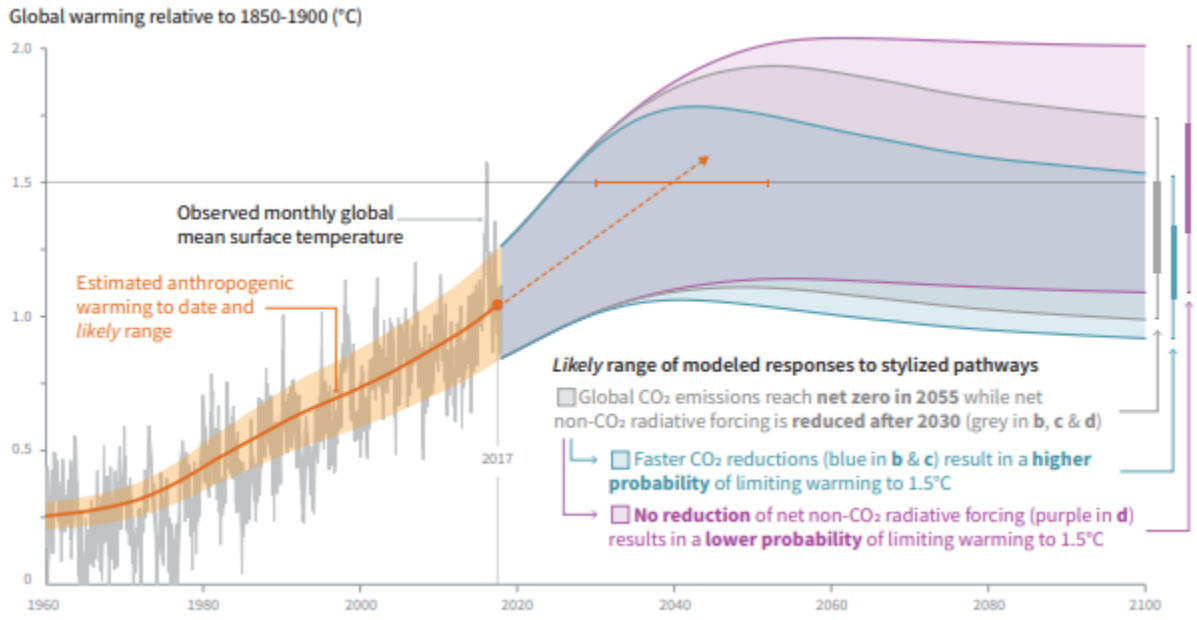


Figure 1: Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways (IPCC, 2018)

A heatwave begins when a high atmospheric pressure system settles over an area, sometimes triggered by disturbances halfway around the world. The high-pressure system compresses and heats up the air while squeezing out clouds. Without clouds above, sunlight hits the land below directly, stripping away moisture that would otherwise help cool the air. As the pressure builds up, the sun bakes the ground more, and over the course of days, heat accumulates.

1.2. Understanding the Problem

Pakistan lies climatically in the warm geographical region, which is highly vulnerable to climatic extreme events like drought, heatwaves, and floods. Because of extreme heat events over the last decade, the rate of heat-related disease and mortality (in both animals and humans) has increased in the country, specifically in the southern regions. The country ranks among the top 5 countries globally with a climate risk index (CRI) score of 28.83 for the years 1999 to 2018 [3]. The latest ranking of the Global Climate Risk Index 2020 ranked Pakistan as the 8th most climate-affected country [4]. The heat index of Pakistan has increased from 1961to 2007, with increased mortality and heat-relevant diseases during the recent decade[18]. Heatwaves were a cause of more than 200 deaths in 2015 in Pakistan [5]. The warming stripes in Figure 2 is indicating long-term temperature trends in Pakistan. Each strip shows a specific color depending upon the average temperature for the corresponding year as higher (red) or lower (blue) than the region's average temperature during the reference period (1991 to 2020).

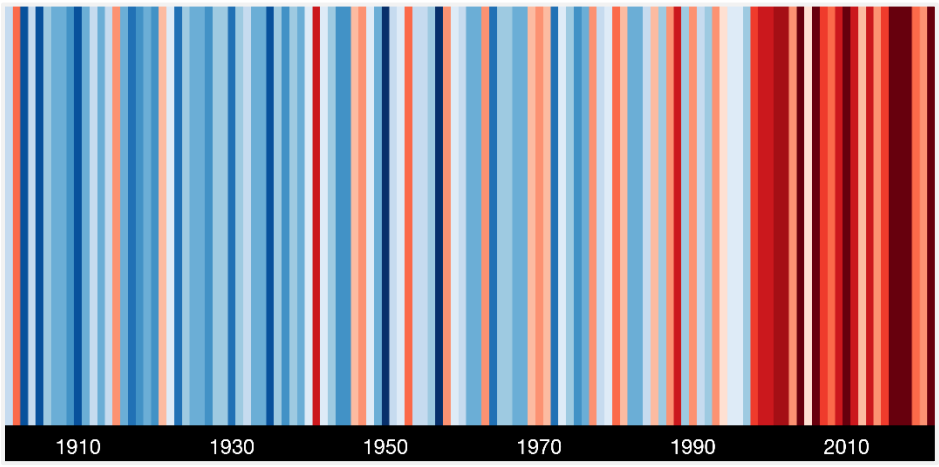


Figure 2: Temperature Change in Pakistan since 1901

Agglomeration of cities and urban areas with few green spaces and microclimates, particularly more vulnerable to severe and long-lasting heatwaves in the region. Moreover, heating patterns and the phenomenon of Urban Heat Islands (UHI)is more pronounced in recent years in which Sindh, Baluchistan, and central and south Punjab are more affected due to extreme heat and droughts. Whereas the northern region is facing melting of glaciers and higher frequency and intensity of Glacier Lake Outburst Floods (GLOF) due to torrid heatwaves.

In the mega cities of Pakistan, like Karachi and Lahore, the UHI effect has exacerbated the thermal environment by interacting synergistically with urban environments and heatwaves. Land cover changes increase the surfaces of impermeable materials like asphalt and concrete, reducing evapotranspiration

and increasing heat-related morbidity and mortality. Surging electricity demand and stress on the power grid triggered power outages at a time when people need cooling the most. Prolonged heatwaves also spiked the ozone level in the air, resulting in air pollution and ozone-related illnesses across major cities like Lahore. In short, unplanned development, high rate of urbanization, poor governance, political disruptions, and economic fallout are some of the drivers of the lower adaptive capacity of the region to manage heatwave in an effective way.

1.3. Setting the Context

This study is focusing on Lahore city, located on the eastern bank of the river Ravi, covering 1772 km^2 of area. The intensity and frequency of extreme climatic events such as excessive rainfall, heatwaves, and flash floods have increased in the city [6].

Lahore has experienced extreme temperatures in the form of heatwaves, reaching 49°C between April 20 to May 20, 2022. The intensity and frequency of extreme climatic events such as excessive rainfall, heatwaves, and flash floods have increased in Lahore city. Recently, the National Weather Forecasting Center Islamabad issued a series of heatwave warnings on March 15, March 30, May 6, and May 14 in 2022 [7]. The 2022 heatwave is considered to be the worst heatwave in the climatic history of Lahore.

One of the major reasons for extreme heat events in Lahore is an uncontrolled and unplanned urban expansion that has detrimental impacts on the urban green spaces of the city which are not even vanishing at a very fast pace but also resulting in higher land surface temperature in the concrete areas. The below figure exhibits the increase in the built area of Lahore city from 1990 – 2017 [8].

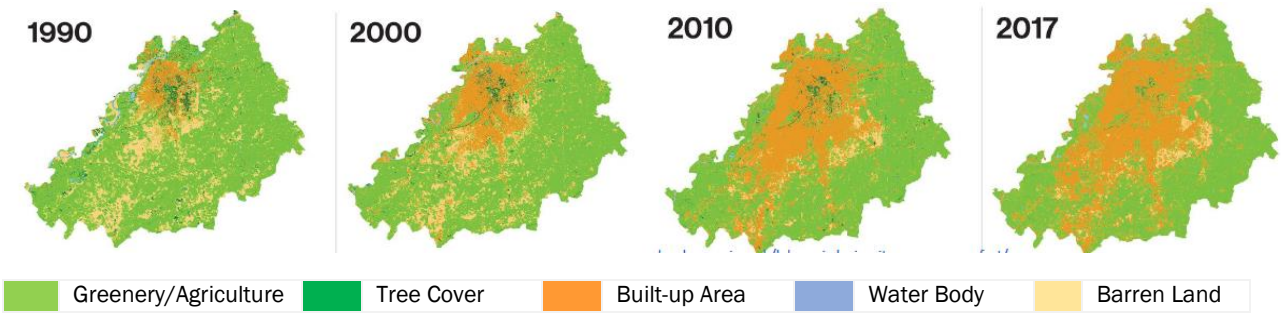


Figure 3: Landcover Change in Lahore (1990 – 2017)

The built-up land cover increased by 34.7% from 147 sq. km. to 759 sq. km, indicating an increased population influx into the city. In comparison, the agricultural land, water bodies, and tree cover shrank by 14.5%, 0.95, and 3.9%.

Figure 4: Percentage of Landuse in Lahore (1990 – 2017)

The comparison of urban sprawl from 2000 to 2020 in Lahore city showed a 32% significant loss of agricultural land in the built-up area. In the year 2000, the cultivated area of Lahore was 1,161 Sq.km, which is reduced to 873 Sq.km in the past twenty years. Whereas, 287 Sq.km of cropland is converted to a built-up area. The situation is alarming!

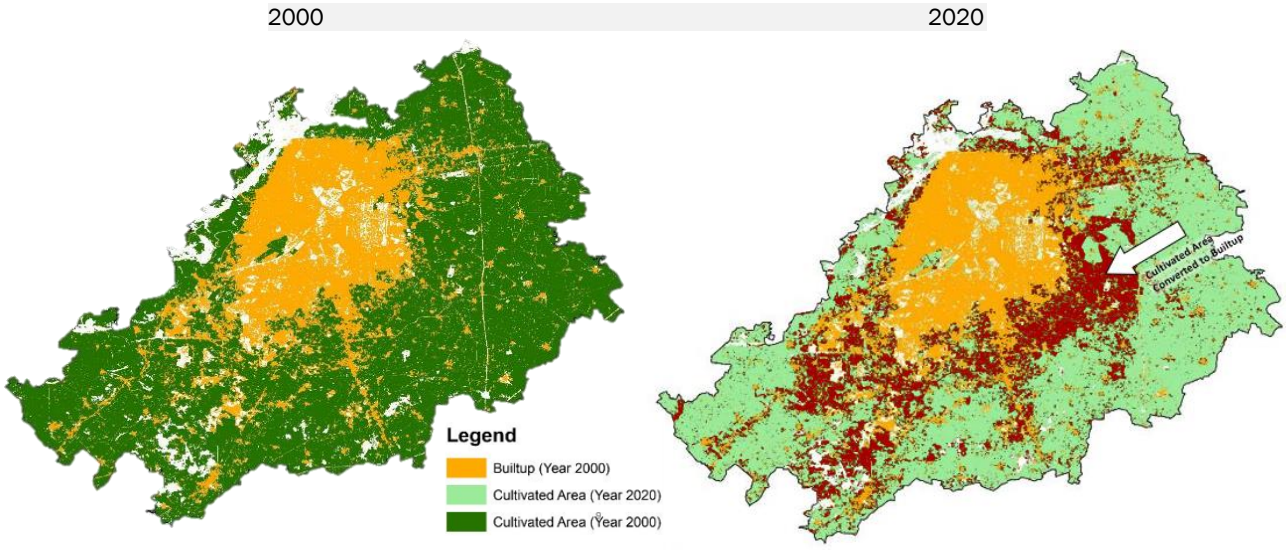


Figure 5: Landcover Change in Lahore (2000 – 2020) *(The Urban Unit-2020)*

The summer of 2022 in Lahore brought a substantial variability in the temperature, resulting in the issuance of several health advisories/heatwave alerts in Lahore. The frequency and intensity are now accompanied with another increasing factor i.e. duration of heatwaves. Current extreme heat events are prolonged in nature and causing water stress on water (reservoirs), crops, vegetable and orchards, increased energy and water demand, higher vulnerability to health-related illnesses and reduction in water base flow.

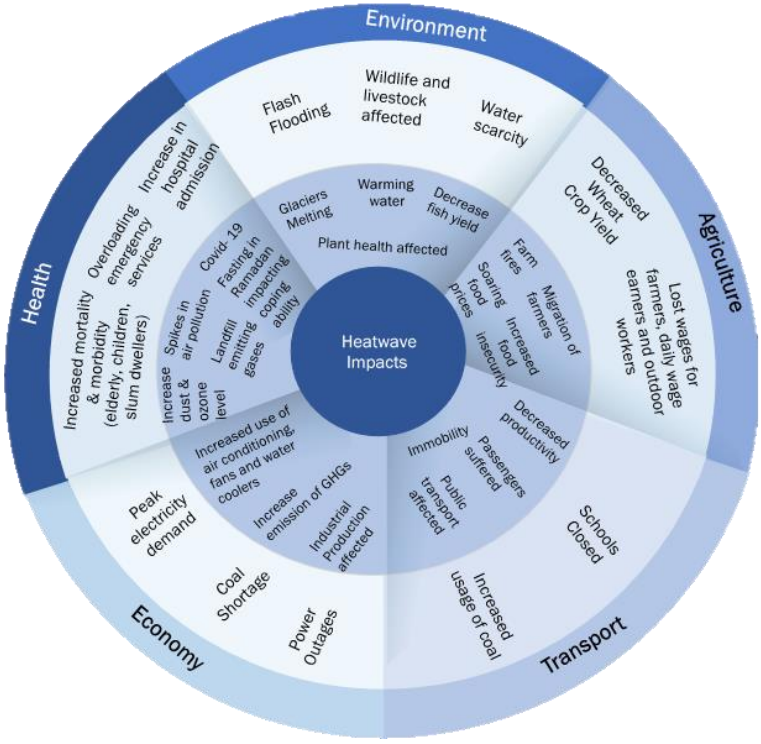


Figure 6: Conceptual Design of Impact Pathways in Pakistan (WMO)

Despite the temperature alerts, an effective and attainable plan to manage heatwaves is not prepared yet. Hence, the Urban Unit has taken a lead to prepare a Heatwave Management Plan (HWMP) keeping in view its dire need.

1.4. The Approach

The overall approach was to conduct a rapid survey for on-ground field assessment and conditional assessment to design heatwave management plan. Following steps were taken;

- The heat vulnerability assessment was conducted through a combination of multiple parameters including social, demographic, geographic, and environmental. Maximum temperature data was acquired from MODIS / Terra daily Land surface temperature (MODIS Collection 6) during summer was downloaded and processed in Arc GIS. Heat Vulnerability maps were generated by overlaying layers of maximum temperature, demographic layer and land cover change.
- Hotspots analysis by using ARC GIS tool and vulnerable areas were identified by using hotspot areas.
- A Perception Survey of 100 respondents and 45 filtration plants were visited in the vulnerable areas. Data was recorded through a questionnaire and analyzed by applying different statistical techniques.
- Consultations with key stakeholders were also done to discuss their existing and future role in heatwave management of Lahore (Annex – A)

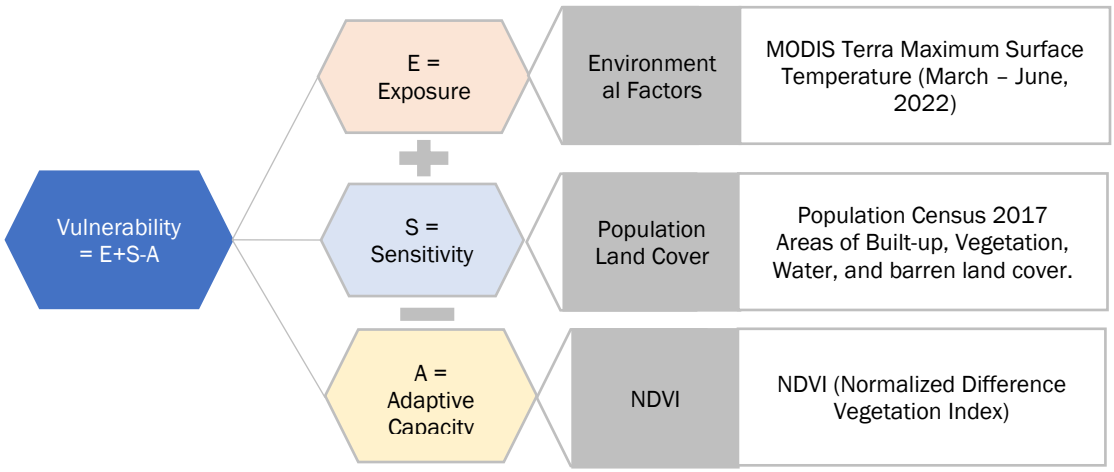


Figure 7: Framework for Heatwave Vulnerability Assessment

Field Assessment pictures and Legal Landscape are provided in Annex – B and C respectively.

Current State Assessment of Lahore

The current state assessment of Lahore city, based on the aforementioned approach, is as follows;

2.1. Heatwave Vulnerability Assessment

The dense urbanization, unchecked urban settlements, unregulated traffic emissions, and imbalanced stratification of the lifestyles of the inhabitants puts them at risk of depleting resources and a poor environment [9]. Therefore, it is imperative to prioritize the highly vulnerable areas of Lahore pertinent to heatwave-induced risks, to facilitate government departments and communities for the development of mitigation and adaptation plans. To analyze heat vulnerability, land surface temperature data during the daytime for the summer of 2021 is used in the following figure.

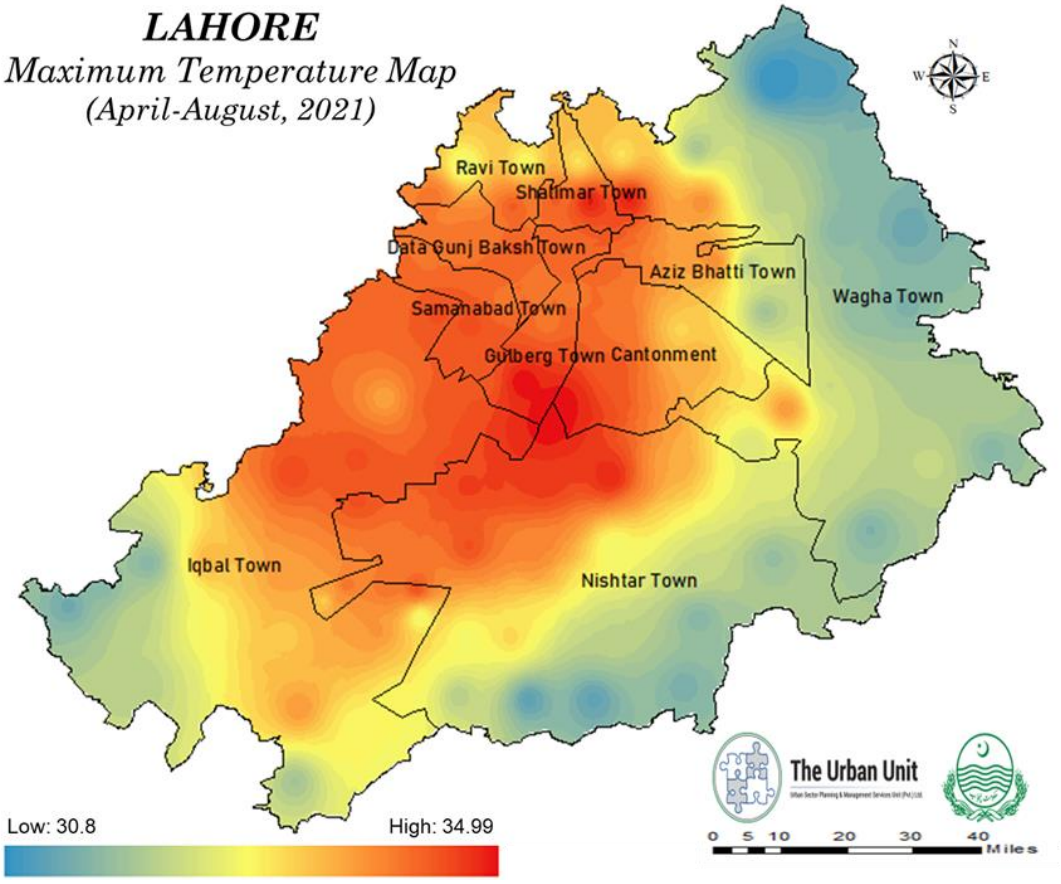


Figure 8: Maximum Temperature Map of Lahore.

Population Map of Lahore city based on population census of 2017, indicated that cantonment, Allama Iqbal town, Samanabad, Ravi town, Data Gunj Baksh town, and Nishtar town have higher population number, as compared to the remaining zones.

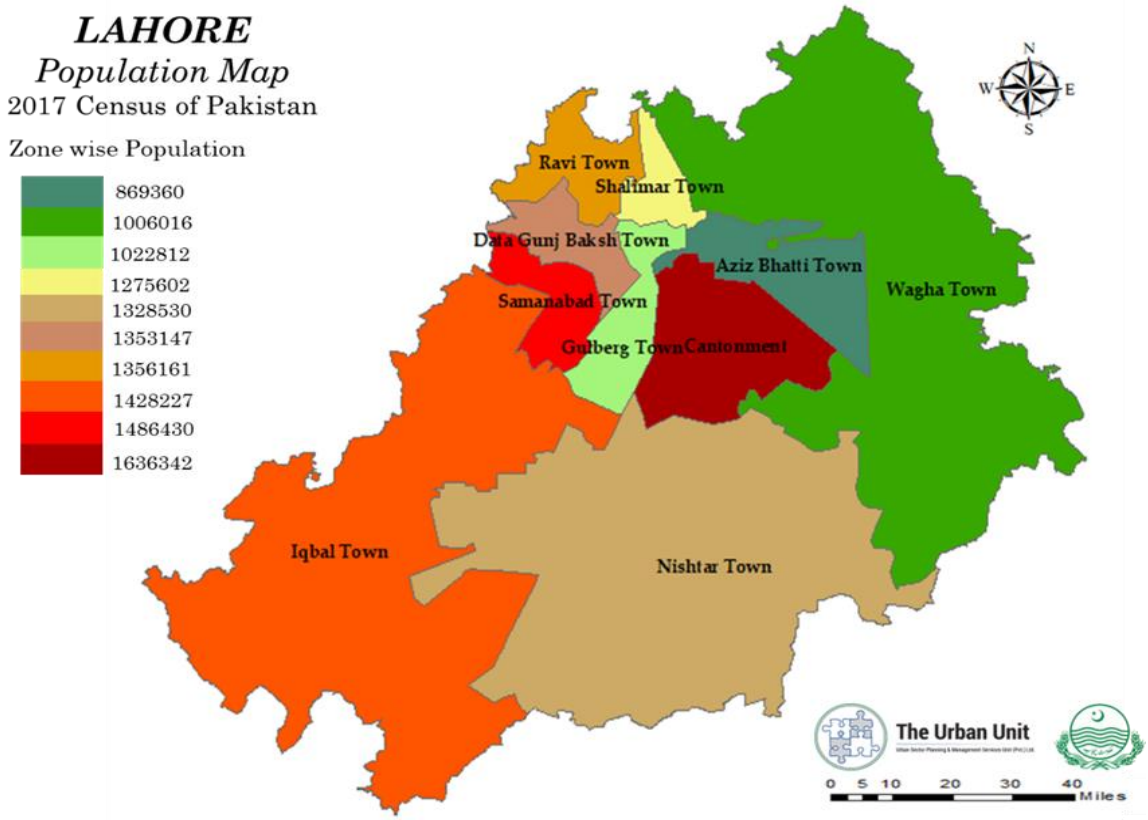


Figure 9: Population Map of Lahore

The land use land-cover change in Lahore city from 1990 to 2020, was also assessed which showed a gain of 326.23 km^2 and 72.83 km^2 in the built-up area and barren land, respectively. Thus, a loss of 6.38 km^2, 189.96 km^2, and 202.72 km^2 in water bodies, agricultural land, and forest land respectively is found [10]. In contrast, the 2017 land utilization statistics map showed that the built-up area is located at the center of the city, whereas the outskirts of the city are less inhabited and consist of vegetation.

The expansion of the urban heat island phenomenon in Lahore city by spatially correlating the land surface temperature and land cover between 1990-2020 showed the temperature increases by 5℃, because of the increase of 0.35 to 1, and a decrease of 0.5 in NDBI (Normalized Difference Built-up Index) and NDVI (Normalized Difference Vegetation Index), respectively. Consequently, the study recommends increasing the vegetation cover to increase NDVI as compared to NDBI, to decrease the urban heat island phenomena in Lahore [11].

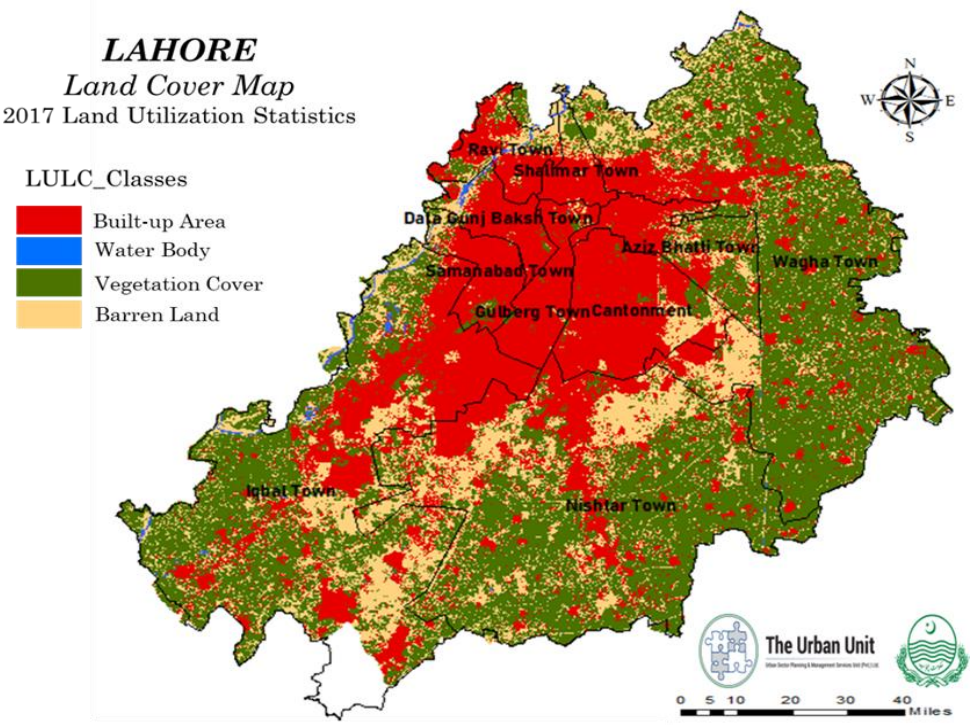


Figure 10: Land Cover Map of Lahore

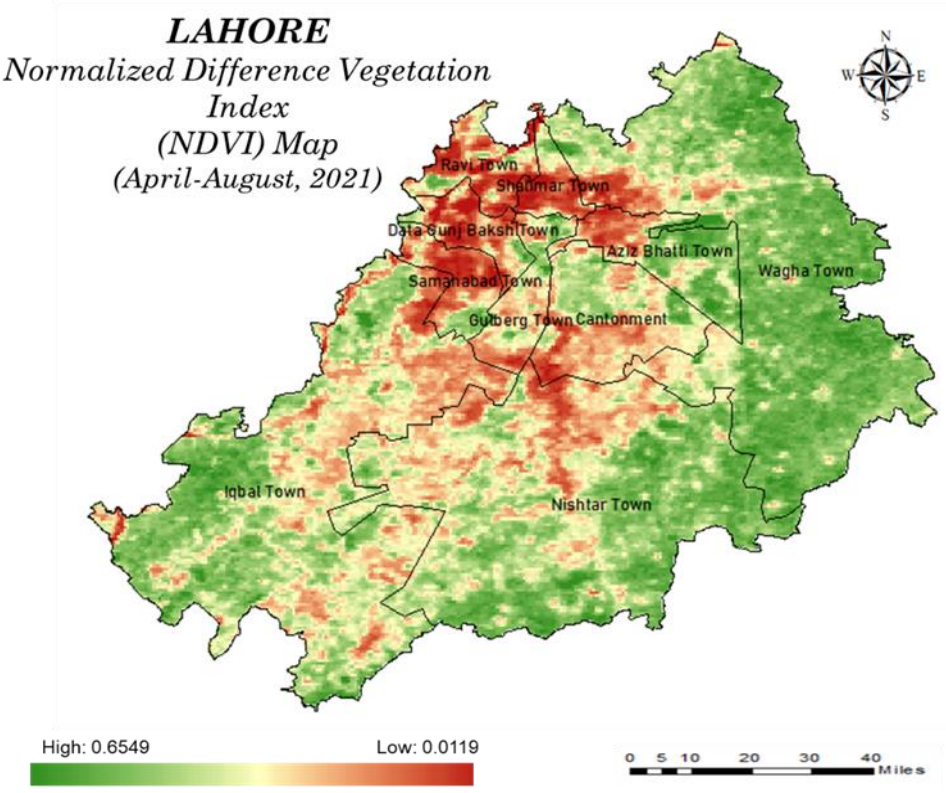


Figure 11: Normalized Difference Vegetation Index of Lahore

Multi-Criteria Decision Analysis (MCDA) was applied in Weighted Overlay Spatial Analysis Tool in GIS for achieving spatial representation of results [12]. The data sets used for this purpose were the Population of Lahore; Maximum Summer Temperature, NDVI, and the Land Use classification map of Lahore city. The weighted average and preferences were defined in GIS, and weighted overlay analysis was applied to the raster format of each layer, to produce the final heat vulnerability map of Lahore city.

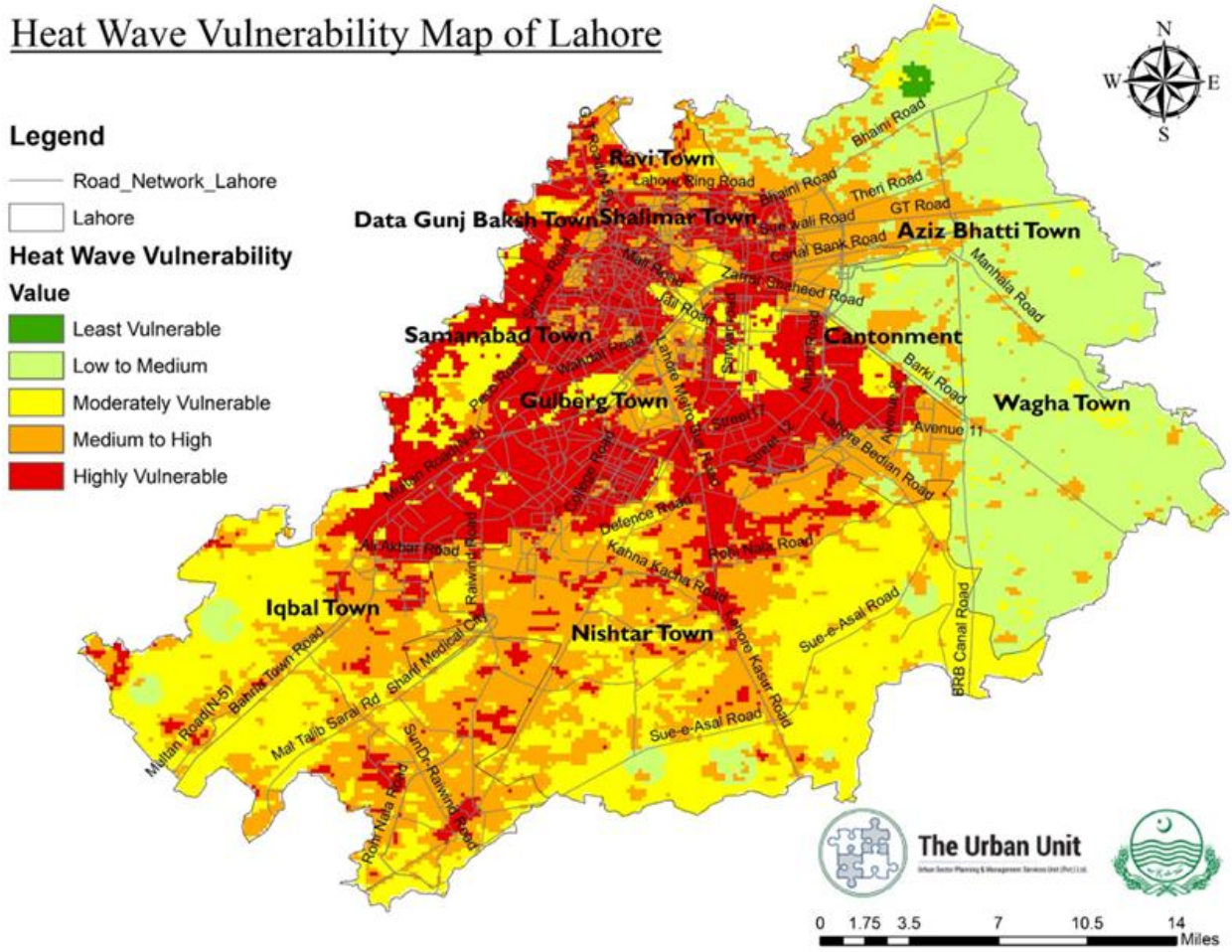


Figure 12: Heatwave Vulnerability Map of Lahore

As built-up and rocky surfaces have a higher heat storage potential as compared to forests and agricultural lands [13], thus land Surface Temperature in Lahore city was reported to be highest in densely populated areas of Lahore [14]. Less vegetation cover increases the heat storage capacity of the land, increasing the temperature by 2°C-12°C [15]. Zones with higher populations and less vegetated land are highly exposed to heatwaves. Increasing the green cover of Lahore city in all local climatic zones will increase the climate resilience of the inhabitants.

2.2. Perception and Awareness towards Heatwaves

The survey consisted of demographic and professional attributes of the respondents, awareness, and knowledge of Heatwave occurrence, health impacts, mitigation measures, sources of information, and multiple actions of the Government in their areas.

2.2.1. Demographic and Economic Profile of the Respondents

The cross-sectional study involved 100 respondents (16% females and 84% males) of which majority of the respondents were illiterate (34%), 29% primary education, 18% were of university level and 13% had secondary education. The same study for heat exposure explained by Tasgaonkar et al., a recent study on heat measurement [16].

Figure 13: Gender Distribution of Respondents

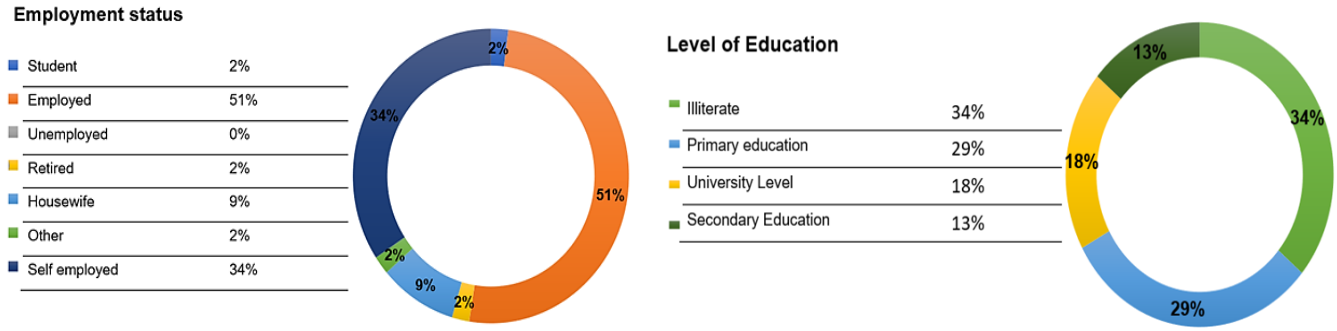


Figure 14: Employment status and Education Level of Respondents

2.2.2. Knowledge of Heatwaves

A high proportion (73%) of respondents demonstrated that they are well informed about the heatwave same as described in the case studies of Amsterdam and Brussels by van Leonhout et al.,[17] with 75% agreeing that extreme weather event in the future are likely to occur more frequently in Lahore city. It has been observed that 62% of respondents reported that they work outside during the warmest hours (12:00 PM to 4:00 PM). Most of them were laborers, maids, shop owners, waste collectors, and peddlers. 84% of the respondents were well aware of high-temperature hours.

Knowledge and Perception	YES	NO
Do you know about the heatwave?	73%	27%
Do you know about high-temperature hours (12 PM-5 PM)?	84%	16%
Do you believe that heatwaves will occur more frequently in your area?	75%	25%

2.2.3. Health Impacts of Heatwave

Dehydration, sweating, extreme thirst, exhaustion, muscle cramps, headache, accelerated pulse, fever, faintness, dizziness, food poisoning, and sunburn are the health impacts that were reported by the respondents. Most frequent health impacts due to heatwave are excessive sweating and dehydration which is reported by 19% and 16% of the respondents respectively. 14% of respondents reported that they face exhaustion and extreme thirst while working outside. Headache and accelerated pulse were also reported by 13% and 12% of respondents respectively. Only 3% of respondents did not know about heat-related symptoms.

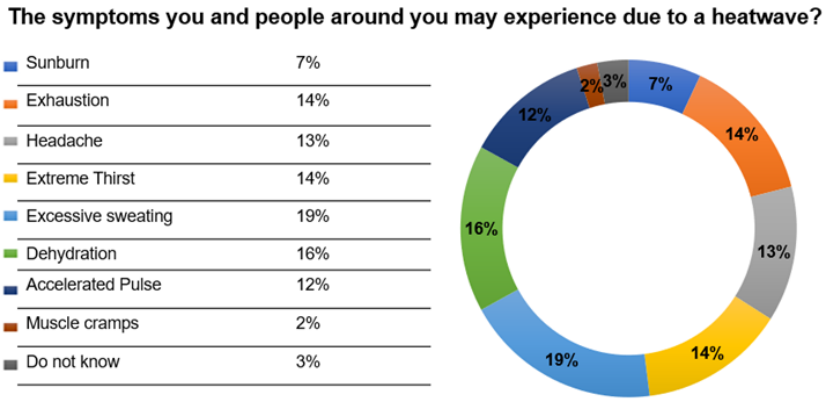


Figure 15: Symptoms experienced during Heatwave

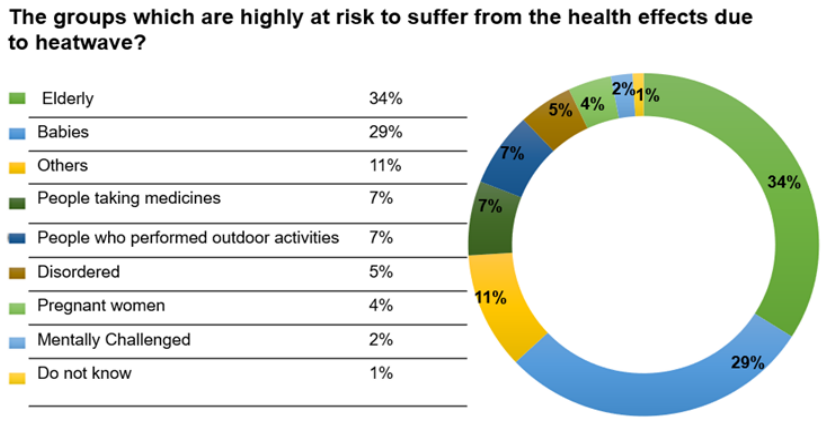


Figure 16: Highly Vulnerable Groups

34% of the respondents stated that elderly, and 29% said that babies are high-risk groups. The same results were reported in different studies, where the people reported that babies and elderly people are highly at risk [18,19]. According to the survey results 11% of respondents belongs to other category, those stated that the people who are socially isolated and obese (others) are highly at risk. Also, the people who are on medication, who perform outdoor activities, disordered, mentally challenged, and pregnant women are at risk due to heatwave in Lahore. More than 80% of respondents also highlighted that they have not seen anyone who got severely affected by the heatwave.

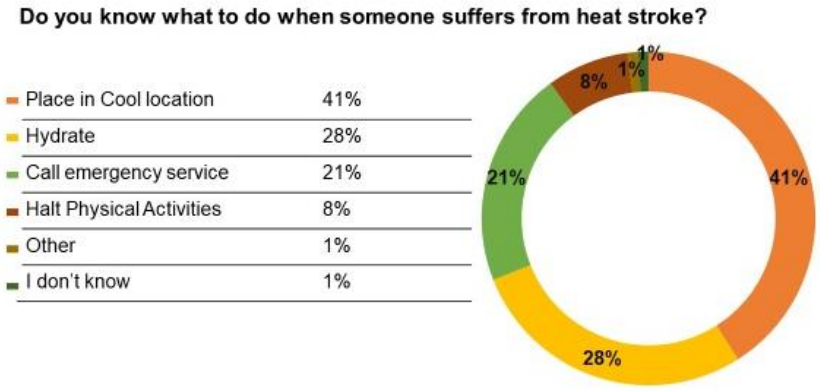


Figure 17: Community knowledge of first-aid for heat stroke patients

Almost all the respondents know the preventive measures to cure from heatstroke. 41 % of participants answered that placing in a cool location is a better way to reduce the impact of heatstroke. 28% of the respondents reported that Hydrating (cold fluids) is also an effective way to reduce the heatstroke impact. To Call emergency services and halt physical activities were also reported by 21% and 8% respectively.

Almost 63 % of respondents agreed that it is effective to drink more water during the heatwave and 30% strongly agreed in the response and only 4% were neutral. As it helps to replenish the fluid lost from body due to excessive sweating.

63 % of the respondents agreed that it is effective to avoid outdoor activities during the heatwave. 4% remain neutral in the response and 0% disagreed due to their job requirements.

36% of respondents demonstrated that to stay inside during warmest time is better measure to avoid the heatwave impact and 19% of respondents said that walking under the shades is better to avoid heatwave impact.

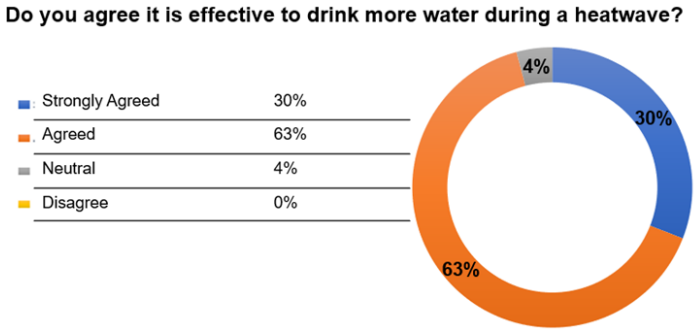


Figure 18: Perception of effectiveness of increased drinking water

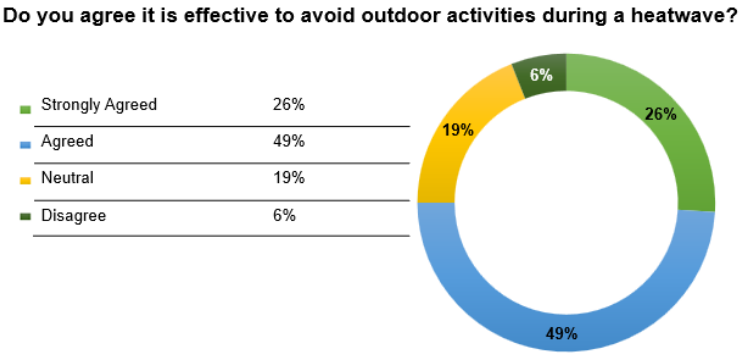


Figure 19: Perception to avoid outdoor activities

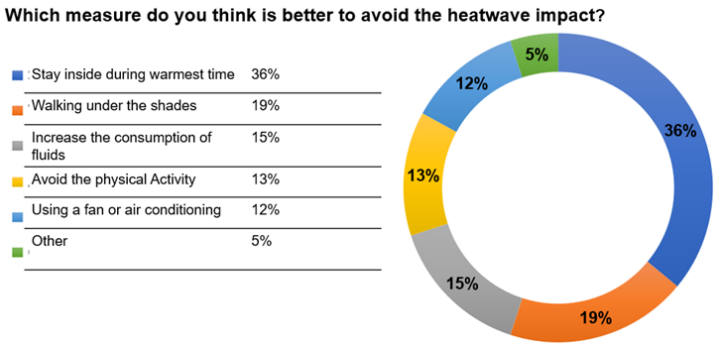


Figure 20: Community Perception of Measures to avoid heatwave impact

2.2.4. Effective Source of Information

28 % respondents claimed television as an effective source of information which is also reported in the literature as a most common source of information on heatwave. 24% marked Government brochures, 13 % google, 10 % Alert messages, 7 % Announcements and 6% reported that online news & newspapers as source of information. Only 2% people did not consult any source of information for heatwave.

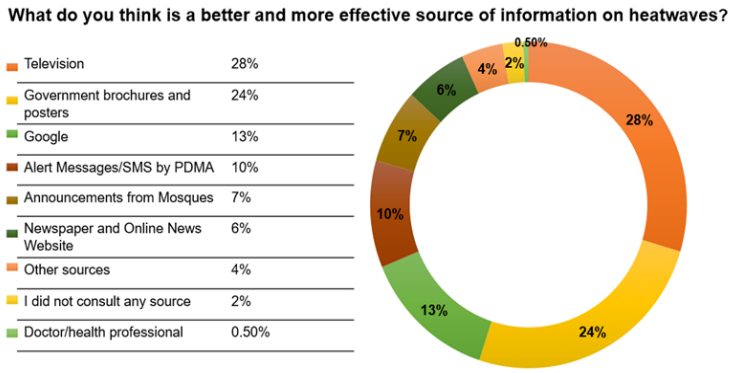


Figure 21: Effective sources of Information

2.2.5. Availability of Facilities

This section consists of collecting data on community perception regarding available facilities such as water coolers, heatwave camps, or canopies for protection from heatwaves.

The data was also collected with respect to community perception on effectiveness of different government departments for heatwave management. 31% and 25% of the respondents considered Provincial Disaster Management Authority (PDMA) and Health departments as effective departments for taking mitigation and prevention measures respectively.

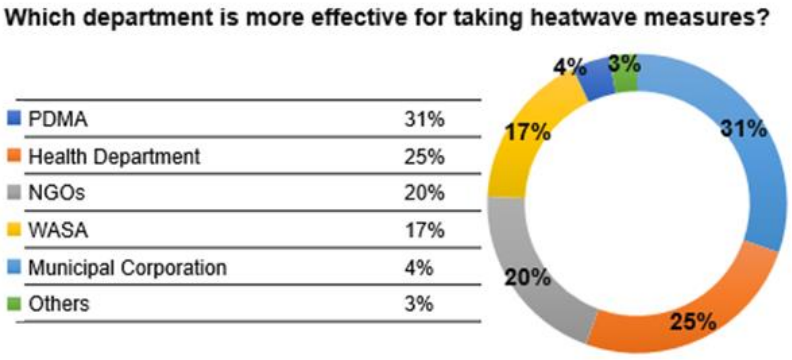


Figure 22: Effectiveness of Government Departments

Out of the 100 respondents, 51% said that water coolers are available in the area. The water coolers available in 81% of locations were privately-owned. 19% of locations include areas in the walled city, bund road, and Ravi town. 46% of the respondents complained about the absence of shelters, and insufficient tree canopy for heatwave protection. These areas were Ravi town, the walled city area, and bund road.

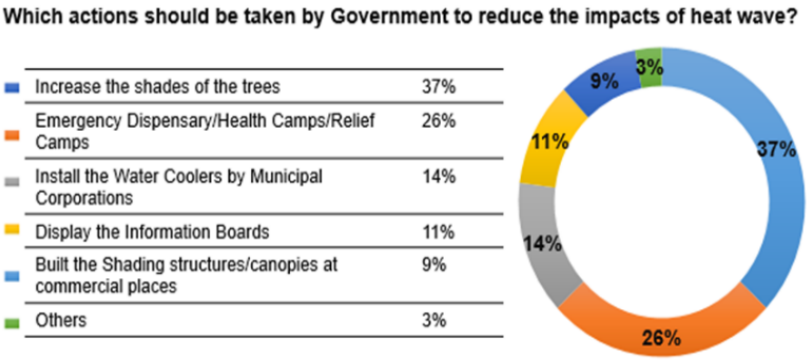


Figure 23: Government Actions required for heatwave mitigation and preparedness

In response to the demand of community regarding different interventions that may assist in prevention from heatwave, 37% of the respondents demanded to green cover, 26% suggested development of emergency heatwave camps, and 14% asked for water coolers. Respondents also suggested that Information dissemination, building shade structures, mitigating the load-shedding issues, and ensuring water supply throughout the day can lessen the heatwave impacts.

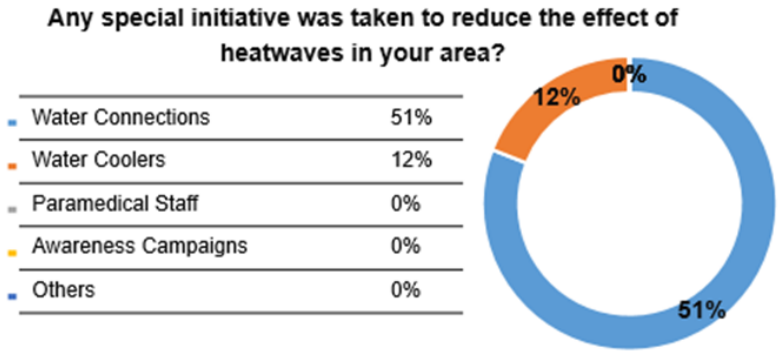


Figure 24: Government actions required for heatwave mitigation

2.3. Conditional Assessment of Water Supply Facilities

Team visited various localities and areas spread across 5 towns of Lahore for field survey. Data related to a multitude of features were collected from the field, however, the primary target of the survey was to collect data pertaining to features or assets contributing directly to the heatwave relief cause. These appurtenances include assets related to the provision of drinking water to the masses and necessary features at the aforementioned assets providing appropriate shade to the public. This approach was exercised in order to assess the spatial spread of the availability of relief features at the survey areas. Due to this reason, this report features the primary data collected and analyzed for three main relief appurtenances including:

- Water Filtration Plants
- Water Coolers/Dispensers
- Relief Camps

2.3.1. Water Filtration Plants

Water Filtration Plants are a primary asset for provision of drinking water of appropriate quality and in appropriate quantity to the masses. There are approximately 573 such filtration plants spread all across the city, 449 of which are owned by WASA-L. These units were installed by both government and private authorities like WASA-L, Punjab Ab-e-Pak Authority, NGOs and other private stakeholders. The role of these assets for contributing to the provision of water is of prime importance, especially when the need to sources of drinking water appurtenances has increased due to climate change. The need is especially high during the Heatwave hours as they serve as a direct mean of relief from the phenomenon. Different data regarding filtration plants was collected within the engineering survey forms, including but not limited to capacity, tap count, available shade temperature, satisfaction of public, source of water, source of power and more.

2.3.2. Water Coolers

Water coolers are another asset that serves as a source of drinking water to the general public. These coolers are installed at many places across Lahore, majorly installed by general public and NGOs for the sake of public welfare. These coolers are an excellent mean of relief from heatwave providing clean drinking water to the heat stricken public during hot summer days. Also, these assets usually operate 24/7 rather than following government schedules, as they are not dependent on the operating hours of the source of water like filtration plants. Different data regarding these water coolers was collected like capacity, type, satisfaction of public, source of water, available shade, source of power and more.

2.3.3. Relief Camps

Relief camps are also an important feature to consider as a relief measure from heatwave. These camps are provided during times of crisis or disaster to cater for the emergency needs in a streamlined manner. These medical camps for heatwave include appropriate shade, fans, medical staff and equipment, potable

water and more. However, it should be noted that not a single relief camp was observed at any of the survey points across the city.

2.3.4. Analysis of Filtration Plants

Team visited filtration plants in the vicinity of all the 45 survey points and collected data pertaining to the overall functionality of the plant. Data was collected from filtration plants at each site, which included details about the spatial location of the plant, ownership of the filtration plant, type of filtration, condition of the civil infrastructure, functional status, serving capacity, source of water, source of power, operational taps, available shade and more.

Figure 25: Filtration Plants visited around Lahore

The detail of data collected has been provided as annexure to this report. The data collected was then analyzed and following results were observed:

- Filtration plants were observed in the vicinity of all 45 survey locations.
- All of the filtration plants visited during the survey were of Ultra Filtration type.
- 3 out of the 45 filtration plants observed were owned by private stakeholders and remaining were operated by public sector authorities.
- All of the 45 filtration plants visited operated on electricity from WAPDA grid.

Functional Status

The operational status of these filtration plants was performed based on the collected data during heatwave hours and it was observed that 17 out of the 45 filtration plants visited were non-functional. This makes up about 38% of the filtration plants constituting the data set. The town-wise functional status of these filtration plants is as follows;

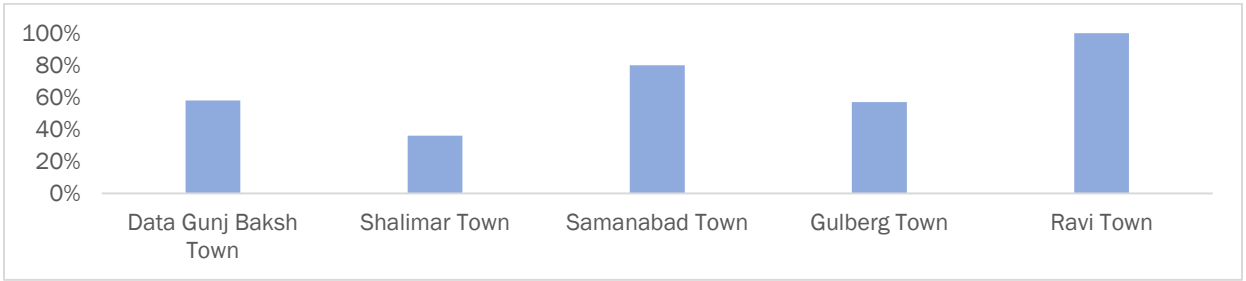


Figure 26: Functional Status of Filtration Plants

Conditional Analysis

The data regarding the overall condition of these filtration plants was also noted during the survey. The condition was assessed and then grades were assigned from A to D indicating condition from Excellent to Worse. The data revealed that 60% of filtration plants were in C to D indicating an overall deteriorating condition. This is especially true for the plants that have a masonry structure, as plaster had started to spall off due to lack of maintenance and aging.

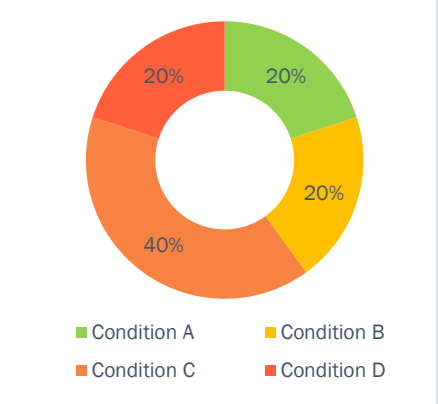


Figure 27: Conditional Overview of Filtration Plants

The details of condition-wise categorization of filtration plants can also be assessed individually for each town. The percentage of filtration plants from each town falling into a particular category has been tabulated below:

Table 1: Condition-wise categorization of filtration plants

Condition	Data Gunj Baksh Town	Shalimar Town	Samanabad Town	Gulberg Town	Ravi Town
A	0%	45%	10%	29%	20%
B	17%	18%	40%	14%	0%
C	58%	18%	40%	43%	40%
D	25%	18%	10%	14%	40%

2.3.5. Provision of Shade Analysis

The provision of appropriate shade was also assessed during survey and it was found that no appropriate shade of any kind was found is 47% of the filtration plants. Majority of the shade found was tree canopies, as majority of these plants were located adjacent to parks. Temporary shades were also found in some filtration plants. It is to be noted that majority of privately-operated filtration plants had permanent sheds providing shade to the public. Appropriate shade is necessary as it provides relief from the sun during times of heat.

Figure 28: Shade over filtration plant in Mustafa Town

The shade observed at these filtration plants during the field survey has been distributed into three categories:

- Full Shade: Provides shade to 100% of the area
- Appropriate Shade: Provides shade to 60-70% of the area
- No Shade: No shade was observed

The details of shades and its approximate distribution in the five towns is tabulated here;

Table 2: Percent shade observed at filtration plants

Town	Shade observed
Data Gunj Baksh Town	33%
Shalimar Town	82%
Samanabad Town	40%
Gulberg Town	43%
Ravi Town	20%

It can be assessed from the data above, that the most affected filtration plants were located in Ravi Town with shade availability of mere 20% and Data Gunj Baksh Town with 33% of Lahore. Samanabad Town ranked third with shade available at only 40% of filtration plants.

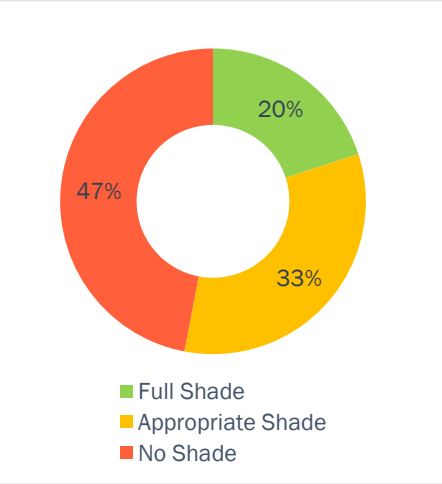


Figure 29: Percent shade observed at filtration plants

2.3.6. Analysis of Water Coolers

The presence of water coolers in the vicinity of survey point were also recorded and data related to the overall functionality of these assets were observed. Data regarding the ownership of the asset, type of asset, condition of the cooler, its serving capacity, number of operational taps and more were recorded during the visit.

Figure 30: Water Coolers observed at different survey locations

The detail of data collected has been provided as annexure to this report. The data collected was then analyzed and following results were observed:

- Water Coolers were observed in the vicinity of at least 19 out of 45 survey sites.
- All 19 of the Water Coolers observed were Standard Electrical Steel Coolers.
- 18 out of 19 Coolers observed were owned by private stakeholders whereas only one was owned by public sector entity.
- All of the 19 Coolers observed operated on electricity from household connections.
- None of the coolers observed had appropriate shade or seating facility due to constraint of space.

Functional Status

The operational status of these water coolers was performed based on the collected data during heatwave hours and it was observed that all 19 water coolers visited were functional (100%).

Conditional Analysis

The conditional analysis data revealed that 66% of these coolers were in C to D indicating deteriorating condition for these assets, mostly due to aging and rusting of the body of these coolers.

Fig. 32: Conditional Overview of Coolers

The percentage of coolers from each town falling into a particular category has been tabulated below:

Table 3: Conditional Categorization of Coolers

Condition	Data Gunj Baksh Town	Shalimar Town	Samanabad Town	Gulberg Town	Ravi Town
A	0%	25%	0%	0%	100%
B	20%	25%	25%	50%	0%
C	60%	25%	75%	50%	0%
D	20%	25%	0%	0%	0%

2.4. Spatial Risk Assessment

2.4.1.Scoring Criteria

A scoring-criteria for the assessment of different water supply appurtenances was developed. This criterion lists the various properties and conditions associated with the operationality and capacity of these assets that are directly related to the provision of safe drinking water to the public as a mean of relief during the heatwave hours. The criterion extracts data from the field survey charts and assigns score to each condition. The cumulative score is then multiplied with a weightage in order to get a unique percent factor. Each drinking water feature has been assigned a different weightage based on its importance as follows:

Table 4: Weightage of various water appurtenances

Drinking Water Feature	Weightage
Water Filtration Plants	60%
Water Coolers	30%
Medical Relief Camps	10%

The final percent score is then changed to a grade in order to represent the overall availability of drinking water facilities/appurtenances in the area. This was achieved by generating ranges and assigning the unique grades to each numbered range. The ranges that make up each grade have been tabulated here;

Table 5: Percent Range of Grades

Grade	Range
A	> 50%
B	40% - 50%

C	30% - 40%
D	< 30%

The detailed scoring criteria for each individual feature has been attached as annexure to this report.

Criticality

Criticality was developed in order to spatially distribute the availability of drinking water sources in an area. Three separate ranges were proposed to distribute criticality of an area based on the influx of public relying on the asset as well as the availability of alternate relief sources in the vicinity. The criticality criteria for availability of drinking water sources in an area has been tabulated below:

Table 6: Criteria for Criticality

Criticality	Range
1 – Low	Residential Areas
2 – Intermediate	Semi-Commercial Areas
3 – High	Commercial Areas

2.4.2. Risk Assessment Matrix

The risk assessment matrix was developed to spatially assess the areas that would be most affected by the heatwave. The scoring criteria defines the categorization of availability of drinking water in an area and makes up one axis of the matrix. The criticality criteria define the spatial severity of the condition and makes up the second axis of the matrix. This simple mechanism morphs and forms the risk assessment matrix as shown in the figure below, that helps visualize the risks associated with a particular area and assists in effective decision making for possible relief interventions.

Table 7: Risk Assessment Matrix

	Ease of Availability of Drinking Water			
Criticality	A	B	C	D
1- Low (Residential)				
2- Medium (Semi-Res.)				
3- High (Commercial)				

2.4.3. Risk Analysis

The risk assessment strategy was then used to analyze the type of risk associated with each survey point. Scoring criteria was used to judge the condition of ease of availability of drinking water facilities at heatwave hours where was the criticality criteria was used to judge the spatial importance of the location. The risk associated was then calculated and classified into three categories as:

Table 8: Categorization of Risks

Non-Significant Risks	Risks that need minimal attention and can be ignored due to their insignificant nature.
Tolerable Risks	Risks that have some severity but can be ignored based on given constraints.
Non-Tolerable Risks	High priority risks that need immediate attention and timely decision making for effective management.

These three categories define the nature of risk that can be encountered at the survey sites, and the appropriate relief intervention that can be proposed for effective risk mitigation. The details of risk categorization of each survey point were calculated and is presented in the table below:

Table 9: Risk Assessment of Survey Points

Sr.	Town	Name	Latitude	Longitude	Risk
1	DATA GUNJ BAKSH TOWN	Shadman	31.540437	74.330102	D2
2		Mazang	31.558554	74.315105	C3
3		Mochi Gate Circular Rd	31.576406	74.321655	D3
4		Lakshmi Dayal Singh	31.570181	74.322758	D1
5		Cathedral	31.567034	74.317359	B3
6		National Town	31.562201	74.292712	C1
7		Sanda #1 WAPDA Office	31.560356	74.280420	A1
8		Sanda #2 Chauhan Road	31.567170	74.286575	A1
9		Sanda #3	31.561421	74.285419	C1
10		UVAS	31.572790	74.288844	D2
11		Ayehsa Park	31.570378	74.293614	B1
12		Nehru Park	31.569190	74.294430	B2
13	SHALIMAR TOWN	Singhpura	31.580000	74.378063	D2
14		Baghbanpura	31.585401	74.368131	B1
15		China Scheme B-I	31.598707	74.363740	D2
16		Bhagatpura	31.598595	74.352950	C1
17		Kot Khwaja Saeed	31.589729	74.357455	A1
18		Bhogewal	31.585932	74.356297	D2
19		Sawami Nagar	31.579840	74.348570	A1
20		Sultanpura	31.580671	74.342349	C2
21		Chah Miran	31.593039	74.341922	D1
22		Misri Shah	31.591679	74.332167	C3
23		Shadbagh	31.599176	74.335173	B1
24	SAMANABAD TOWN	Rehmanpura	31.523638	74.317187	B2
25		LOS	31.542312	74.316005	C2
26		Gulshan Ravi	31.546962	74.274928	A1
27		Babu Sabu	31.538925	74.266141	C1
28		Ittehad Colony	31.526356	74.287458	C1
29		Kareem Market	31.503822	74.274477	B2

Sr.	Town	Name	Latitude	Longitude	Risk
30		Mustafa Town	31.493235	74.273532	A1
31		Gulshan Iqbal	31.515510	74.293484	B1
32		Hunza Block	31.512556	74.296125	C1
33		Iqbal Town - 1	31.518067	74.297294	C1
34	GULBERG TOWN	Railway Road	31.576480	74.331353	D2
35		Mohammad Nagar	31.566292	74.341246	D1
36		Gulberg #1	31.523707	74.344615	A1
37		Gulberg #2	31.522799	74.342538	B2
38		Khan Colony	31.492182	74.338800	B1
39		Liaqatabad	31.470401	74.329536	B1
40		Faisal Town	31.469179	74.309831	B2
41	RAVI TOWN	Truck Adda	31.602920	74.305645	A2
42		Qila Lachman Singh	31.593758	74.305464	C1
43		Batti Chowk	31.599129	74.298171	C2
44		Pani Wala Talab	31.584015	74.315783	C2
45		Sheranwala Gate	31.587486	74.323703	B2

It can be assessed from the above data that while approximately 49% of the survey area involves non-significant risks, the other half area involves more sever categories. Almost 22% of the areas visited has Non-Tolerable Risks that needed immediate attention to minimize the effects of the heatwave.

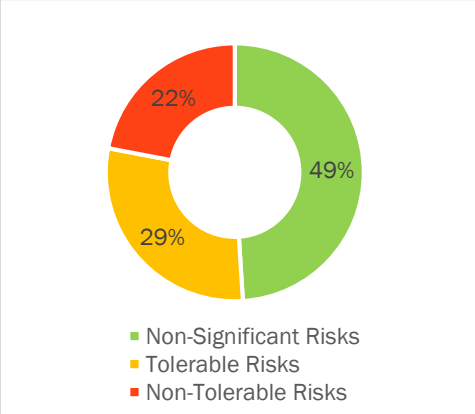


Figure 31: Risk Assessment of Survey Points

The geo-spatial spread of the of risks can be better assessed by overlaying the risks over a map. The subsequent map shows the location of the survey points and the category of the risks extrapolated over the area. It can be observed that the areas that are have a high-risk priority fall in the city center in areas of Data Gunj Baksh Town, Ravi Town and Shalimar Town.

The areas of Data Gunj Baksh Town and Ravi Town have a high population influx with very little green spaces. Although drinking water appurtenances were observed at these places, most of them were operational during heatwave hours due to varying tube-well hours, load shedding and other issues.

The areas of Shalimar Town include mostly the industrial areas along GT Road, where the heat signatures were especially high due to furnace and burning activities. The population in this town is also very concentrated leading to elevated risk potential here.

These areas are the most vulnerable to heatwave among the five towns visited in Lahore due their high population influx, less tree cover, a smaller number of relief appurtenances and greater congestion.

Immediate interventions are proposed to provide effective and appropriate relief to the residents of the above-mentioned areas.

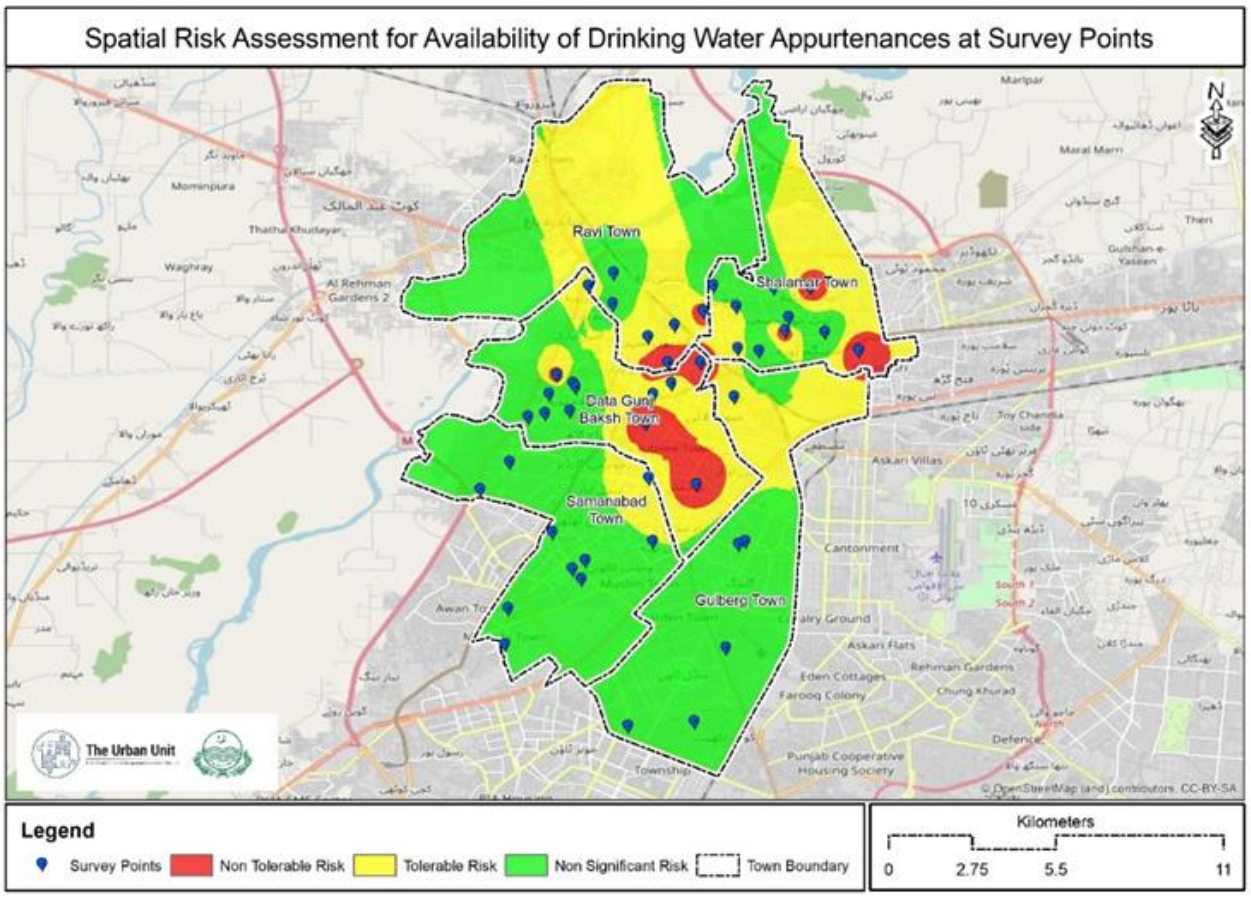


Figure 32: Spatial Risk Assessment Map

Heatwave Management Plan

The 2022 heatwave in Lahore raised the urgency and commitment of provincial stakeholders to develop a coordinated response action plan at the city level to prepare and mitigate future heatwave effects. The summer season in Lahore generally lasts from April to October. Extreme temperature and low humidity levels are experienced during the onset of the summer season, which is followed by monsoon showers, and finally high humidity season. However, climate change has altered the start and end of all seasonal variations, along with the intensity of local temperature, rainfall, and humidity, as was discerned during the heatwave of 2022. The vulnerability of heatwaves is often seasonal and occurs during a specific time of year based on the geography and local climate. It is impertinent that preparedness and plans should be formulated after vulnerability mapping, weather forecasts, consultative meetings, etc. to enhance community preparedness and mitigation during the heatwave.

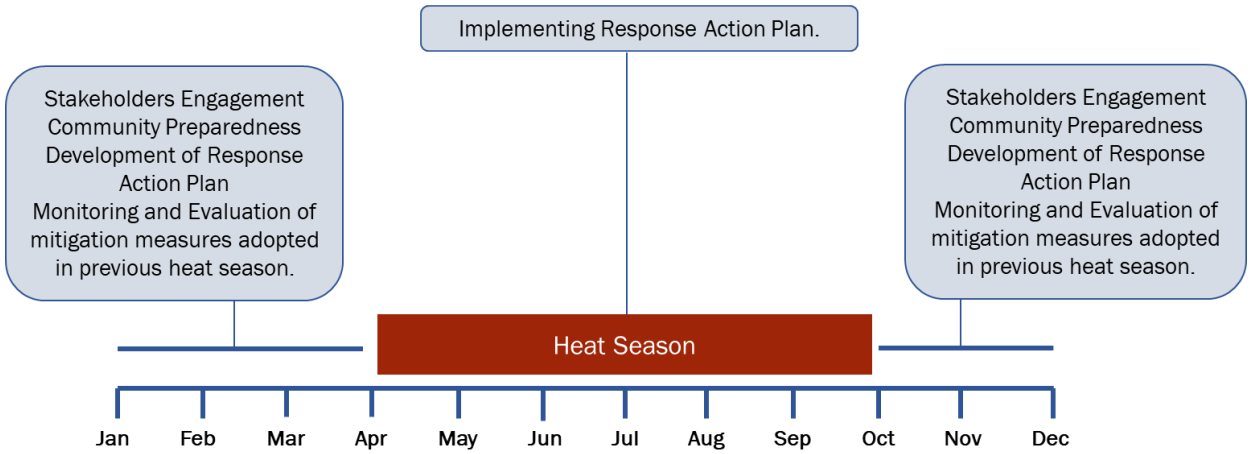


Figure 33: Heatwave Management Plan Lay-out (Pre-During-Post)

This section comprises of action measures that will be taken before, during, and after the heatwave season in Lahore city.

3.1. Early Warning System:

An early warning system for a heatwave is a meteorological alerting mechanism that provides information to the general public and governing stakeholders about the impending rising temperature, its impacts, and stimulates the need to implement an action plan for its prevention and mitigation. The joint report of World Meteorological Organization (WMO) and World Health Organization (WHO) on development of

warning system for heatwaves and health risks, discusses following key components of an early warning system [20];

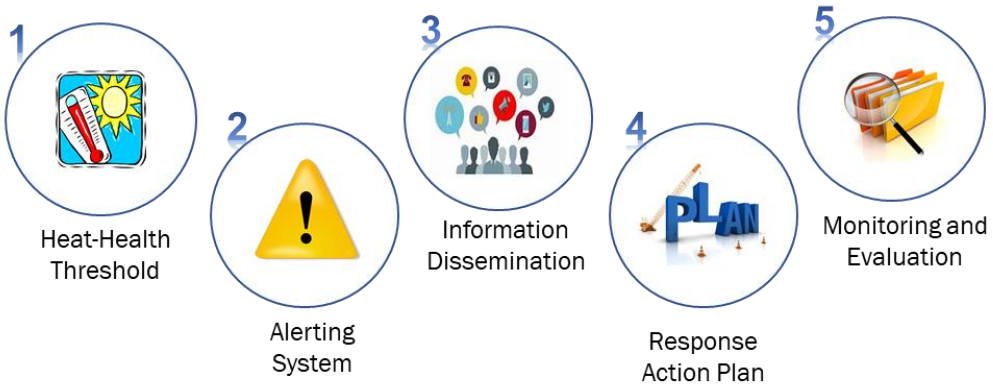


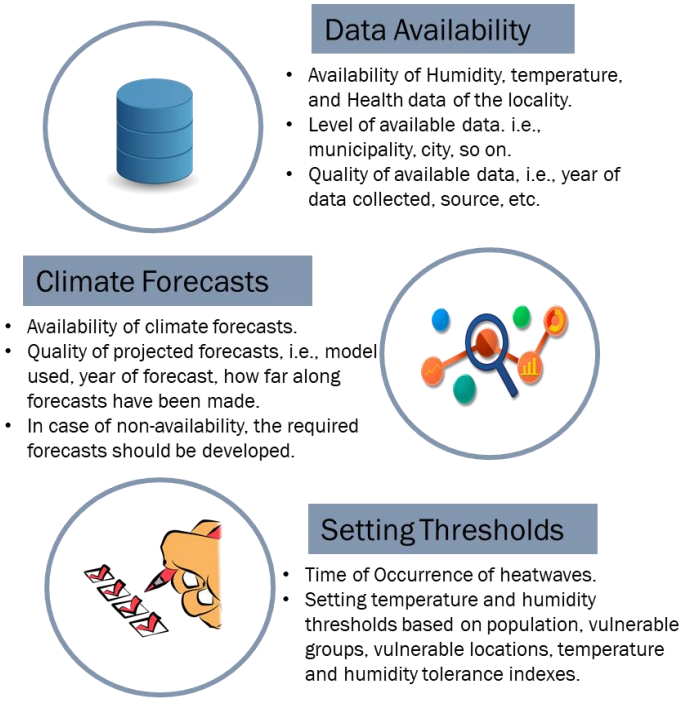
Figure 34: Key Components of Early Warning System for Heatwave

An early warning system for heatwave preparedness and mitigation provides a basis for a broader action plan, that is implemented when risks are met. The success of an action plan depends on standards developed based on the availability of reliable data, community awareness plan, stakeholders' identification and engagement, formalizing defined actions for each stakeholder, and composing an implementable action plan focusing upon the community under risk.

3.1.1. Heat-Health Thresholds:

The Pakistan Meteorological Department is mandated for weather observations and provides current and forecasted weather information for optimization of weather-sensitive operations. The PMD issues warning against severe weather phenomena including drought, heavy rains, heatwaves, etc. Lahore city has the characteristic climate of tropical areas, comprising of extreme temperatures and humidity levels, which puts it at higher risk of impacts.

The regional meteorological station and health departments of the city are the key players in defining heat-health thresholds. These thresholds can be developed through availability of updated and reliable data and forecast patterns specific to Lahore city.



3.1.2.Surveillance and Alerting System:

Forecasting heatwaves well in advance of their occurrence provides the time for preparedness. The following set of information will be reviewed on regular basis to anticipate heatwaves and take appropriate action throughout the heat season.

- Regular forecast of maximum and minimum temperature for the next 7 days from RMC Lahore
- Reports on heat-related health impacts and fatalities from all clinics, hospitals, and health centers.

The forecasting of extreme temperatures is significant for declaring heatwave emergencies and initiating mitigation measures. The health impact reports can assist in identifying the additional ongoing impacts to define health-related thresholds.

Alerting System:

The response action plan in Lahore will be implemented based on a three-tier alerting system.

Table 10: Three-tier Alert System

Alert	Criteria	Public Advisory	Government Response
Hot Day Alert	Forecast 40℃-41.9℃	Avoid outdoor activities. Cover your head. Drink more water. Wear light colored and loose cotton clothes.	Increased communication in media on heat issues.
Hot Day Warning	Forecast≥ 42℃	Avoid Heat exposure. Drink sufficient fluids. Replenish body salts through IV Fluids. Wear light colored and loose cotton clothes. Walk and sit under shades.	High level of public awareness, increased focus, and preparedness of government agencies.
Heatwave Emergency	≥ 42℃ Forecast and minimum temperature ≥ 30℃ for 2 or more consecutive days. Significant levels of heat related illness and mortality reports.	Extreme care needed for vulnerable people. Avoid Heat exposure. Drink sufficient fluids. Replenish body salts through ORS. Wear light colored and loose cotton clothes. Walk and sit under shades. Call emergency helpline for any additional assistance.	Declaration of Heatwave Emergency

The yellow and orange alerts will be used to increase public awareness and institutional readiness of administrative and facilitating departments. Pakistan Meteorology department will issue the following statements, that will be replicated and used by PDMA and RMC Lahore;

- Regular information statements regarding heatwave forecast events for administrative departments.
- Public advisory statements for during alert and warning notices.
- Heatwave Watch when there is potential risk of heatwave.
- Emergency Alert statements when there is a risk of heatwave lasting for more than 2 days.

3.1.3. Declaring a Heatwave Emergency:

Pakistan Meteorology Department will issue a notice when the defined temperature thresholds are met, based upon the forecasted weather patterns. The PMD will declare emergency notice in Lahore city, when:

1. The maximum dry bulb temperature measured at RMC, Jail Road Lahore is forecasted to be ≥42°C with no significant relief, and night time air temperatures are not expected to drop below 30°C for at least 2 days.
2. When there are significant levels of heat-related illness and even mortality there must be a declaration of heatwave Emergency and rapid response.

Once the heatwave emergency is declared, action plans will be triggered by the administrative and facilitating departments across the Lahore division. Heat-related illnesses and mortality will be monitored throughout the heat season to determine potential events that raise health concerns. The plan will be reviewed and improved considering the health impacts of previous heat season to increase preparedness and prevention. Heatwave emergency will also be declared by the Commissioner Office when significant number of heat related diseases and mortality are reported, regardless of the climate pattern.

3.2. Communication Plan:

The communication plan is as follows;

- An Emergency Response Coordinator will be responsible for the entire coordination during heatwave.
- The Emergency Response Committee will maintain constant communication with relevant departments and the general public during the heat season. The level of communication between stakeholders and response will be amplified or diminished in accordance with the level of concern issued by PMD.
- The efficient implementation of the Response Action Plan will depend upon the adequate and timely sharing of forecast information from the Pakistan Meteorology Department. Regional Meteorological Centers in Lahore will also be monitoring the regional weather patterns in coordination with PMD.
- Environment Protection Department and Environment Protection Agency in Lahore are mandated with managing the environmental concerns at provincial level in Punjab. EPD will play a key-role in coordination and implementation of response action plan.

The facilitating departments will be tasked with the implementation of the response action plan, according to the level of issued notice. These departments will ensure the appropriate and well-timed delivery of a range of actions in accordance with the following arrangements. The operational feedback will be shared with ERC regularly, which will review the efficiency of all operations. Details are given.

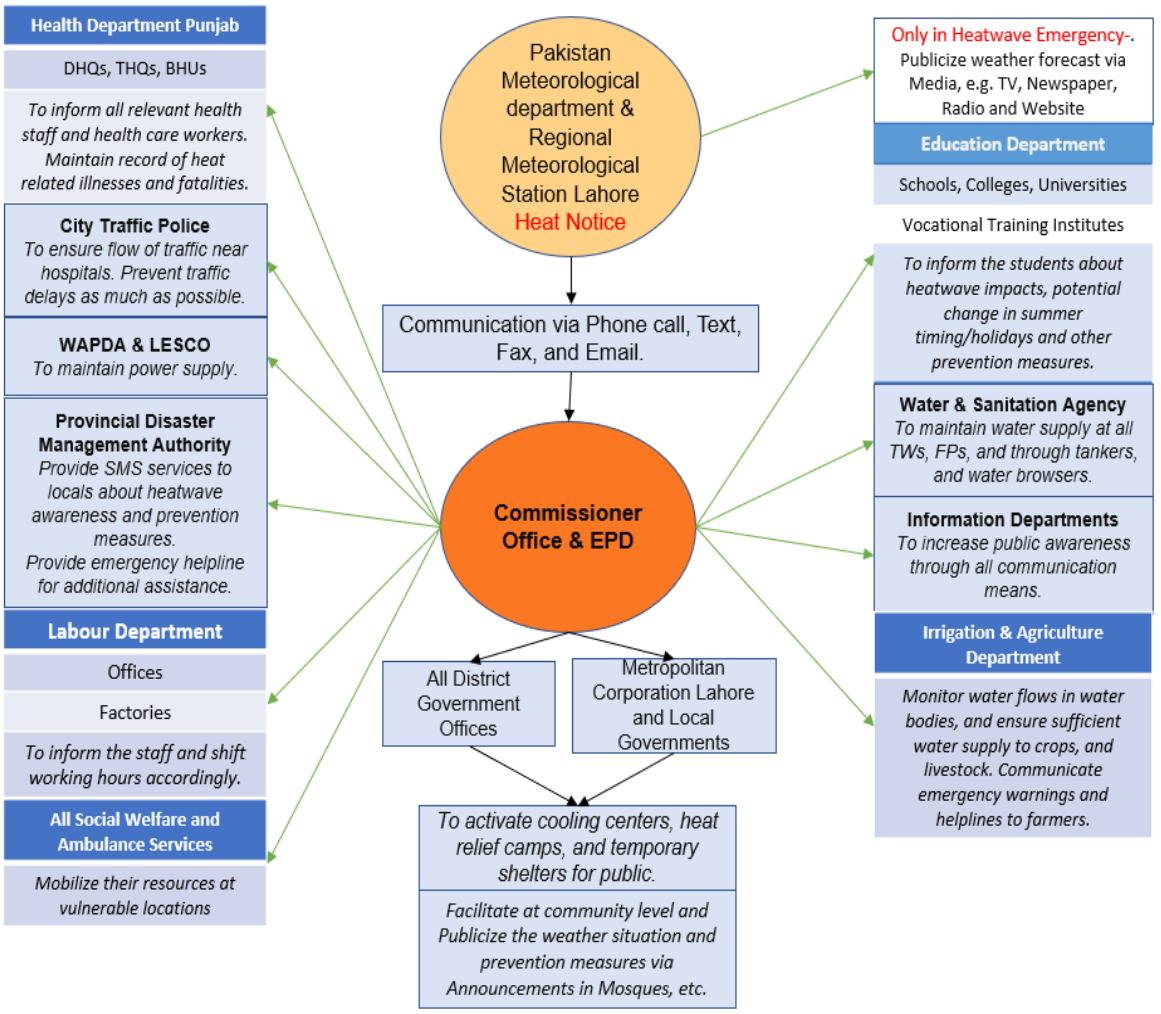


Figure 35: Communication plan

3.2.1. Key Actors:

- **Deputy Commissioners (DC):** The DC will be responsible for organizing and coordinating resource deployment, including locations for heat relief camps, cooling stations, shade structures, etc. at the district level.
- **Municipal Corporations (MC):** the MC will trigger field response by ensuring that medical supplies, ice packs, relief camps, emergency response teams, and emergency contacts are in operation. The MC Officers will visit health care centers and prepare weekly reports of the municipality for ERC.
- **Union Councils:** The Union Councilors in each union will be responsible for managing community-based services, and engaging all stakeholders and the general public for increased preparedness and collaborative planning. They will also disseminate information pertinent to locations of cooling points, display information brochures, and will manage the information outreach to all people.

- **Health and Medicine Departments:** They will be responsible for information sharing and the equipment of all health care units with human resources and medicines throughout the heat season.
- **WAPDA, LESCO, WASA:** These utility agencies will be responsible for maintaining an adequate supply throughout the heat season, with a special focus on highly vulnerable areas.
- **Social Welfare Organizations:** These organizations will mobilize their resources such as ambulance services, volunteers, paramedical staff, etc. to provide emergency relief to heatwave patients. Customized awareness material focused on heat-related illness and first-aid actions will be developed and displayed in ambulances for effective and timely treatment.
- **Education & Labor Departments:** These departments will inform their relevant line departments to consider public holidays under emergency notice. They will also disseminate awareness material regarding the prevention from the heatwave.
- **Information Departments:** The information department will be responsible to publicize all awareness material through all conventional and modern communication means.
- **Irrigation & Agriculture Departments:** Information and Agriculture departments will monitor water flows in the water bodies, assist farmers in managing adequate water supply to crops and livestock, and will devise plans to safeguard the food security.

3.2.2. Heatwave Awareness Campaign:

Heatwave Awareness Campaigns will be conducted pre-during season in coordination with emergency response committee and key stakeholders. The aim of the campaign will be to increase awareness and preparedness of the general public well in advance of the perceived risk. The primary audience for this campaign will be;

- Locals living in Lahore (focusing the highly vulnerable locations and populations)
- Travelling visitors in Lahore (preferably people at local transit terminals)

The awareness material will include information pertinent to risk probability, prevention measures, time and magnitude of heatwave occurrence, appropriate response, and emergency contact numbers.

The paramedic staff, ambulance drivers, traffic police wardens, and emergency response volunteers will also be provided information on heat related symptoms, illness, first-aid treatments, and locations of nearest relief centers in the local language. This is significant for reducing medical surge in DHQs and THQs.

The key messages to reduce the impact of high temperature and dry conditions on public will be shared in simple, clear, and short format through local languages, via;

Leaflets	Handouts	Brochures	SMS Alert
Social Media Graphics	Display boards	Posters	

Public Messaging:

The information dissemination to the public will be conducted in a regular series of multiple messages before and during the heat season, and will be focused on the following six components:

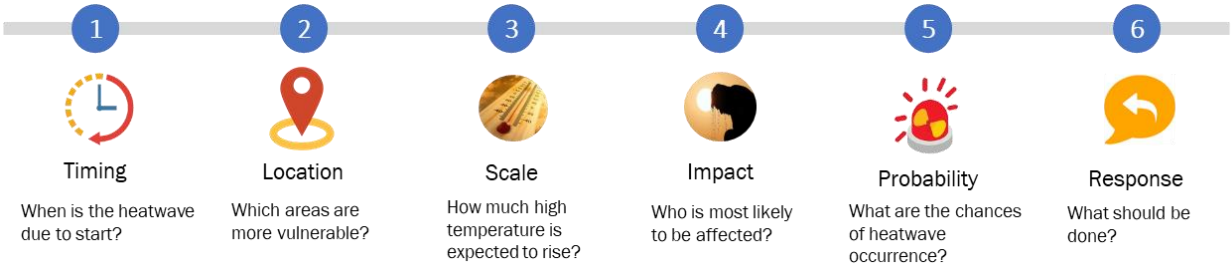


Figure 36: Components of information dissemination

Sufficient knowledge dissemination to the public is important to trigger their efforts to take precautionary measures beforehand.

3.3. Heatwave Emergencies

When the climate forecasts will meet or exceed the defined threshold for maximum temperature in Lahore, the PMD will issue a yellow, orange, or red notice in accordance with the threshold level or reported heat-related illnesses. The different levels of target groups are:

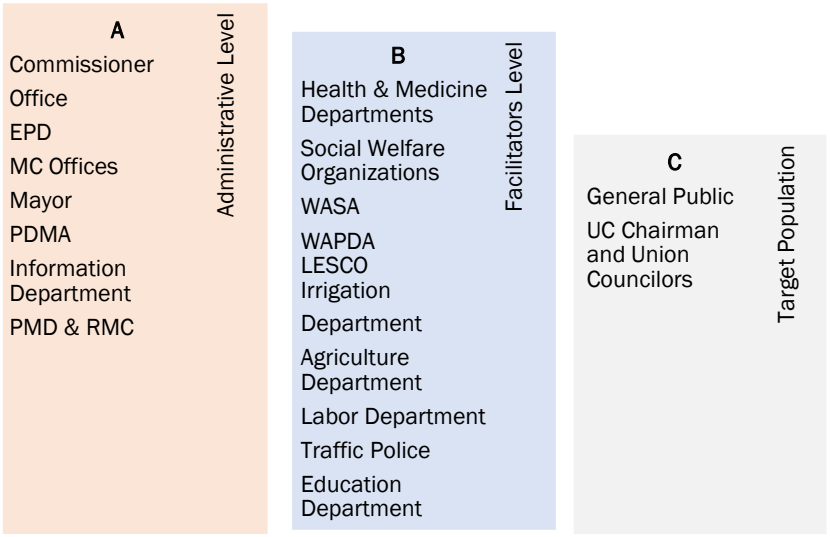


Figure 37: Levels of Target Groups

The notice will be issued in coordination with the Regional Met center of Lahore, to EPD, PDMA, and other administrative departments in Lahore. The communication strategies will vary for each level of issued advisory and will increase the involvement of stakeholders according to the severity of climate situations. The alert levels will identify the issuance of three types of notices concerning potential heat risk by the PMD. These notices will identify the groups to be notified by the ERC (Emergency Response Coordinator).

Mobile Applications, Social Media, and Websites will be used as vehicles for coordination. The advisory notices are as follows:

Yellow Alert:

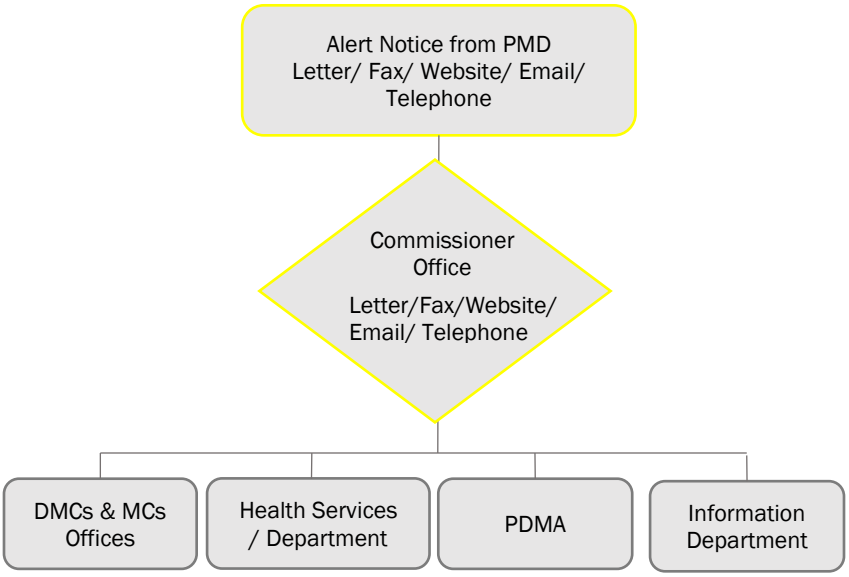


Figure 38: Yellow Alert

Orange Alert:

Group A and Group B will be notified for action under the Orange Warning Notice.

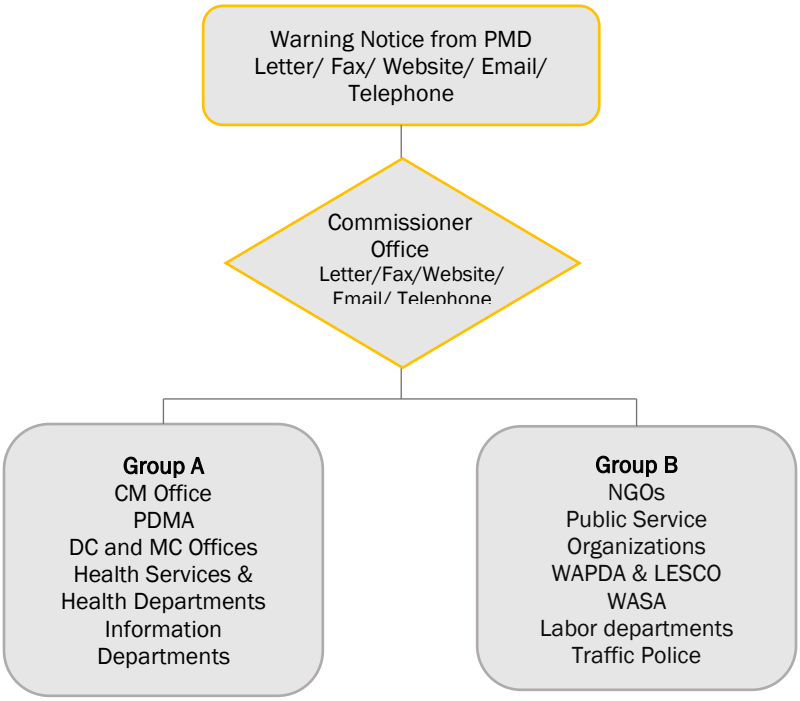


Figure 39: Orange Alert

Red Alert:

All groups will be notified for action under the Red Emergency declaration notice.

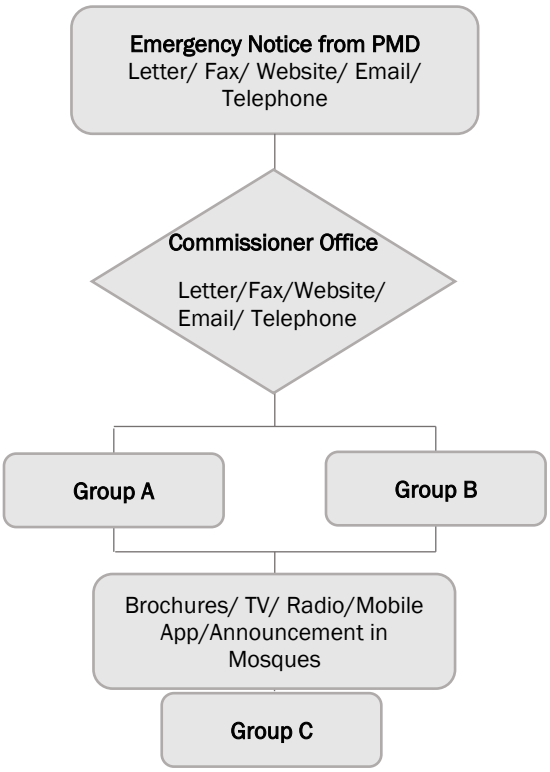


Figure 40: Red Alert

3.3.1.All Clear Notice:

After the heatwave has terminated, the PMD will notify the forecasts to administrative departments with an All Clear Notice. The All Clear Notice will initiate performance evaluation process.

Table 11: All-Clear Notice

All Clear Notice
After the Heat Season, PMD will issue All Clear Notice, that will terminate all actions conducted under alerts, warnings, and emergency notices. The emergency response coordinator will convene meeting with the key stakeholders to organize an evaluation of the annual heatwave management plan. The agenda of the meeting would be to discuss and review the past performance of all key players. After the consultation, recommendations for the improvement of the heatwave management plan will be recorded as minutes of the meeting and will be sent for incorporation into the revised plan.

3.4. Response Action Plan:

The potential outcome of such a framework can include:

- Clarity in roles and responsibilities of all major stakeholder groups in ensuring preparedness for, and timely response to heatwaves
- Scope for regular stakeholder interface, knowledge sharing and capacity building
- Draw lessons from case studies of global and national experiences

- Prioritize vulnerable states and cities with implementable interventions
- Generate inventory of potential knowledge partners and area fir future research

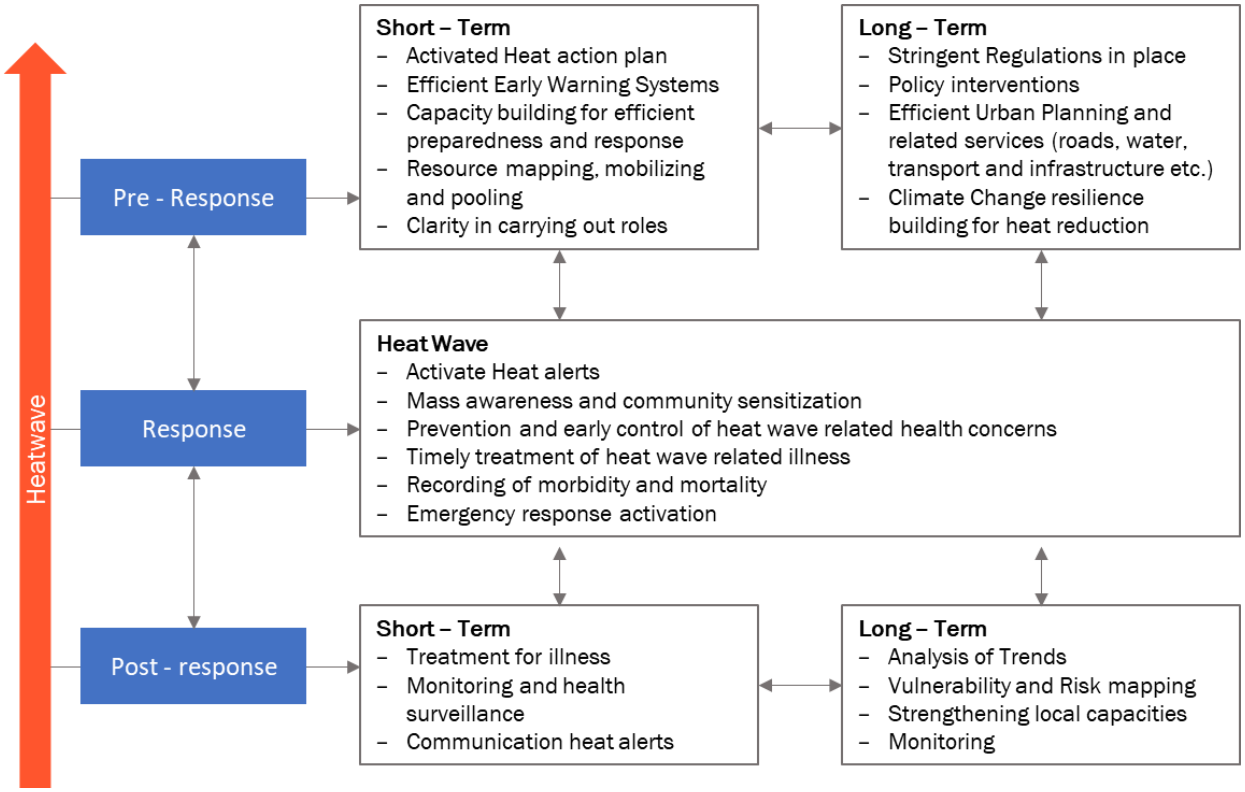


Figure 41: Response Action Plan

The actions to be taken by different departments under various levels of heatwave alerts, are included in the following tables.

Table 12: Actions to be taken during the Heat Season

Departments	Actions	Facilitating Departments
Commissioner Office	Maintain situational awareness on potential heatwave occurrence through regular review of forecasts and notifications from PMD.	PMD & RMC NDMA & PDMA DC & MC Offices Health Department Information Department Social Welfare Organizations
	Contact focal person from each department prior to heat warnings.	
	Activate the heat alerts and response action when heat forecasts are notified in accordance with the Communication Plan.	
	Regularly monitor the situation and increase the level of alert in accordance with the severity of the situation and heat forecasts.	
Pakistan Met Department	Model forecasts, develop advisories, and share alerts with relevant departments in accordance with the communication plan.	Commissioner Office Health Departments
	Issue heat alerts, warnings, and emergency notices based on expert guidance and heat tolerance threshold levels.	

Departments	Actions	Facilitating Departments
Health & Medicine Departments	Ensure availability of information on precautionary measures in the form of brochures, posters, etc. in all health departments, relief camps, and hospitals, for the general public.	Commissioner Office Health Departments DC & MC Offices NDMA, PDMA
	Maintain a sufficient stock of medicines for all heat related health problems.	
	Monitor preparedness in all first-aid centers and relief camps through case audits and zonal health officer.	
Information Department	Initiate information dissemination process to the public in collaboration with Response coordinator via press conference about heat-related health impacts.	Commissioner Office Health Departments DC & MC Offices PDMA EPD RMC
	Circulate alert messages via social media and mobile applications, in collaboration with private telecom companies utilizing the central mobile database, along with the use of traditional media during a heat alert.	
	Circulate bulk warnings using the centralized email database maintained by the information departments.	
	Develop a direct SMS Alert system to disseminate upcoming heatwave information to medical professionals, private practitioners, and First Aid centers.	
	Utilize the local television and radio broadcast programs to provide information on prevention tips for highly vulnerable localities and ways to get emergency help.	
Labour & Education Departments	Conduct public awareness campaigns during heat alerts and warning days focusing on heat risk to labourers and workers.	Commissioner Office District Education Office Education Departments Industries Department
	Conduct information dissemination speeches during assembly and display awareness posters at schools to inform the students about the causes, impacts, and prevention measures of the heatwave.	
	Organize training for outdoor workers/labourers and other employees focusing on potential harmful impacts and prevention measures.	
District Offices & Metropolitan Corporation & Local Governments	Ensure readiness to implement the response action plan and maintain situational awareness.	Commissioner Office Police Department PMD & RMC PDMA Health Department
	Open emergency response and first aid centers in all UCs. Develop shade structures, and benches; and open mosques, and wedding halls for people to sit during high-temperature hours.	
Social Welfare Organizations	Work with EPD, PDMA, DC and MC Offices to provide necessary services to locals.	Commissioner Office DC & MC Offices
	Ensure the supply of IV Fluids and ice Packs.	
	Confirm points of contact for emergency response and maintain 24x7 emergency contact information through SMS, Email, and other contact sources.	
Water and Sanitation Authority (WASA), Lahore	Review water allocation plans under high heat alerts and warnings. Increase the duration of TWs operation and ensure sufficient water supply in low-pressure areas	Commissioner Office DC & MC Offices
	Maintain regular contact with Emergency Response Coordinator for situational awareness.	

Departments	Actions	Facilitating Departments
WAPDA & LESCO	Confirm points of contact for emergency response and maintain 24x7 emergency contact information through SMS, Email, and other contact sources.	Commissioner Office PMD & RMC DC & MC Offices PDMA EPD
	Maintain regular contact with Emergency Response Coordinator for situational awareness.	
	Review electric supply plans during days of high heat alerts and warnings.	
	Collaborate with PMD and RMC Lahore to increase the duration of power supply during high heat days.	
City Traffic Police, TEPA	Confirm points of contact for emergency response and maintain 24x7 emergency contact information through SMS, Email, and other contact sources.	Commissioner Office DC & MC Offices
	Maintain regular contact with Emergency Response Coordinator for situational awareness.	
	Review traffic control plans during days of high heat alerts and warnings.	
NDMA	Maintain regular contact with PDMA, PMD, DC and MC Offices for situational awareness.	Commissioner Office PMD & RMC DC & MC Offices EPD
	Review PDMA forecasts and operations on daily basis.	
PDMA	Ensure coordination and implementation of response action plans.	Commissioner Office DC & MC Offices PMD & RMC NDMA
	Continue SMS services and other awareness campaigns conducted by PDMA in Lahore for heatwave awareness and prevention measures.	

Table 13: Actions to be taken during the Heat Season

Departments	Actions	Facilitating Departments
Commissioner Office	Coordinate with DC & MC Offices, WASA, WAPDA, and LESCO	PMD & RMC NDMA & PDMA DC & MC Offices Health Department Information Department Social Welfare Organizations
	Ensure access of vulnerable populations such as slum communities, and outdoor workers to shady areas and water supply. Temporary shelters, first-aid centers, and response camps should be kept open 24x7 for migratory populations.	
	Ensure timely information display for forecasts, and prevention measures.	
	Conduct consultative meetings and conferences wit response team to discuss ongoing situations during heat alert.	
Pakistan Met Department Regional Meteorological Centers.	Ensure timely coordination of all relevant information with NDMA and PDMA.	
Health & Medicine Departments	Develop Information centers specialized for information dissemination in all health centers, hospitals, and health professionals.	Commissioner Office DC & MC Office NDMA & PDMA

Departments	Actions	Facilitating Departments
	Produce regular reports (weekly basis) for the response coordinator during heat alert/	
	Ensure preparedness and response readiness of doctors/paramedical staff/human resource	
Information Departments	Display emergency contact numbers, nearby relief camps/first-aid centers/hospitals in all schools/offices/universities/factories/other public places.	Commissioner Office DC & MC Office Health departments
	Initiate awareness campaigns at all levels. E.g. media, schools, NGOs.	
Education & Labour Department	Initiate pilot projects for the provision of prevention material (such as caps, umbrellas) and distribution of ice-packs to construction workers, traffic police and transit staff.	Commissioner Office
DC & MC Offices	Declare highly vulnerable areas as emergency centers	Commissioner Office Health Department Police NDMA & PDMA
	Coordinate installation of relief camps and cooling stations.	
Local Government-Mayor & Union Councils	Ensure information access from Emergency repose coordinator through union council and mayor offices to the general public regarding current situation.	Commissioner Office DC & MC Office
Social Welfare Organizations	Mobilize human resources at all vulnerable locations.	Commissioner Office DC & MC Office Local Government
	Display awareness on ambulances and camps for public awareness.	
	Early-cooling treatment must be invoked when the patient is picked up.	
WASA	Coordinate with emergence response coordinator to determine critical areas and availability of facilities regularly.	Commissioner Office DC & MC Office
WAPDA & LESCO	Coordinate with emergence response coordinator to determine critical areas and availability of facilities regularly.	Commissioner Office DC & MC Office PMD & RMC
	Maintain regular contacts with the emergency response coordinator for situational awareness.	
City Traffic Police	Prevent unnecessary traffic delays, avoid road blockades, and restrict transit of people on rooftops during high heat hours.	Commissioner Office DC & MC Office
NDMA	Coordinate with armed forces, UN Bodies, NGOs, and philanthropists' organizations for mobilization of resources.	Commissioner Office PMD, PDMA
PDMA	Launch public awareness campaigns and ensure its outreach to the general public	Commissioner Office PMD, PDMA
	Utilize its coordination network for effective implementation of awareness plan.	

Table 14: Actions to be taken on Warning Notice

Departments	Actions	Facilitating Departments
Commissioner Office	Mobilize all relevant departments to initiate response.	PMD & RMC DC & MC Offices Health Department Information Department Local Government
	Ensure all shade-supplying locations are open, activate temporary night shelters, and ensure water supply to public at all filtration plants and tube-wells.	
	Coordinate suspension of all unnecessary water usage, other than drining and cooling purposes.	
	Communicate with WAPDA & LESCO to ensure power supply protocols in all health-care centers and vulnerable locations are in place.	

Pakistan Met Department Regional Meteorological Centers.	Keep monitoring the temperature forecast patterns. Ensure timely coordination of all relevant information with all departments.	
Health & Medicine Departments	Increase the human resource at hospitals and first-aid centers by employing young volunteers to attend to the influx of patients.	Commissioner Office DC & MC Office NDMA & PDMA
	Maintain the record of each heat-related patient at each health-care center.	
	Increase coordination with community health workers to increase outreach to highly vulnerable areas.	
	Produce health impacts reports for emergency response coordinator on regular basis.	
Information departments	Initiate public awareness campaign regarding the availability of relief camps, first-aid centers, emergency contacts, and nearby hospitals.	Commissioner Office DC & MC Office Health departments
	Include religious scholars program anchors, and social influencers.	
Education & Labour Department	Advise employers of concerned organizations to shift the schedules of outdoor workers away from the peak heat hours (12:00 pm – 5:00 pm)	Commissioner Office
DC & MC Offices	Adopt all necessary arrangements required at all DHQs, and BHUs.	Commissioner Office Health Department Police NDMA & PDMA
	Coordinate with Commissioner Office and Local Government Offices in Lahore Division	
Local Government-Mayor & Union Councils	Enable self-sufficiency of all neighborhoods, and assist vulnerable populations.	Commissioner Office DC & MC Office
Social Welfare Organizations	Mobilize the human resources and facilities at all vulnerable locations.	Commissioner Office DC & MC Office Local Government
	Allocate the number of relief camps, first-aid centers, and ambulances in densely populated locations.	
WASA	Coordinate with emergence response coordinator to determine critical areas and availability of facilities regularly.	Commissioner Office DC & MC Office
WAPDA & LESCO	Ensure uninterrupted power supply at all critical locations such as healthcare centers and vulnerable locations.	Commissioner Office DC & MC Office PMD & RMC
City Traffic Police	Ensure the uninterrupted traffic flow near hospitals and emergency centers.	Commissioner Office DC & MC Office
NDMA	Activate all emergency operations as appropriate	Commissioner Office PMD, PDMA
PDMA	Issue timely warnings as received from Met Department.	Commissioner Office PMD, PDMA

Table 15: Actions to be taken on Emergency Notice

Departments	Actions	Facilitating Departments
Commissioner Office	Declare emergency in all hospitals.	PMD & RMC DC & MC Offices Health Department Information Department Local Government NDMA & PDMA
	Consider declaring public holidays under heatwave emergency.	
	Increase public water supply through the distribution of handouts, and facilities at all religious places, shopping centers, community parks, major roads, etc.	
	Monitor the operation of all cooling stations through designated teams.	
Pakistan Met Department Regional Meteorological Centers.	Keep monitoring the temperature forecast patterns. Ensure timely coordination of all relevant information with all departments. Ensure the information outreach to the public about potential heatwave impacts through media, mobile applications, and website.	

Health & Medicine Departments	Initiate launch of mobile teams for emergency support and first-aid.	Commissioner Office DC & MC Office NDMA & PDMA
	Maintain the record of each heat-related patient at each health-care center and produce weekly reports.	
	Report the number of heat-stroke patients and mortalities to the Commissioner on daily basis.	
Information departments	Ensure information dissemination in local languages through the use of all resources about precautionary measures during heatwave emergency.	Commissioner Office DC & MC Office Health departments
Education & Labour Department	Consider declaring public holidays under heatwave emergency.	Commissioner Office
DC & MC Offices	Monitor the activities of all subordinate departments and provide regular updates to emergency response coordinator.	Commissioner Office Health Department Police NDMA & PDMA
Local Government-Mayor & Union Councils	Engage with the social welfare organizations to manage the medical surge by ensuring access to nearest health-care center in all localities.	Commissioner Office DC & MC Office
Social Welfare Organizations	Mobilize the human resources and facilities at all vulnerable locations.	Commissioner Office DC & MC Office Local Government
	Ensure the attendance of all emergency calls from heat-affected people, and ensure their timely transport to a nearby emergency relief center.	
WASA	Ensure water supply through water browsers, water tankers, and all necessary means.	Commissioner Office DC & MC Office
WAPDA & LESCO	Coordinate with Commissioner Office and Health Care departments to ensure an uninterrupted power supply at all critical facilities and highly vulnerable areas.	Commissioner Office DC & MC Office PMD & RMC
City Traffic Police	Ensure the uninterrupted traffic flow near hospitals and emergency centers. Allocate traffic wardens at all congestion points in Lahore.	Commissioner Office DC & MC Office
NDMA	Monitor all emergency operations.	Commissioner Office PMD, PDMA
PDMA	Direct all relevant departments to implement precautionary measures.	Commissioner Office PMD, PDMA

3.5. Long Term Strategies

There is a need to adopt long-term strategies for a livable city that can sustain the hot temperature. There is a need for urban development, transport policies, building design and codes, energy-efficient designs, and cooling urban designs that can reduce the vulnerability of extreme heat events. The heatwave resilience strategies set out additional open doors for supporting, extra plan targets, and building political reasonability. Nonetheless, it is emphatically suggested that open doors for an activity to reduce the heatwave impact. These longer-term methodologies structure a significant part of the general reactions to heatwave events and must be considered during the review of the plan.

There are some of the plans that must need to be considered to make the population of Lahore more resilient during the heatwave.

- Revise the residential and commercial building design by choosing the cool roofs, installing the cool pavements, increasing the canopy cover, and green roofing to reduce the exposure to the heatwave.
- Designing high-rise buildings, more green open spaces, acceptable transport infrastructure, and water supply and sanitation design to reduce the scattered growth.
- The walled city has become more populated and denser which is highly vulnerable to the heat island effect so there is a need of redesign, renewal and regeneration of the major areas to reduce the heatwave impact.
- At the policy level, there is a need to enhance the capacity building of the officials, encourage the collaborations among the partners, raise the public awareness, created the cooling zones and define the new standards or building bye-laws to reduce the exposure of heat.
- Decreasing the congestion by sustaining the development of a few downtown areas. Lahore, one of Pakistan's megacities, has developed and urbanized and this pattern will probably keep, considering the significantly less developed areas of the city. There is a need to change Lahore into a policy of a centric city, decreasing the traffic congestion and urban sprawl.
- There is a need to develop the rainwater harvesting tanks under the ground by WASA, develop the open spaces and parks, and increased vegetation and trees along the roads which can lead to the green urbanization of existing poor urbanization.
- Public transport demands the major focus to reduce the congestion of traffic on the roads which is a major cause of heat island effect. There is a need to better the traffic management system and encourage the public to reduce the use of their personal cars and bikes to lessen the effect of air pollution.

3.6. Monitoring & Evaluation

Monitoring and Evaluation is an important component to check the effectiveness of the plan. The assessment and evaluation structure include staggered markers and their suggested means and recurrence of estimation. It helps in working with boundless partner exchange on encounters and examples so that convenient and informed choices can be made at both key and functional levels.

A formal evaluation is basic to evaluate whether strategies are viable in lessening heat-related mortality and bleakness. This guides in characterizing components that need improvement, measuring the viability of variation endeavors, and assists in relating to costing compelling mediations. The following incorporates three principal components:

- Vulnerability and risk for population and health frameworks,
- Impacts on Health and health system, and
- Resilience for the health system and the population at national as well as local levels

The criteria that should be followed for the evaluation planning:

Simplicity: There should be simple objective of the meeting as;

- Type of information for the warning issuance
- Number of People and Coordinating agencies that will be involved in warning issuance.
- Time for monitoring, issuance of warnings and maintaining the system.

Acceptability: There must be the willingness of individuals who will be participated;

- Participation of the coordinating partners
- Completeness of response of different agencies

Timeliness: There must be a time record of warning before its issuance;

- Are the warnings delayed or timely with respect to the different activities?

Sensitivity: It will involve the number of times of warning issuance;

- Are How many times the warning will be an issue and what are the meteorological conditions that occurred?

Specificity:

- The accuracy of the heatwave mortality forecast should be estimated in order to avoid the false forecasts

Reach:

- Who is getting the information and what message they are communicating?
- Is the information effective?

The Emergency Response Coordinator in the Office of the Commissioner will guarantee that checking data is incorporated in the arrangement's execution, regulating a course of yearly surveys, and plan refreshes as new data is accumulated.

The following steps will be involved in the evaluation process:

- The coordinator will produce the report on the following indicators as a result and lesson for the next year. This will be distributed among the public.
- The emergency response coordinator will organize the meeting in which coordinating committees and implementation partners will be involved in the review and evaluation of the plan. Each partner will come with the monitoring data and recommendations.
- The changes will be made in the plan on the basis of the results of meetings and consultations which will enhance the effectiveness of the plan. The emergency response coordinator will update the plan for next year and will be disseminated it to the coordinating parties prior to the next year's heat season.

Table 16: Evaluation question and potential indicators for the implementation process

Evaluation Questions		Indicators
Availability of Facilities	Were water facilities, supplies, and health facilities available in the areas?	▪ Number and type of the water and health facilities in the vulnerable areas ▪ The water facilities are properly functional or nonfunctional. ▪ The number of functional hours and the number of hours without water supply in each area
Beneficiary satisfaction	Was the beneficiary satisfied with the available facilities?	▪ The satisfaction rate of the beneficiaries in vulnerable areas.
Identification of Vulnerable groups and places	Were the vulnerable communities all around served during heatwave occasions? What do they know about the heatwave vulnerability in their areas?	▪ Number of the groups who are highly at risk ▪ Geography of coverage and understanding of the heat vulnerability. ▪ Number of the people who took advantage of facilities like cooling and relief camps ▪ Number of the people with their demographic data who took advantage of the response actions. ▪ Satisfaction of stakeholders and capacity building of practitioners and emergency responders to check the heat-related illness during the season
Warning system	Was the warning issued timely and efficiently?	▪ The efficiency of warning occurrence ▪ Timeliness of alert notices and warning messages
	Were the heatwave events precisely observed?	▪ Frequency of the warnings according to the meteorological conditions. ▪ PMD's Capacity to covey the information
Framework for coordination	Major key components for the implementation of the Heatwave management plan?	▪ Major and sufficient resources available for completing the TORS ▪ Coordinating committee how many times reviewed the plan and gave the feedback? ▪ Is staff appropriately available in the control room? ▪ PMD is forecasting the information regularly and appropriately? ▪ Are complete mortality data available from hospitals? ▪ Is an Appropriate alert system used? Enough or not? ▪ Additional weather stations installed (with the detailed samples along with the approx. prices) ▪ Data collected efficiently and centralized?
	Did coordinating partners consider it helpful and follow the guidance?	▪ Views of partners on the coordination activities ▪ Do response actions deliver by the partners during heat season? ▪ Number of the engaged and responsible partners for their assigned roles
	Were the vulnerable communities all around served during heatwave occasions?	▪
	Did the rate of morbidity and mortality reduce this year? Analyze the weather data and health records?	▪ Patterns of the mortality and morbidity rates ▪ Reduction or increment in health impacts during the season

Evaluation Questions		Indicators
Sources of information and communication	Were the sources of information available on heatwave?	▪ Communication with the relevant stakeholders ▪ Number and type of notices issued by the implementing partners
	Were the key notices or bulletins available for the target groups and public	▪ Number and sources of information for a heatwave ▪ Effectiveness of different sources and which one is more efficient source for giving information to vulnerable communities? ▪ The capacity of the media to deliver the appropriate messages for high-risk groups
	Do they understand and follow those key notices?	▪ Any change observed in behavior and awareness ▪ Built the capacity to cope with the heat-illness
Immediate and Long-term strategies	Is heatwave relief and public awareness-related facilities available?	▪ Posters, Brochures for heatwave awareness, electronic and social media, and heatproof shelter available in the area?
	Has the city become more livable for groups and individuals vulnerable to heat events?	▪ A number of policies and practices along with different technologies to improve the condition of the city. ▪ Level of satisfaction of local community and other involved stakeholder with perceived changes
	What kind of practices and measures are taken to reduce the urban heat island effect?	▪ Number of urban planning, technological and policy solutions.
	How heatwave management is integrated with the other kind of policy actions?	▪ To which extent the transportation, climate change and urban development proposal help to reduce the heat impacts?
Costing	What kind of resources are used for the warning and response system?	▪ Costs of the Asset commitments for plan ▪ Staff time spent on various exercises ▪ Cost for climate and health related observations

Proposed Interventions

The following interventions are proposed in order to cater for and minimize the effects of Heatwave in the vulnerable areas of Lahore as identified through remote sensing analysis of climatic factors. Different interventions are provided for different drinking water appurtenances throughout the vulnerable areas of city. Following interventions are thus proposed under this exercise:

4.1. Provision of Sheds

It was observed during the survey that majority of filtration plants of Lahore do not have appropriate seating and shade available for public. These public level utilities play an important part by providing relief to the heat-stricken populace during especially during heatwave hours. Permanent Shed are thus proposed to be provided the scope of which is define as under:

- Provision of Permanent Sheds (Steel Frame – Fiber Glass) at 10 sites each in Data Ganj Baksh Town, Ravi Town, Shalimar Town, Samanabad Town and Gulberg Town with benches

The concept design of this intervention was developed for an ideal site, to visualize the final frame after laying and fabrication of the shed at the site, as shown below;

Figure 42: Concept Drawing of Sheds at Filtration Plants

4.2. Provision of Electric Coolers

Electric Water Coolers are an important drinking water feature that is easy to access and does not occupy much space. This is the reason that these are proposed to be provided at sites with clusters of population and constraint of space like markets, bus terminals and others. 2-Tap Electrical Steel Dispensers are thus proposed to be installed in Lahore with scope of the project containing:

- Provision of Electrical Steel Water Dispensers/Coolers at 25 sites across Lahore.
- Provision of Water Filtration Systems and Plumbing works for these coolers.

4.3. Cooling Stations

Cooling stations are medical relief camps with facilities to provide relief to the heat-stricken public and to cater for any possible medical cases. These features are established at the most vulnerable areas for heatwave, with high influx of population and less water availability. The scope of this project involves the following:

- Establishment of Cooling Stations/Medical Relief Camps at 25 sites across Lahore.
- Provision of temporary shades and fans at these camps.
- Provision of appropriate drinking water and cooling facilities at these camps.
- Provision of Medicines and Para-medical staff at these camps.

Figure 43: Concept of Cooling Stations

Figure 44: Concept of Medical Facility

4.4. Costing

Table 17: Proposed Interventions Cost

Sr.	Proposed Interventions	Scope	Cost (Million)
1	Provision of Permanent Sheds at Filtration Plants in Lahore	▪ Provision of 50 No. Fiber and Steel Frame Shed at Filtration Plants in Lahore ▪ (10 No. Sheds each for Data Gunj Baksh Town, Ravi Town, Shalimar Town, Samanabad Town, Gulberg Town) ▪ Provision of Seating Benches	14.91
2	Provision of 25 No. Electric Water Coolers for Lahore	▪ Provision of 25 No. Water Coolers at 25 Sites ▪ Provision of Filter System for Water Coolers	1.70
3	Establishment of 25 No. Cooling Stations (Relief Camps) for Heatwave relief	▪ Establishment of Heatwave Relief Camps at 25 Locations in Lahore ▪ Provision of Water Coolers, Medicines, Fans, Seating Facility	0.75
4	Establishment of Medical Camps	▪ Provision of portable cabins, tables, beds, chairs, stool and benches	1.578
		Total Amount Rs.	**18.93**
		Add Contingencies Cost (2%)	**0.35**
		Add PST (5%)	**0.87**
		G-Total Amount	**20.15**

Annexure

Annex – A: Stakeholder Consultation Meetings

Stakeholder consultations aimed to identify the intervention of government departments, in-process planning, and future plans pertinent to heatwave preparedness, management, and mitigation in Lahore city. Urban Unit organized consultation meetings with stakeholder departments, including the following:

Provincial Disaster Management Authority (PDMA):

The Environment Team of Urban Unit had a meeting with Director General of PDMA on June 15, 2022. PDMA conducted significant interventions during the heatwave of 2022, which are mentioned below:

- Provision of drinking water in some of the hotspot areas
- Issuance of heatwave advisory in collaboration with Meteorology Department.
- Awareness campaign through social media and television (development of awareness brochures, TV advertisements, emergency number 1129 was communicated through all campaigns).
- Collaboration with the health department to develop separate blocks in hospitals for emergency heat stroke patients.

Incremental housing, unplanned Durban developments, rapid urbanization, and the non-availability of HR, were discussed as major challenges faced by the department. PDMA has developed SOPs for reactive handling of all kinds of emergencies and will be very effective in the implementation of the plan. The meeting resulted in the following agreed recommendations to be included in the heatwave management plan;

- Involvement of Expert in Plan-making process.
- Quantification of the affected population, and food security issues.
- Coordination of different departments to develop a holistic approach.
- A plan aimed at developing preparedness and resilience in the community should be developed.

Water and Sanitation Authority (WASA):

The Environment Team of the Urban Unit had a meeting with XEN Engineering, WASA on June 16, 2022. Various short-term measures were adopted by WASA during heatwave, and medium-term measures have been proposed.

WASA owns 594 Tube wells, and 573 Filtration Plants in Lahore. The maintenance of Filtration Plants has been outsourced to Punjab Aab-e-Pak Authority (PAPA). PAPA has maintained 42 filtration plants from 2021-to 22, in collaboration with Al-Khidmat Foundation and UNICEF. Load-shedding and limitations of funding were the major problems issued by WASA. WASA recommended the development of an effective communication plan to raise community awareness for water conservation.

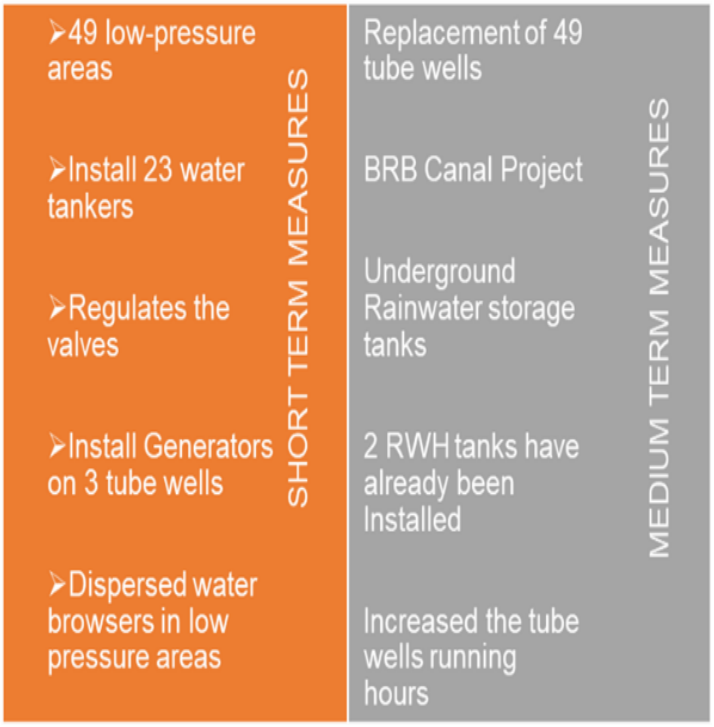
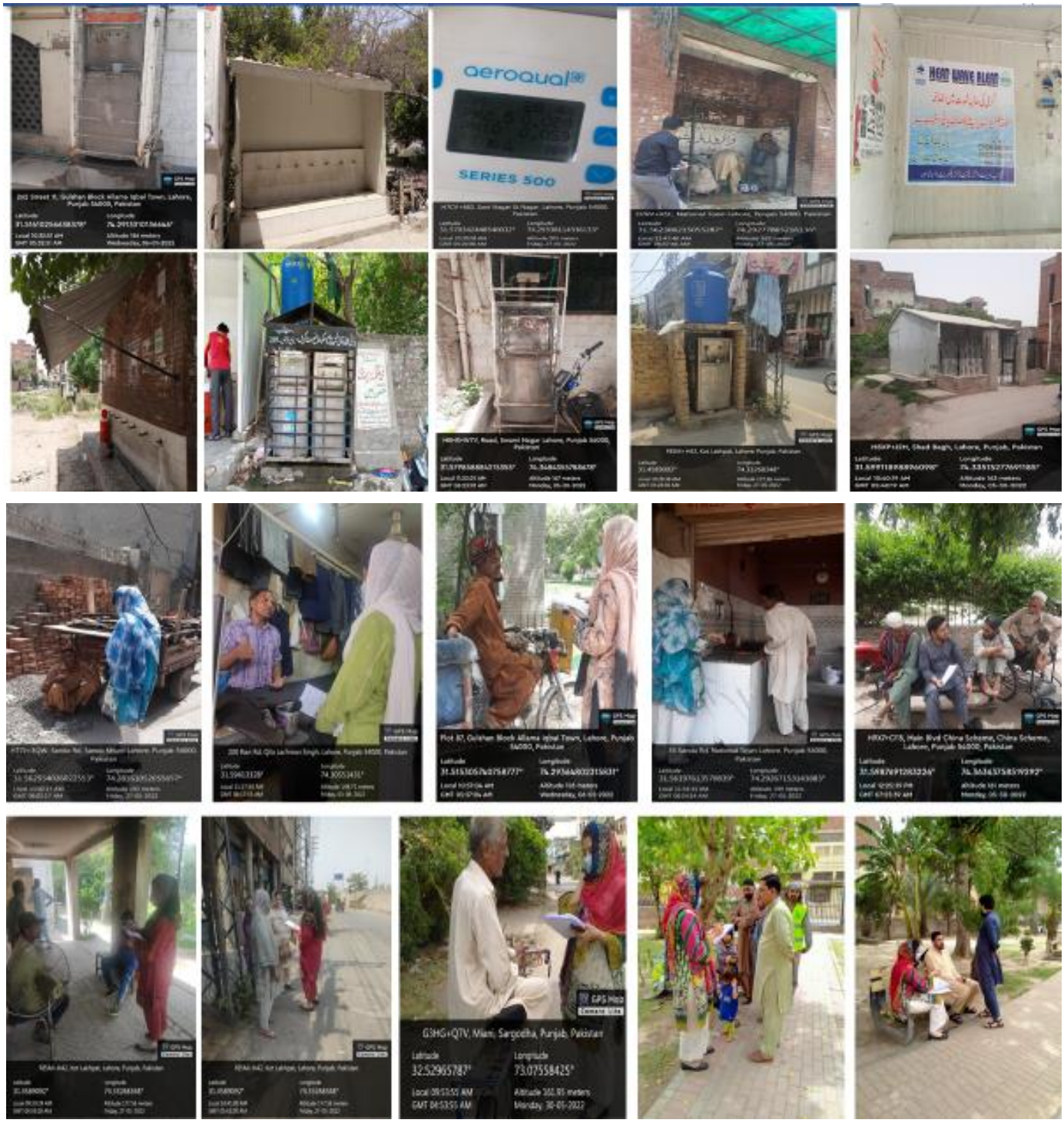


Figure 45: Measures adopted and proposed by WASA

Annex – B: Pictures



Annex – C: Legal Landscape

Climate Change Legislation in Pakistan

Pakistan's climate change action spans over two decades from the first time it ratified the United Nations Framework Convention on Climate Change (UNFCCC) back in 1994 and became an official partner in the international commitment to bring down greenhouse gas (GHG) emissions in the atmosphere. Pakistan actively participated in United Nations Conference on Human Environment and made preservation of Environment in 1973 as constitutional mandate. In 1983, Pakistan achieved another manifestation i.e., establishment of Pakistan Environmental Protection Ordinance in 1983. Under its Umbrella, National Environmental Quality Standards (1984) was prepared. Afterward, the Pakistan Environmental Protection Ordinance, 1983 was superseded by Pakistan Environmental Protection Act (PEPA), 1997, however, this Act doesn't provide any foundation to cater the climate change.

From subsequent endorsements of the goals of Kyoto Protocol 1997 and Paris Agreement 2015 to passing a National Climate Change Policy (NCCP) in 2012, followed by a Framework for Implementation of Climate Change Policy (2014-2030) and most recently, the Climate Change Act of 2017, which after a long wait provided the regulatory framework for Pakistan's climate change strategy, this confused relationship continued to develop sluggishly. However, during the same period, the implications of climate change for Pakistan changed drastically; from being a tiny voluntary partner in the developed world's wake-up to rectify its collective damage to the atmosphere, we are known today as the world's 7th most impacted country by climate change. The tragedy is that despite all of these developments, Pakistan's climate change strategy remains elusive and without any direction.

International Agreements

Pakistan ratified the Kyoto Protocol (KP) in 2004 and the Paris Agreement in 2016, both containing mandatory goals for the signatories. KP mandated industrialized countries to cut down their GHG emissions (during 2008-2012) by 5% below their levels in the 1990s and gave developing countries the option to comply voluntarily. Subsequently and according to the latest and most ambitious commitment under the Paris Agreement of 2015, all member countries are required to implement their nationally determined contributions (NDCs) to reduce GHG emissions and bring down the rise in global temperatures from 2°C to 1.5°C by 2020. This entails introducing new laws catering to climate change or revising existing laws and/or policies to keep pace with the new global commitments, as well as developing a monitoring mechanism to ensure the implementation of the Paris Agreement. In Pakistan, the Climate Change Act of 2017 came as the first primary legislation dealing with climate change and is especially relevant in the context of the above international agreements as it empowers the federal government to make rules to give effect to the international commitments.

Climate Change Act 2017

The 2017 Act establishes the Pakistan Climate Change Council (PCCC) to approve, oversee and monitor the implementation of adaptation and mitigation policies by federal and provincial ministries, divisions, departments and agencies across all sectors of the economy. To complement the PCCC, the Act establishes a separate body called the Pakistan Climate Change Authority (PCCA) tasked with researching, preparing and advising the government regarding legislative, policy and implementation measures related to climate

change. This includes formulating comprehensive adaptation and mitigation policies and measures designed to primarily do the following:

i) address the effects of climate change,

ii) meet Pakistan's obligations under international conventions and agreements relating to climate change, and

iii) give effect to the national climate change policy.

The problem with the Act is that while it establishes federal bodies with the specific task of implementing climate change action, it falls embarrassingly short of introducing effective measures to enable these bodies to make a difference. For example, one of the functions of the PCCA is to formulate and – after the approval of PCCC – coordinate implementation of low carbon and green growth strategies. In the absence of an express reference to set out carbon plans (emissions reduction targets), this may be taken as the closest alternative accounting for it. Assuming that is true, this provision is rendered ineffective as there is no response time given for the adaption of these strategies which allows the government to delay their implementation.

National Climate Change Policy 2012

Over the last 15 years, the most comprehensive approach to climate change has been presented in the National Climate Change Policy, 2012 (NCCP). The objectives of the NCCP include mainstreaming of climate change in all sectors of the economy and minimising of risks associated with foreseeable events of climate change, such as floods and drought. While the NCCP fails to set any clear targets for national measures, it does in other respects set out a decent framework for future action plans and practice. It has been six years since its promulgation, but except for a few measures (such as the Billion Tree Campaign in Khyber Pakhtunkhwa that restored 350,000 hectares of forest land) the federal and provincial governments have remained largely inactive to implement the policy objectives.

Overall, the NCCP is successful in setting forth a road map for identifying the national factors and causes adding to the adversity of climate related problems and offering possible adaptation and mitigation solutions to address them. It makes some key recommendations which if taken seriously can prove extremely consequential to counter climate change.

However, the NCCP itself is a "soft low" and its non-binding nature means that it does not provide efficacious tools/mechanism for enforcement.

Framework for Implementation of Climate Change Policy (2014-2030)

As a follow-up to the NCCP, the government introduced the Framework for Implementation of Climate Change Policy (2014-2030) in order to mainstream climate change concerns into decision-making and promote climate compatible development (an extremely important point that does not appear to have made its way to implementation). Meant to serve as a go-to document for preparing detailed provincial and local adaptation action plans, the Framework discusses adaptation plans for each sector separately and proposes actions along with an implementation timeframe for each action, which is divided into the following categories:

- Priority Actions (PA) : within 2-years;

- Short-term Actions (SA): within 5-years;
- Medium-term Actions (MA): within 10 years; and
- Long-term Actions (LA): within 20-years.

Way Forward

While all of the laws, policies and rules discussed above indicate to an appreciable degree the legislators' intent to counter climate change, we cannot and should not hide from the fact that the combined response has been highly ineffective for the most part.

Climate change is a matter of national security for Pakistan and our law needs to set clear milestones for climate change action and hold the government responsible if it fails to fulfill its obligations. The government needs to come up with a clear plan on how climate change laws, policies, practices will be adapted in the provinces and the provinces need to integrate the government's climate change action plan into their own detailed mitigation and adaptation plans. To ensure effective response, both the federal and provincial governments need to work in collaboration and here the PCCC established under the Climate Change Act of 2017 can play a key role.

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