

Public Alert and Warning System: Are We Doing it Right?

A Case Study of Urban Heat Wave Hazard (Karachi)

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Introduction

Background and Introduction

Changes in a climate result in extreme¹ weather events. Heat wave or an extreme heat event, is an uncommon period of humid and hot and/or dry and hot condition in peak summer season. According to the World Meteorological Organization's (WMO), heatwave occurs in a condition where daily maximum temperature remain high for five or more days and exceeds the maximum temperature by average 5 °C (WMO).

Extreme heat event is an extreme natural weather phenomenon that can fatally harm those who are overexposed to it. Russo et al., 2015 reviewed the ten highest heat wave events across the Europe from 1950 to 2015 and observed that the heat waves are not only killer of living things including human-beings, plants and animals but also paralyze the civic life and have far-reaching impacts on the livelihood and socio-economic activities. For overly exposed and vulnerable people, even non-extreme weather events can have extreme impacts (Russo et al., 2015).

The risk of heat hazard is, however, greater in urban areas. City residents are at particular risk of adverse effects of elevated temperatures occurring and the phenomenon is called as the “Urban Heat Island Effect (UHI)”². This occurs because of congested houses, and the lack of greenery and trees. Additionally, in low-income countries or communities, cities are, sources of poverty, inequality, and several health hazards that increases their vulnerability.

¹ **Extreme weather** is an unexpected, unpredictable, unusual, [severe weather: occurring at the extremes of the historical distribution—the range that has been seen in the past. \(Intergovernmental panel on climate change, 2007\)](#)

² **Urban Heat Island (UHI) hazard:** an urban phenomenon where excessive heat poses an environmental and occupational hazard for human health.

Figure : Map of Pakistan (Sindh).



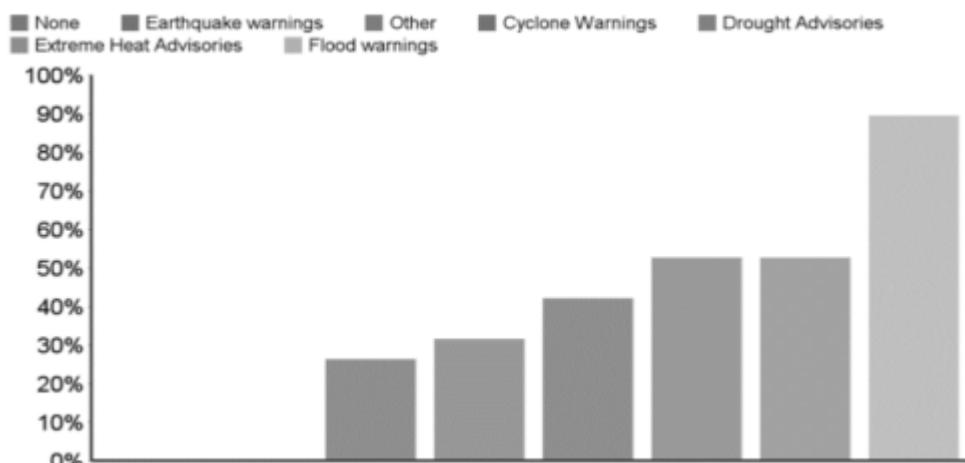
Both natural as well as human-induced disasters pose greater risks specifically for Sindh province. Flood is a major recurrent disaster which hits the province every year. Droughts and cyclones in the coastal districts are due to sea intrusion every year. Heat waves have frequented over the past decade and are an emerging challenge for disaster management and risk reduction public services.

The primary function of disaster and risk communication is to protect lives and build resilience in the community for future disasters. In particular, disaster warnings entail communications of risks that have an ability to critically help receivers limit or mitigate harm in impending disasters (Sell now & Seeger, 2013).

Global governance actors have issued guidelines for warnings as a risk-reduction policy initiative to be enacted at the national and provincial levels. All over the globe, developing an early heat warning system, with an emphasis on alerting the most vulnerable population, is among the most recommended measures taken to prevent the negative impact of increasing extreme heat associated with climate change. Public alerts and heat warnings are triggered at the city level as a function of emergency management by meteorological agencies to alert the public and facilitate public health response to heat emergencies.

The adaptation response and following monitoring and research needs for early warnings are now being acknowledged visualizing the cross-scale nature of climate. Governments are continually implementing innovations in building capacities towards critical risk reduction. However, this transformation differs greatly among regions, and is lesser in less-resourced areas. The result is uneven disaster landscape that is leading to unnecessary and significant losses of life. The need to establish a viable public alert system for reducing the damage and loss due to extreme heat events in Karachi and other urban centers of Sindh is well placed in earlier research (Shaikh, 2016) (see Table).

Table : Distribution of disaster warning need assessment in Sindh Province³



Research Scope

Aim/Objective

Taking the case of heat wave disaster of 2015 in Karachi, this research aims to analyze:

- a) Key factors that turned the heat hazard into a deadly heat wave disaster.
- b) Communicative practices of heat wave warnings that can play an important role in reducing the risks to lives in a disaster.

Statement of a Problem

In the developed world, cities are made of built-up environment and are a source of economic growth and development. Therefore, urban regions often have adequate resources to communicate and manage heat hazards to save lives and prepare city dwellers, as the disaster management agencies use several available communication mediums.

In low-income countries, cities are, however, sources of poverty, inequality, and several health hazards from the environment,⁴ a fact that increases the vulnerability of city populations even more. Karachi is an urban center that typically exhibits a case of interest in this regard.

In hot summers the Karachi metropolis is frequently gripped by a heatwave with temperatures soaring to 42°C-48°C. The heat wave in Summer 2015 in the populous city of 20 million residents in Karachi, the fatal scenario took 2,000⁵ lives of poor,

³ Shaikh, M., 2016. Evaluating the Uses and Adoption of Media Innovations in Disaster Warnings.

⁴ Bull World Health Organization, vol.78 n.9 Geneva Jan. 2000

⁵ <https://www.bloomberg.com/news/articles/2015-06-24/heat-wave-death-toll-rises-to-2-000-in-pakistan-s-financial-hub>

In hot summers the Karachi metropolis is frequently gripped by a heatwave with temperatures soaring to 42°C-48°C. The heat wave in Summer 2015 in the populous city of 20 million residents in Karachi, the fatal scenario took 2,000 lives of poor, elderly, lower wage laborers, and residents who were living in inner city dwellings. People, including the authorities, were caught in surprise by the fatal impact of the heatwave. Concerned agencies were criticized for failing to forecast the tragedy or issue timely warnings.⁶ Lack of education, and inadequate access to information diminished their chances of being warned effectively. Incapability of responsible agencies to establish warning systems exacerbate the situation and result in substantial increase in damage.

Research Question/Hypothesis

Following research questions are posed:

***RQ:** What are the contributing factors that resulted in failure to timely and effective dissemination of heat warnings in summer 2015?*

***RQ:** Whether the current policies, plans, and practices are adequate to prepare at-risk community?*

***RQ:** What can be done for effective public service delivery of heat warnings as a risk-reduction measure in a case under study?*

Link with Public Policy Debate

Sound policy on improving community access to timely warnings (ISDR, 2005) is fundamental to improving institutional practices. Establishment of Early Warning Systems (EWS) has become a global priority element of the International Strategy for Disaster Reduction (ISDR). In the Third International Conference on Early Warning (EWC III, 2006), all the signatories were urged to institutionalize warning mechanisms at national, regional, and international levels.

Pakistan is one of the signatories to the *UN Hyogo Framework for Action (HFA)*⁷ 2005-2015: “*Building the Resilience of Nations and Communities to Disasters*”. National Disaster Risk Reduction (DRR) Policy is an effort to establish multi-tier Disaster Risk Management (DRM) planning in conjunction with the requirements and provisions of the HFA.

⁶ Why did so many dies in Karachi's heatwave? BBC news. retrieved from <https://www.bbc.com/news/world-asia-33358705>

⁷ <https://www.unisdr.org/we/coordinate/hfa>

A multi-hazard early warning system plan (MHEWS, 2012) is a comprehensive plan under the national disaster risk-reduction plan (NDMP, 2012).⁸

After the tragedy of 2015 of heat hazard, several specific policy initiatives were taken proposing establishment of early warning system for heat waves. Karachi Heatwave Management Plan was prepared as a guide to planning and response⁹ where dissemination of heat warnings was key to preparedness.

Boundaries of Research/Scope

The scope of this study is a case of public alerts and heat wave warnings for heat hazard in Karachi city that represents a time scale of higher temperature and heat index that was experienced during the heatwave event of Karachi, in 2015.

Limitations of the Study

This study does not include other urban centers of the country due to resource and time limitation. The sample data will be limited and will represent only case under study. However theoretical and practical implications for policy formulation can be made for similar contexts. The research will assess operational; policy and user implications for establishing heat wave warning systems. A comparative policy analysis will be done using document and policy analysis approach. Analytical data will be presented in both graphical and descriptive format.

Literature Review

The relevant literature was reviewed, and its findings are systematically organized to present three key concepts:

Warnings as a Public Service

Lindell & Perry (2004) described warnings as risk communication efforts addressing an imminent/impending threat or any hazard that may turn into a disaster if timely actions are not taken. This is distinct from the other forms of risk communication that have long term objectives.

Issuance of timely and effective warnings is a public service akin to the Government. The preventive communicative practices in situations of hazards can reduce associated risks and save countless lives.

⁸ <http://www.ndma.gov.pk/plans.php>

⁹ <http://www.lead.org.pk/attachments/HeatwaveManagementPlan.pdf>

The earliest research on warnings (Anderson, 1969) insisted that hazard warning is the responsibility of local officials and is a public service (Sorenson, 2000). The findings from cross-national research (Samarajiva, 2005) suggest that the effective warning dissemination and public safety is closely linked to governance issues. Disaster warnings as a public service can be defined as the routines, behaviors, and ways of working of public service officials in public service agencies assigned to communicate critical safety information and updates in times of disasters. Citizens whose lives may be affected by critical emergencies arising from disasters expect public agencies to ensure their safety (Boin & Hart, 2003). In the scope of a national government's responsibilities, emergency and disaster management draws on science, technology, planning, and management (Drabek & Hoetmer, 1991). Management communicates with the public at preparedness stage to limit or mitigate harm from the onset of a disaster (Wogalter, DeJoy, & Laughery, 2005). Disaster warnings involve the effective and timely provision of critical information to people when a disaster may occur (McEntire & Myers, 2004), how severe it may be, and what protective actions are required to reduce its impacts.

Warnings are considered to be safety communication in situations (Wogalter, 2006). therefore, considered as a critical, urgent, and protective communicative action on the part of governments to reduce the impact from potential disasters. These are also called pre-impact communication.

The implementation of heat/ health early warning systems (H/HEWS) is therefore also a responsibility of a government. Heat warnings contain information on how to stay safe when extreme heat threatens.¹⁰ Previous studies are of view that implementation of heat/ health early warning systems (H/HEWS) serves to save lives (Kalkstein, Sheridan et al. 2009). Such systems necessitate close coordination among scientific agencies, disaster management agencies, and the general public at risk.

Inequalities in Disaster Landscape

Inequality in disaster preparedness has been given attention in the disaster literature (Collins). Sorenson (2000) said that 'uneven preparedness' (p.122) across communities is one of the reasons for an uneven level of protection for the people (Sorenson, 2000). Impacts of a gradual shift in climatic pattern are adversely felt by resource lacking populations through increase in the magnitude and distribution of the extreme weather events (IPCC, 2012).

¹⁰ <https://www.ready.gov/heat>

Studies (Brewer, Demmer et al., 2005) suggest that different urban heat islands display different characteristics, developing their own microclimates in some parts, thus should be managed in their specific contexts (Koppe, Sari Kovats et al. 2004). Studies of heat waves have shown that sick and poor people living in the poorly ventilated areas form a majority of the victims of a heat wave (Semenza et al., 1996).

One study (Pulwarty & Siwakumar, 2014) is of view that changing climate require that there is ongoing need to take on the “capacity” and “coordination” aspect at national, provincial, and local levels. Samarajiva (2005) argues that the absence of proper institutional structures is the major impediment.”

Approaches to Establishing Heat Wave Warning System (HEWS)

Most communities try to manage heat wave risk through crisis- driven and reactive approaches (WMO, 2006; UNISDR, 2011). General Circulation Models (GCMs) are being used to provide accurate predictions of impending climate anomalies for increasingly useful forecasts of the occurrence, severity and extension of heat spell for expansive geographic regions on monthly and seasonal timescales (Dai, 2010). Improvements in social variables i.e. high living standards, spacious residential areas, increased no of open green spaces in the city, expanded air conditioning use along with improvements in non-structural social variables i.e. increased numbers of heat wave early warning systems' effective implementation are attributed to reduce heat wave event's mortality rate.

Hanif (2017) observed that during 2015 heat wave event of Karachi, though the high temperature is said to be the main culprit of extreme heat wave, other factors, included the unplanned urbanization, inadequacy of open and green spaces, lack of heat early warning systems and awareness, along with polluted transportation system were the reasons behind the Heat Island Effect (Hanif, 2017). It is asserted that fewer people lost lives after the establishment of heat warning systems.

Research Methodology

Research Method (s)

This study employs a case study design (Yin, 2003) to address the research question. To bring useful insights for future improvement besides knowledge development (Mark, Henry, and Jules, 2000), this study uses a sequential mixed method design, that combines both qualitative and quantitative methods of data collection and analysis. Initial findings were analyzed and integrated for holistic presentation of results.

The main rationale for using a mixed-method design is to discover the fresh perspectives through the various methods of data analysis (Rossman and Wilson, 1985). The significance of using a method with initiation intent increases the ability to cover a broad range of data while maximizing the possibility of unlikely findings. The inevitable organizational, political, contextual, and professional challenges of an analysis of policies, plans and practices in a specific context of warning system mandate the use of multiple tools in a research design.

Data Source

The sequential mixed method sampling design involves two phases of data sources. The first phase involves the purposeful sampling of policy initiatives, legal frameworks, and practices of management and decision-makers. Secondary data resources are employed in a first phase using document analysis. The next phase (e.g., structured phase) involves the stratified purposeful sampling of community at risk using survey questionnaire and interview method as primary sources of data collection.

First Phase of Data Collection

Document Analysis- Secondary Data Resources

Document analysis is a “systematic procedure for reviewing reports and official papers– both printed and electronic material (Bowen, 2009). It entails the study of relevant journals, newspapers, government documents, books, memorandums, policy papers, progress and action reports and other written documents. Fitzpatrick., Sanders, & Worthen (2012) provide three reasons why it should be the first method of data collection: cost effectiveness, non-reactiveness, and utilization (Fitzpatrick., Sanders, & Worthen, 2012). Policy agendas, reviews, reports, progress and actions reports from the national and international agencies, as well as other institutional and web-based resources are easily accessible. Most are in electronic format or can be easily scanned, making them cost effective (Fitzpatrick, Sanders, and Worthen, 2012). Document analysis provides basic information about the structure and functioning of an organization (Lindlof and Taylor, 2002). Secondary Data was collected from previous research data, policy and planning documents, news reports, technical evaluation reports, and official data present in the public domain. Official literature (government, quasi-governmental documents, and non-profit agencies) were the main documents under review.

Second Phase of Data Collection-Primary data sources

Semi-Structured Interviews

Document analysis alone cannot enable the researcher to gain sufficient insight into the perspective, attitudes, behaviors, and experiences of others (Fitzpatrick, Sanders, & Worthen). The second step to collecting empirical material involved interviewing key participants in decision-making and policy level activities in the source organizations. “Interviews are considered as key to a qualitative data collection” (Fitzpatrick, Sanders, & Worthen, 2012, p.347). Stake (1995, p.64) remarks that an interview is “the main road to multiple realities,” that individuals bring to the subject, issue or experience. Semi structured Interviews were conducted in this study from policy as well as management professionals of Disaster Management authority and Meteorological department operating in the area.

Survey Questionnaire

After collecting policy level data from key participants and documents, the evaluation proceeded to the fixed/structured data collection to obtain ground level data from local settings and participants. The sample and data collection instruments were constructed after initial qualitative data collection and analysis. The study utilized stratified purposeful sampling. Stratified purposeful sampling is defined as a sampling frame that is divided into strata with a purposeful sample (Onwuegbuzie & Collins, 2007). This primary data was collected using structured survey method from at-risk population i.e., low-income community of Karachi.

Overall sampling scheme is depicted below:

Table. Overall Sampling Scheme

Data collection Method	Sampling strategy	Sampling Size	Data Category
Document Analysis	Purposeful	12-15 policy and planning documents/ official websites/ Research Reports	Secondary Data
Interviews	Purposeful	5 Managers at disaster management and meteorological agencies	Primary Data
Survey Questionnaire	Stratified Purposeful	80 community at -risk participants from low -income areas of urban settlements in Karachi	Primary Data

Findings & Discussions

Every disaster emerges with a hazard (Thywissen, 2006; Lindell & Perry, 2004). Hazards are threatening events, which have high likelihood of an extreme event occurring (Lindell & Ronald, 2007).

Because of their rapid onset potential, some hazards pose an impending threat of disasters with significant casualties and property damage unless timely action is taken (Storsul & Krumsvik, 2013). These hazards create an immediate need of communication of information, guidance, and action plans in the fight for survival (Seeger et al., 2003). All over the world heat wave hazard turned into a deadly disaster especially in low income urban centers. In the heat waves of 1972, occurred in the city of New York and parts of Northeastern part of United States, almost 900 people were fatally impacted; the heat wave went on for 16 days, that was aggravated by very high humidity levels. Around 1000 people died in 1990 heatwave in central and eastern United States. In 1995 Chicago heat wave, in lower income areas of Chicago and other Midwestern cities, caused 778 deaths. 1988 - intense heat spells across the United States caused some 5,000 to 10,000 deaths. The European heat wave (2003) affected western Europe left nearly 15,000 people dead.

In the year 2015, soaring temperatures were observed globally. During April-May 2015, heat wave also occurred in India, that killed around 2200 people in varied geographical regions. Daytime temperatures were between 45-47 °C (113–116 °F) in parts of two states over the weekend. The city of Andhra Pradesh was the most affected area, with 1,636 people died from the heat since mid-April. During the same time, 561 people died in Telangana.¹¹ In August 2015, a heat wave also had affected much of the Middle East that caused almost a hundred deaths in Egypt. In the same wave, starting 20–21 June 2015, severe heat wave resulted in the death of more than 2500 people in Karachi, Pakistan.”¹²

This study gathered the data on extreme heat wave events in Karachi in general and 2015 tragedy in particular and reports the findings and a discussion on the results in three separate sections. First section will present the details of case under study i.e., Karachi; its weather patterns, and vulnerability to heat hazard. Second section will present the disaster management- legal and an institutional framework in place to facilitate the establishment of a heat warning system. This section will also present a policy and management perspective in this regard. Third section will detail the community at-risk in an urban setting of Karachi and will present their perspective.”

¹¹ Iyengar, Rishi (22 June 2015). "A Heat Wave in Pakistan Has Killed Around 140 People". Time

¹² "Rain brings little relief to southern India as heatwave death toll nears 2,200". The Guardian.

Section-1

Quantum of Heat Wave Disaster & Damage in Karachi

Thermal Disaster Profile of Karachi

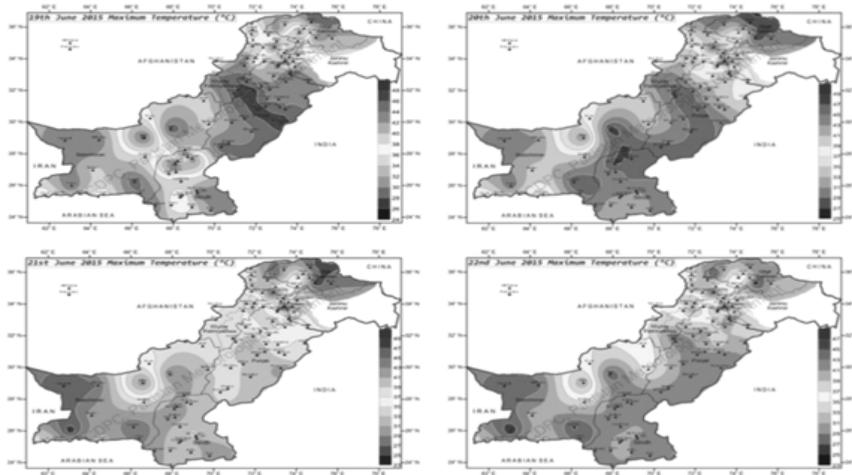
In Pakistan, summer season persists from April to September and heat-wave events commence from month of May and extend up to September. The probability of the occurrence of the heat waves is higher in monsoon shadow zones (where monsoon rains seldom reach) as compared to monsoonal areas. Seasonal heat index profile of the whole of the Pakistan reveals that during the last few decades apparent annual temperature has increased significantly. The heat index value of Pakistan is offspring of this rising trend.

The city of Karachi is most populous city of Pakistan, it ranks 7th most populous city of the world. The city is home to 14.91 million population and its population grew with the rate of 59.65 percent since 1998 to 2017 (Pakistan Bureau of Statistics, 2017). Usually in summer season, Karachi displays high and/or occasionally high temperature during daytime. The gigantic city's higher temperature data profile for the month of May and June reveals very high maximum temperature on May 09, 1938 i.e. 47.8 oC and 47 oC on June 18, 1979. For the period of 1961-2007, in Pakistan, the overall change in humidity is 6.2 percent (Zahid & Rasul, 2010). Rapid urbanization along with impact of global warming has triggered the UHI effect in Karachi. The effect of UHI is the exclusive characteristics of the 2015 heat wave of Karachi. Around the globe, including Karachi, UHI has posed a big threat to the low-income majority of mega cities population due to increasing level of global warming coupled with other vulnerabilities (Khan and Omer, 2008)".

Heat Disaster 2015

The heat index is considered to be a good tool to measure the effects of heat wave on people in a distinct region by enveloping the aggregate impact of temperature, wind rate and direction, air pressure and humidity. On Karachi's heat index scale during 2015 heat wave event, the maximum temperature was around 44.8°C. On the peak heat wave day of 20 June, the heat index reached as high as 66°C due to reduced wind speed and air pressure along with soaring humidity. The hardships were further exaggerated when power supply system of Karachi metropolitan could not sustain the increased load and ultimately water supply was also suspended in poor and congested areas without electricity. A weeklong extreme heat wave (from June 17 to June 24 June) caused death of 1200 human lives leaving thousands impaired by heat stress.

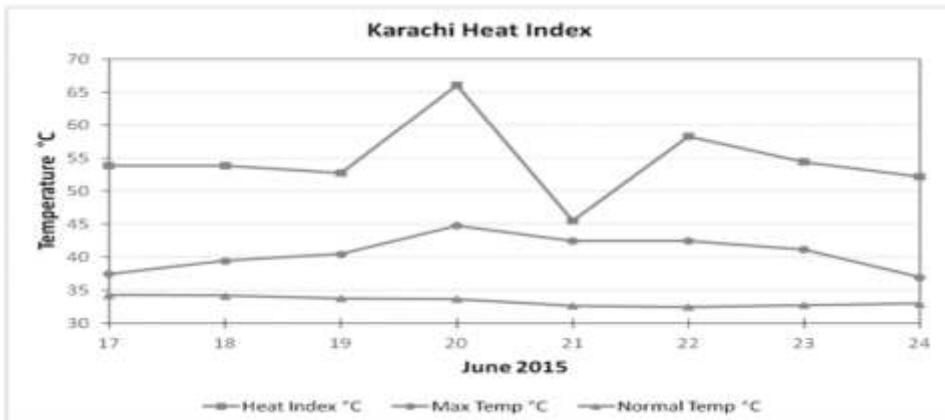
The victims were mostly elderly people (>50 years age) especially laborers followed by the children and women. The major causes of deaths identified by various health units were heat cramps, heat exhaustion, heatstroke and de-hydration” (Chaudhry, et al., 2015). That heat wave occurred when the holy month of Ramadan was ongoing.



Source: Various Issues of Pakistan Meteorological Department

Figure 2 : Maximum temperature in Pakistan on June 19-22, 2015.

Figure above indicates the flight of maximum temperature from its average range of 5.3 oC - 11oC in the time of sever heat wave. On June 20, 2015, the highest maximum temperature of Karachi recorded as 44.8 oC with a flight of 11.1 oC. It is a generally accepted opinion of managers, scholars, and community of Karachi that the severity and persistence of Karachi heat wave in June 2015 was a rare occurrence (Hanif, 2017). After 2000, it was highest recorded temperature for the month of June. In terms of constancy, the heat wave was unprecedented.



Source: Various Issues of Pakistan Meteorological Department

Figure 3 : Karachi Heat-wave Temperature and Index Time Series 2015

The figure represents maximum temperature time series along with index of heat indicating that temperature remained more than 50oC on average during the entire period of heat wave. On June 19 and June 23, these conditions became particular grave, as level of peak heat was intolerable. The highest maximum temperature on these days found mostly more than 45 o C that persisted more than one to two days.

It is estimated that for a city having one million or more population size could have average yearly 1 to 3 °C hotter air temperature than its neighborhoods. This difference can reach to its high limit as 12°C in the evenings. The UHI induce inhabitants to increase energy demand for cooling of their homes, workplaces, shopping areas, and indoor activities centers etc. Which, in turn, give rise to Green House Gas Emission and air pollution. Moreover, public and private health expenditure increases due to heat related morbidity and mortality.

Figure 4 : Loss of Lives during Heat Wave Karachi 2015

Table 1: Number of Deaths caused by heat wave in different hospitals in Karachi 17-24 June 2015

S. No.	Name of Hospital	Male	Female	Total
1	Jinnah Hospital	341	133	474
2	Abbasi Shaheed Hospital	253	78	331
3	Civil Hospital	194	82	276
4	Cardiology Hospital	110	21	131
5	Qatar Hospital	42	17	59
6	Metropolitan Hospital	57	14	71
7	Korangi Hospital	39	18	57
8	Lyari Hospital	35	16	51
Total				1350

More than 80,000 people were affected by the heat wave and brought to the nearby hospitals for treatment or first aid. The survival ratio was quite low for those victims who suffered severe stroke and could not get proper treatment within 24 hours and brought to the hospital in critical condition. Most of them were from densely populated localities of Karachi where people live in high-rise building, low-cost houses, one to two bed accommodations with poor ventilation. From defense Housing comparatively a rich neighborhood, no resident's causality was reported. Most labors were brought to the hospital. All of them were fasting and digging the ground for cabling to earn their livelihood.

In Muslim communities, most of the adult males and females fast from dawn to dusk without water and food. Elders are religiously stricter and do not give up the fasting practices despite their health status. Most of the male elders became victims of heat stress, heat strokes and dehydration which led them to final fate. In most of the cases, the family heads and bread earners lost their lives as they could not stop working under the harsh weather conditions due to economic compulsions. Thousands of the poor survivors went through long medical treatment for rehabilitation costing heavily on their pockets and could not go for work to earn the livelihood despite dependence on day-to-day earnings.

Section-2

Policy, Legal, and institutional Framework for Heat Warnings

“Where there are no warnings, or the warnings are not linked to pre-provided planning the results are tragic” (Vessey & Aponte, 1989, p.13).

The Yokohama Strategy for a Safer World was adopted in 1994. It provides landmark guidance on reducing disaster risk and the impacts of disasters and to”:

“Develop early warning systems that are people centered, in particular systems whose warnings are timely and understandable to those at risk, which take into account the demographic, gender, cultural and livelihood characteristics of the target audiences, including guidance on how to act upon warnings, and that support effective operations by disaster managers and other decision makers(Yokohama Strategy, 1994) ””¹³

Although, National Disaster Management Framework (NDMF) in Pakistan was developed in 2005 and ensured developing heat warning systems. However, there is no mention of heat wave in annual performance reports of NDMA until 2015 Karachi tragedy. Annual report (NDMA, 2015)¹⁴ mentions heat wave in Karachi (23-26 June 2015) as one of a disaster managed by NDMA. In 2016, In order to make aware the general public about heat wave and floods, Public Service Messages of NDMA were aired during Monsoon at PTV, Radio Pakistan and some commercial channels. Besides TV and Radio Programs were recorded on heat wave, flood, earthquake, drought, fire safety and at-risk communities in disasters. . Two programs of heat wave and floods were aired on PTV News in June / July 2016 while remaining programs were aired during July / August 2016.

¹³ http://www.pdma.gos.pk/new/resources/Hyogo_Framework.pdf

¹⁴ <http://www.ndma.gov.pk/publications/AR2015.pdf>

It did not however state any factual data on deaths and damages due to the event nor it managed the ways and means of response done in that regard.”

Annual report (NDMA, 2017) informed of issuing heat alerts using SMS technology in Punjab:

“NDMA, PMD and PDMA closely monitored/assessed changing weather pattern for possibility of heat waves during Pre-Monsoon period. Some of the indicators projected possibility of heat wave in Karachi and Southern Punjab. To ward off potential heat waves hazards, NDMA in close collaboration with PTA, PDMA Punjab and Cellular Mobile Companies issued SMS Alerts in Bhakkar, Layyah, Dera Ghazi Khan, Rajanpur, Rahim Yar Khan, Bahawalpur and Muzaffargarh districts. These mitigation measures timely sensitized the vulnerable population. No heat wave casualties were reported during the period (NDMA, 2017)”.¹⁵

NDMA initiated in coordination with Lead Pakistan a “Heat Wave Management Plan” for District Karachi on 8 July 2017. The detailed plan covering technical aspects of heatwave in Karachi was shared with all stakeholders including civil administration Karachi. In addition, NDMA prepared Heat wave Campaign for print media and on-air on gratis basis through PEMRA and Ministry of Information, Broadcasting & National Heritage on leading channels about heat wave.

Figure 5 : NDMA initiatives on Heat Wave alerts



¹⁵ <http://www.ndma.gov.pk/publications/NDMA%20Annual%20Report%202017.pdf>

Six monthly report (Jan-June 2018) on NDMA performance mentioned heat wave in Sindh-May 2018 as a disaster being managed through warnings and alerts:

“The meteorological department had issued heatwave alerts for Sindh. The weather in Karachi and surrounding areas became so hot unprecedentedly. NDMA as a response collaborated with HANDS and offered provincial disaster agency Sindh for assistance in establishing 30x Heat Stroke Centres and also launched awareness campaign in Karachi (Malir, Surjani Town & Korangi)”.¹⁶

Annual report 2018 (NDMA)¹⁷ also mentioned the 17th May heat wave occurrence in similar fashion. It did not mention the intensity of heat or the impact therein.

Sindh Disaster Risk Management (DRM) plan for Sindh Province was devised in 2008. This plan envisaged the objective of establishing Provincial Disaster Management Authority (PDMA) in Sindh province. Developing a *resilient Sindh*¹⁸ is termed as a vision of the agency. Later, PDMA Sindh also developed a Multi-hazard contingency plan¹⁹ in 2013. This plan acknowledged that in the last three years, global climate change has resulted in increased temperatures including higher intensity that effect crops, human and animal life. This plan did mention extreme temperatures as one of a disaster. There are separate district-based plans also developed for district level need assessment. Besides, a practitioners' guidebook is developed on Disaster Risk Reduction (DRR) in local development process at district level²⁰ in 2017.

DRM, multi-hazard contingency plans, district-based plans, as well as other plans mentioned above, only outlined planning assumptions for major hazards, vulnerabilities, and disasters in Sindh region did not mention heat wave or urban heat phenomenon for urban centers as a hazard. Recently however, the Sindh Resilience project (SRP) with funding from World Bank has been initiated and it includes heat wave as a key hazard for Sindh.

On 23 April 2019, PDMA published a request for quotations (RFQ) for printing of a heat wave awareness material under SRP. PDMA has now placed guidelines²¹ in extreme heat conditions (English language) for public at risk; and for provincial departments²² outlining different responsibilities.

¹⁶ [http://www.ndma.gov.pk/publications/Final%20-%20NDMA's%20Six%20Monthly%20Report%20\(Jan%20-%20Jun2018\).pdf](http://www.ndma.gov.pk/publications/Final%20-%20NDMA's%20Six%20Monthly%20Report%20(Jan%20-%20Jun2018).pdf)

¹⁷ <http://www.ndma.gov.pk/publications/Annual%20Report%202018.pdf>

¹⁸ <http://www.pdma.gos.pk/new/preparedness/SINDH-BOOK-22-04-09.pdf>

¹⁹ <http://pdma.gos.pk/new/resources/downloads/MHCP2013part2.pdf>

²⁰ <http://pdma.gos.pk/new/resources/Malteser/guidebookmainstreamingenglish.pdf>

²¹ <http://www.pdma.gos.pk/new/Preparedness/Extreme%20Heat%20guidlines.php>

²² <http://www.pdma.gos.pk/new/Preparedness/General%20guidelines.php>

The responsibility of issuing public alerts is on Pakistan meteorology department. The following threshold is given to inform of the intensity of a situation.

Figure 6: Heat Wave Alert Threshold (Source PDMA Website)

RED ALERT	Extreame Heat Alert Day
ORANGE ALERT	Heat Alert Day
Yellow ALERT	Hot Day

Management Perspective for Heat Warnings

This study conducted one-on-one semi-structured interviews. The interviewees from scientific agencies reported that disasters that led to warning system improvements were tropical cyclones (1999) and floods (1992-2010) and heat wave incident (2015).

“After the disaster of the tropical cyclone in 1999 the relevant agencies tried to improve the warning communication system” (Interviewee -Federal-Executive-Scientific Agency-1).

“The real time updating of warnings on the website was started after lessons learnt from the super floods of 2010” (Interviewee-Federal-Executive-Scientific Agency-1)

“There is a marked improvement in a dissemination system. I will quote, super floods 1992, floods of 2012 and tropical cyclone Jasmine. We learnt major lessons from such disaster experiences and realized the dire need to increase our monitoring and communication capacity to achieve last mile information dissemination” (Interviewee—Provincial-Operations-Scientific-1)

“Only after the recent extreme heat disaster in metropolitan Karachi, PMD realized that denser monitoring networks in big cities are required to check urban disasters” (Interviewee -Federal-Executive-Scientific Agency-2).

Major disasters that led to improved procedural and operational practices included an earthquake (2005), floods (2010-11), a cloud burst (2011), cyclones (1992), drought (2010), and sea splash back. After the earthquake of 2005, federal agencies realized the need to systematically assess the risks and develop plans for risk reduction. The interviewees acknowledged that with each disaster, the existing system is improved.

“Before the extreme heat disaster in Karachi happened, we didn't use impact analysis or trends for reporting a heat index, but we learnt a lesson from this and are now giving a heat index” (Interviewee -Provincial-Manager-Scientific Agency-2).

“After the earthquake disaster of 2005, we realized the need to have resource mapping and vulnerability assessment as vital and thus directories were developed to identify resources and needs in disaster-prone areas” (Interviewee-Federal-Operations-Disaster Management-2).

“Floods 2010 Cloud Burst 2011 and followed up emergency, monsoon 2012, 13 and then 2014, then drought in Tharparkar district, disasters are occurring year after year and in response, things are improving slowly and gradually” (Interviewee - Provincial-operations- 2).

One official commented that protocols and standard procedures are routinely developed or improved after each disaster. These information protocols are known as Standard Operating Procedures (SOPs).

“We worked after the heat hazard evaluating the population that was hit the worst and built standard operating procedure (SOPs) for any future event” (Interviewee - Provincial-operations- 4).

One official commented that protocols and standard procedures are routinely developed or improved after each disaster. These information protocols are known as Standard Operating Procedures (SOPs).

“In Sindh, in past years, besides floods, cyclones, droughts threat of sea splash back and recent heat hazard have been realized as emerging risks which are needed to be improved” (Interviewee-Provincial-Executive- 2).

The extreme heat hazard is one example that highlighted the need to focus on urban disasters. Both scientific and management agencies derived lessons out of it that were not realized before.

“For PMD, this event was unprecedented the trend of this combination of high temperature and low humidity was never seen before in last three years” (Interviewee - Federal-Executive-Scientific-2).

“Heat hazard is a new phenomenon that was not understood properly. We learnt a lesson; we were providing day to day weather but not doing trend or impact analysis and giving information on the phenomenon of heat index which is important parameter of heat situation” (Interviewee -Provincial-Manager-Scientific Agency-3).

Policy recommendations and ideas for improvements are generated during coordination efforts between agencies. For example, the preparedness planning for heat hazards is an initiative that was taken as a result of regular meetings of relevant agencies.

“A fact-finding Committee was deputed to develop policy recommendations for heat hazard in summer 2015, coordinating with membership from MET office, Health Department, Provincial/National Disaster Management Authorities” (Interviewee - Federal-Executive-Scientific Agency-2).

“NDMA and PMD also send us alerts and to all the government officials, so at least the warning information reaches the senior management quite efficiently. Our next task is to carry it forward to those at risk” (Interviewee -Executive-Executive-1).

“SMS were sent to local authorities and agencies but not to public due to technical limitations, agencies were however informed through SMS in order to ensure the uninterrupted supply of electricity in order to minimize the heat stress” (Interviewee-Executive-Provincial-Management-1).

According to the participants, current policies have not anticipated emerging risks (such as urban disasters) and corresponding vulnerabilities of specific regions. Since national policies were developed at the federal level, contextual nuances of each province were not fully considered:

“We have a good DRM plan and a DRR Policy, what we are lacking is proper implementation plan and relevant projects” (Interviewee-Federal-Executive-Scientific Agency-1).

“Our policies and plans have not covered the disasters, or the technologies needed to be on over all geographical spread. Take the example of heat hazard. Federal Government developed the national disaster framework after spending billions of rupees on analysis; it included only one paragraph that said heat wave could affect production and livestock. If they had evaluated a little better, they would have anticipated the casualties in recent heat wave in Karachi city where casualties were all human” (Interviewee - Provincial-Manager-Scientific Agency-5).

Moreover, in the context of Karachi, local awareness and understanding of the population towards the risks posed to them is another challenge. This largely has happened in the case of cyclones and recent heat hazards. These disasters are rare, and the general public was not aware of the consequences. The warnings were therefore not received adequately. Illiteracy, poor living conditions, and ignorance are a few reasons which add to the public's inability to respond to warnings effectively.

“Despite the weather warnings 1-2 earlier, for extreme temperatures in summer heat hazard disaster, people did not guess the health hazard and 1000 or more lost their lives” (Interviewee -Federal-Executive-Scientific Agency-2).

“People here also have social issues and religious convictions. For example, this heat hazard occurred in the month of Ramadan (fasting). Despite being dehydrated, over exposed to heat, they did not break the fast and continued the suffering, hence aggravated the trauma” (Interviewee -Provincial-Manager-Scientific Agency-2).

Further, there is a contrasting context of urban and rural systems in the Sindh region. In addition, in the complex society of a developing region of Sindh, belief systems, social taboos, and cultural convictions play a role in accepting a warning message or a particular mode through which the message is disseminated:

“We also have an issue with our belief system, some people do not change their behavior if their beliefs do not coincide with the information they receive” (Interviewee- Provincial-Manager-disaster management-2).

“People here also have social issues and religious convictions. For example, this heat hazard occurred in the month of Ramadan (fasting). Despite being dehydrated, over exposed to heat, they did not break the fast and continued the suffering, hence aggravated the trauma” (Interviewee -Provincial-Manager-Scientific Agency-2).

Urban areas encounter different kinds of disasters, lifestyles, and sets of priorities than rural regions. They also have several avenues which they use as sources of information, but for rural areas basic infrastructure, appropriate communication media and formats of the message that can be well-received by the less literate rural population are challenges:

“Urban areas rich or poor do have several avenues for communication, which we can use in alternative formats, but for rural and remote areas, the basic need is the basic infrastructure for sustainable communication. Certain regions have no electricity at all, if they have electricity, they might have no Internet provider, or may have no cell phone provider in the region at all” (Interviewee -Provincial-Executive-1).

Besides, various aspects of the context that impose certain limitations in complex societies of less-resourced regions, climate change is a factor that is affecting and aggravating these regions' vulnerability even further. The recent calamity of heat hazards in an urban center of Sindh is one example. This was unanticipated and brought numerous lessons for disaster managers' preparedness practices:

“The extreme heat event was unprecedented in the city; the temperature jumped over 40 against the long-term average due to disconnect of the sea breeze...” (Interviewee-Federal-Executive-Scientific Agency-2).

“We did not have any idea of severity of recent heat disaster in Karachi, PMD did not anticipate the seriousness as well and sent us normal weather update” (Interviewee - Provincial-Executive-1).

“For PMD, recent heat hazard was unprecedented, the trend of this combination of high temperature and low humidity in Sindh affecting badly the heat index was never experienced before, thus was not anticipated in its severity and these are climatic change effects” (Interviewee-Federal-Operations-2).

“The unpredictability of recent disasters in Sindh has given rise to risks never imagined before; this calls for constant monitoring of weather phenomenon and emerging risks. We experienced heavy rain in the regions we never had anticipated before. Weather has changed and has been severe for Sindh region; the duration may be short but increased in intensity” (Interviewee-Provincial-Scientific-4).

This calls for a more vigilant and pro-active approach, in view of ever-changing risks in this region and with changing population demographics, and an approach that needs to modify tools and practices in order to address these challenges. An Emergency Operation Center operator during 2015 heat wave disaster at the provincial agency for heat hazard revealed that the landline telephone was a main mode of communication for disasters among different departments.

Section-3

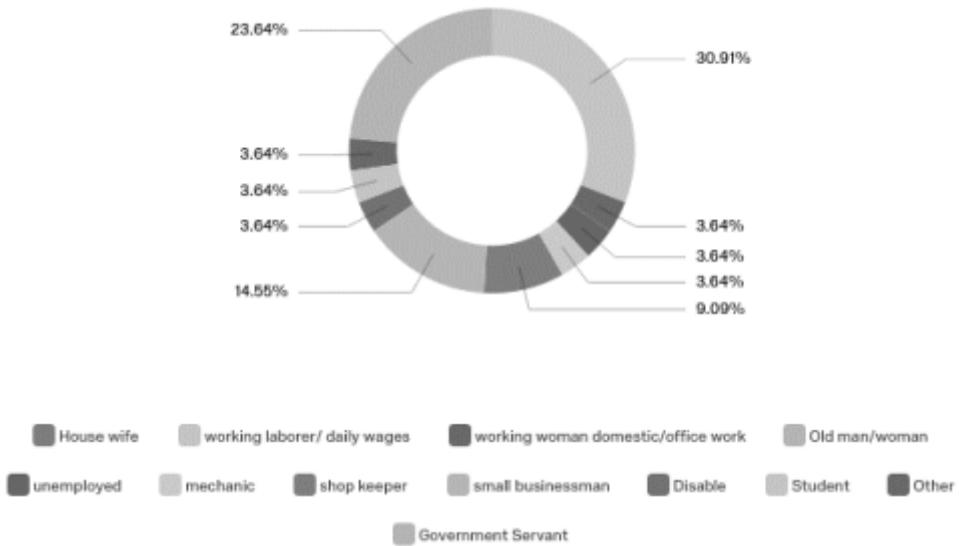
Community at Risk & Karachi's urban heat hazard

Mostly the victims, in all the heat wave scenarios in all vulnerable regions, are women, children, and elderly members of a family. Impacts of the heat waves are far more serious in the densely populated and congested localities due to poor housing structures, hardly ventilated houses, deprived from standard water and power supply. A survey was conducted from residents of high density, low income areas, who are most vulnerable to heat wave hazard. The findings are stated below:

Community Perspectives-Findings

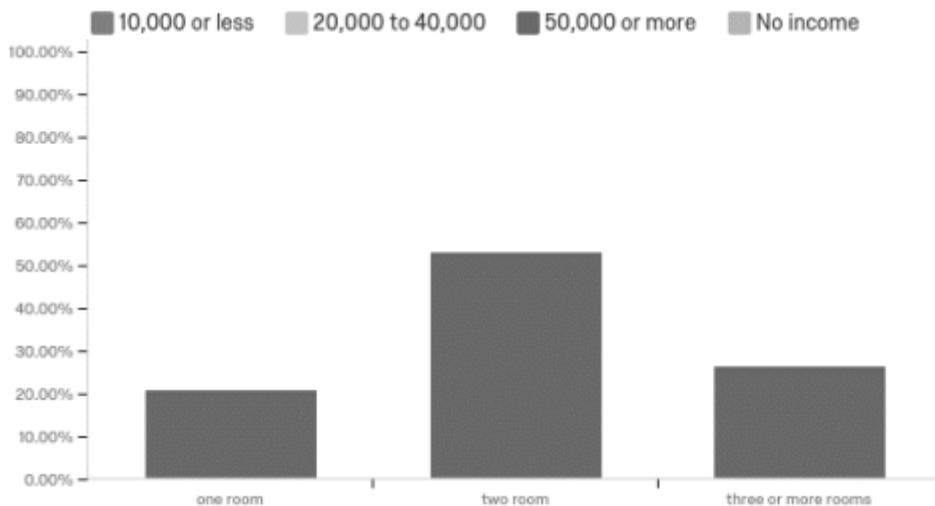
Total demographic surveyed sample included representation from different professions such as working laborers, government servants, shop keepers, small

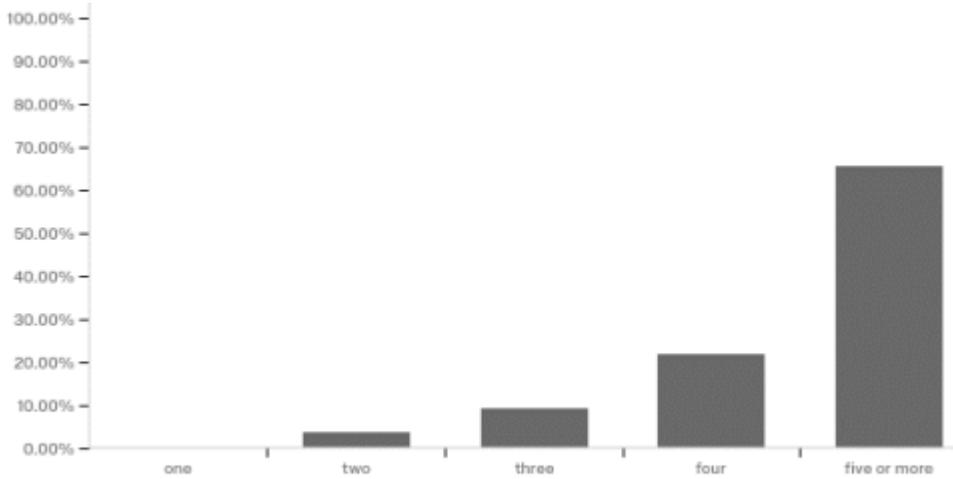
businessman, domestic servants, mechanics, unemployed, old people, disables, and others. The percentage distribution is below:



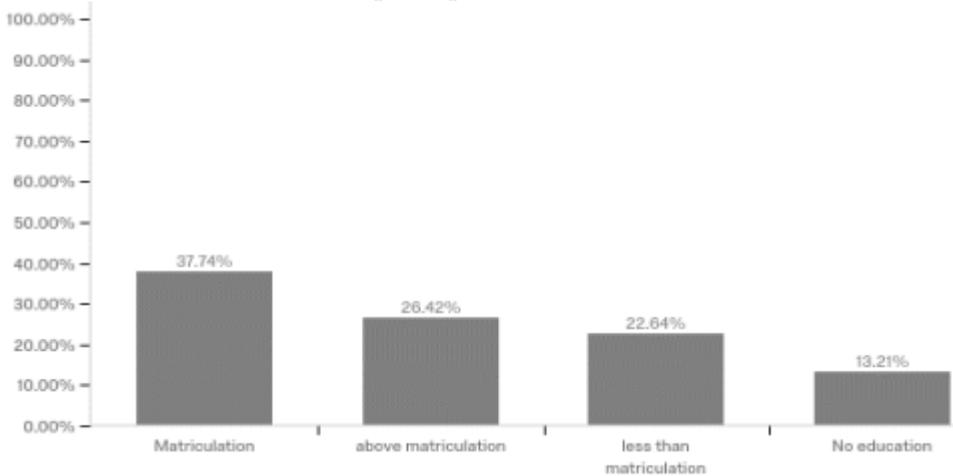
Among these survey participants, the income and living conditions are depicted below that shows their vulnerability to heat hazard in terms of urban poor settings:

Income level:

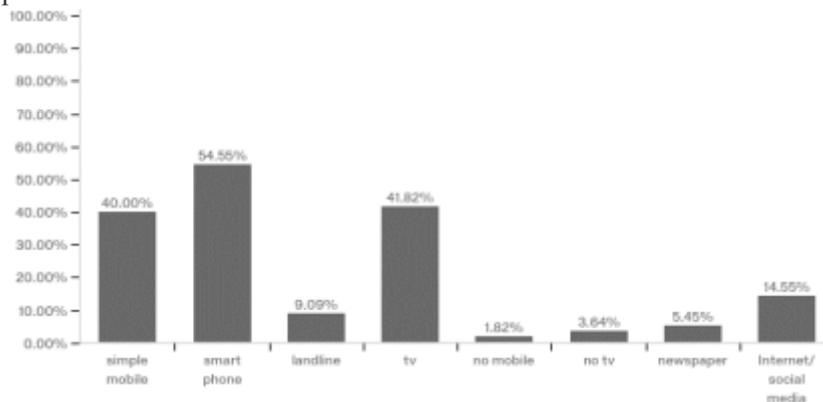




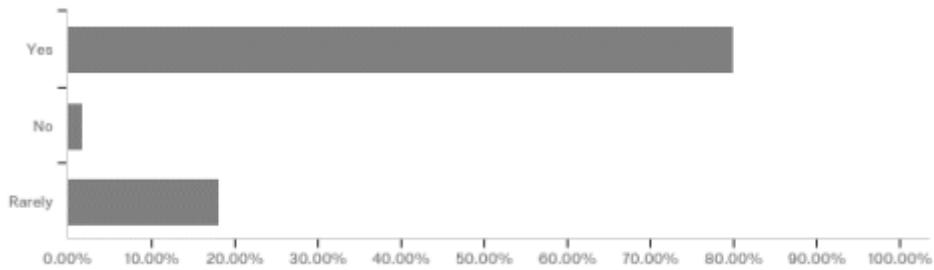
The education level of most of the participants is matriculation or above:



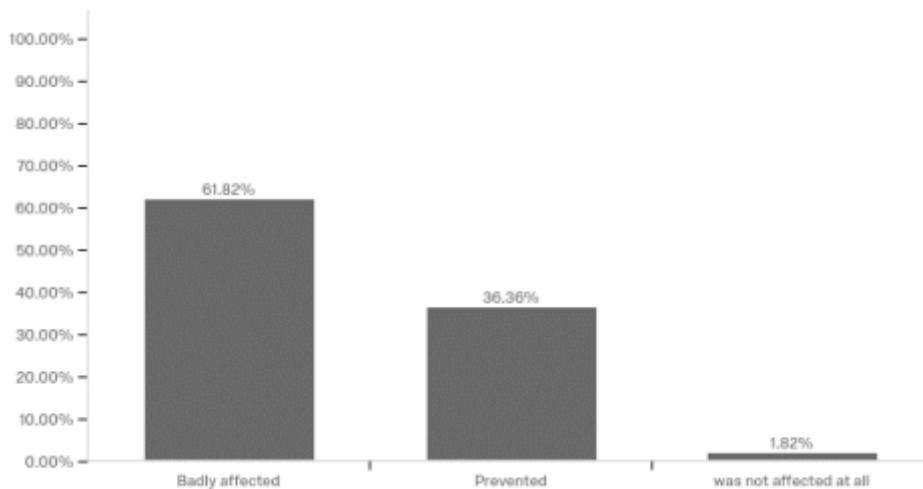
Among those participants, 50% are living in two room houses, and 70% have five or more members in a family living in these small houses. 80% of the participants experience extreme heat events frequently. It should be noted here that most of the participants have access to varied communication tools:



Bar Chart: In my area, climate is too hot during summers



When asked about their experience during 2015 extreme heat event, 61.82% informed that they were badly affected.



When cross analyzed, it was found that among participants who did not receive alerts, were badly affected during the summer 2015. And those who received warnings, 52.6% were prevented.

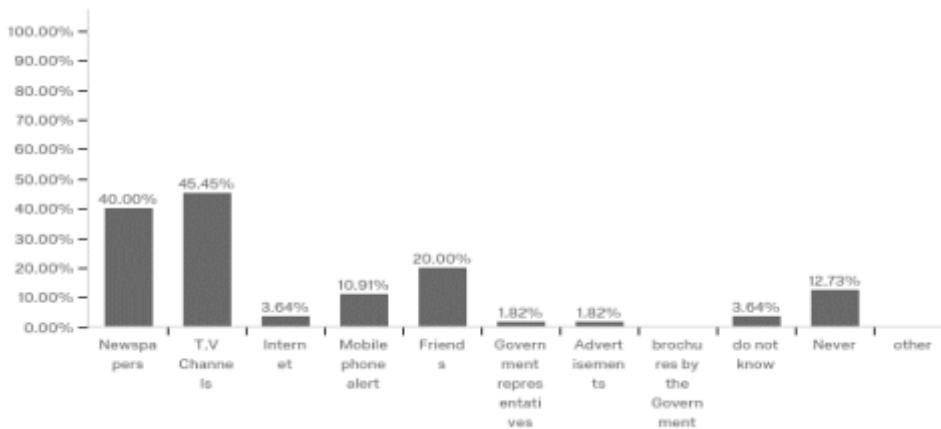
	Q9: During 2015 June heat, I was...			
	Total	Badly affected	Prevented	was not affected at all
Do not Remember	11.5%	6.3%	21.1%	0.0%
No	53.8%	71.9%	26.3%	0.0%
Yes	34.6%	21.9%	52.6%	100.0%

In current practice among the different strata of the demography, 55% of government servants and 22% of labor class is getting mobile alerts.

If the weather becomes too hot then I receive heat alerts							
	Total	Do not get information	I get a mobile alert	Loud speaker around	Mosque announcement	newspaper	
Occupation status							
Disable	3.6%	7.7%	0.0%	0.0%	100.0%	0.0%	
Government Servent	23.8%	15.4%	55.6%	0.0%	0.0%	15.7%	
Rickshaw/taxi driver	3.6%	0.0%	0.0%	0.0%	0.0%	5.7%	
Student	3.6%	0.0%	11.1%	100.0%	0.0%	0.0%	
mechanic	3.6%	15.4%	0.0%	0.0%	0.0%	0.0%	
shop keeper	9.1%	0.0%	0.0%	0.0%	0.0%	15.7%	
small businessman	14.5%	7.7%	11.1%	0.0%	0.0%	23.0%	
unemployed	3.6%	7.7%	0.0%	0.0%	0.0%	3.3%	
working laborer/ daily wq	30.9%	30.8%	22.2%	0.0%	0.0%	35.7%	
working woman domestic	3.6%	15.4%	0.0%	0.0%	0.0%	0.0%	

The participants usually receive information from varied sources. Most of them are getting information from TV and newspapers.

Figure 8 : I usually get heat related information from:



In terms of geographical distribution, 54.5% are those experiencing hot climate receive alerts and 53.7% those living in areas where load shedding is frequent receiving alerts.

I receive extreme heat alerts from the Government									
	In my area, climate is too hot during summers				There is load shedding in my area				
	Total	No	Rarely	Yes	Total	Frequently	Not at all	Rarely	
Do not know	3.6%	0.0%	0.0%	4.5%	Do not know	3.7%	2.2%	50.0%	0.0%
No	41.8%	0.0%	60.0%	38.6%	No	42.6%	46.7%	0.0%	28.6%
Yes	54.5%	100.0%	40.0%	56.8%	Yes	53.7%	51.1%	50.0%	71.4%

Conclusions

Timely and effective communication of warnings ensures citizens' safety and reduces losses and damage during the extreme weather events. Across the world, governments are continually implementing innovations in communication practices to effectively disseminate critical risk information in preventing the risk of loss of lives and huge health costs. This research elaborated on capabilities of public agencies' function in the communication of issuing public alerts and warnings to contain the risk of a heat hazard

The study has drawn conclusions from two key aspects:

The first is the **performance appraisal of a public service** aspect of heat alerts. The research observed that three key factors that affect the performance of a public sector in efficient risk/emergency communication process: First: audience segmentation according to the nature of risk and its probable effects on a community at risk, Second, message formation according to the public's level of comprehension and socio-economic and cultural dynamics; and cost-effective efficient method of medium selection to disseminate timely and effective alerts/warnings. The authorities are currently disseminating heat-related public alerts are generic in nature.

Second is the **focus on the vulnerability of a communities** residing in under-developed/developing part of an urban center of a developing country. The study found that role of both global and provincial level actors in governance is significant in characterizing policy formulation and implementing specific plans to include features of urban planning, urban resilience, and urban population keeping in view the principles of urban heat island phenomenon. Without linking the policies with theoretical paradigms and translating them at the operational level through effective management, the risk governance agendas are not achieved. For other risks, the management developed new protocols and strategies only when the risk is manifested and damages had already occurred, such as the case of heat hazard in summer 2015.

Importantly, the study found that for emergency managers at the local district level, the extreme heat hazards is not covered in planning initiatives. In view of recent heat hazards, where 1000 people were killed in an urban city of the region, new SOPs and media practices were initiated for future prevention and preparedness. These initiatives towards media innovations were contingent on the extent of discretion and support of other federal agencies. For example, in scientific agencies, the initiatives were largely taken by central agency, whereas for the provincial disaster-management agency, the central agencies only acted as facilitators, and discretionary authority to initiate new ideas rested with provincial agencies.

The constant change in weather phenomenon has led managers to devise new communication strategies for risk that were not considered as threatening in traditional risk assessment and planning. The heat hazard of 2015 as a case study illustrates this point.

Policy Recommendations & Action Plan

Sound policy on improving community access to timely warnings, warning systems, and increasing lead times (ISDR, 2005) is fundamental to improving institutional practice and successful innovation development. With the development of media and communication technology has come an increased political commitment across the world to manage risks associated with disasters. The emphasis of global risk governance initiatives on improving warning mechanism and adoption of media innovation has also increased in recent decades.

Alongside the conceptual understanding of the unique context of Karachi, that accounted for the heat wave disaster the research has identified that the organizational and policy disconnects and failure to implement relevant and context specific plans are key policy considerations. Communication of heat warnings is a public service akin to the provincial government. A more pragmatic approach is therefore required to attend to develop policy and planning measures that foster integrated actions in reducing heat wave disasters.

Primarily the policy actors must prepare a communication scheme of a heat wave disaster in sequential terms of magnitude, intensity, specificity, geography, and demography of a heat wave disaster. They must identify key urban settlements where extreme weather events can happen and within that, sub-urban settlements may be identified where the vulnerability is more due to specific nature of an urban heat island phenomenon.

Concerned research institutions, Communication experts, Weather forecast agencies and disaster management agencies must prepare a framework to formulate, plan and implement a heat wave warning system to encompass the contextual realities of urban settlements, climate change phenomenon, and population dynamics in terms of heat wave hazard in Pakistan.

Action Plan

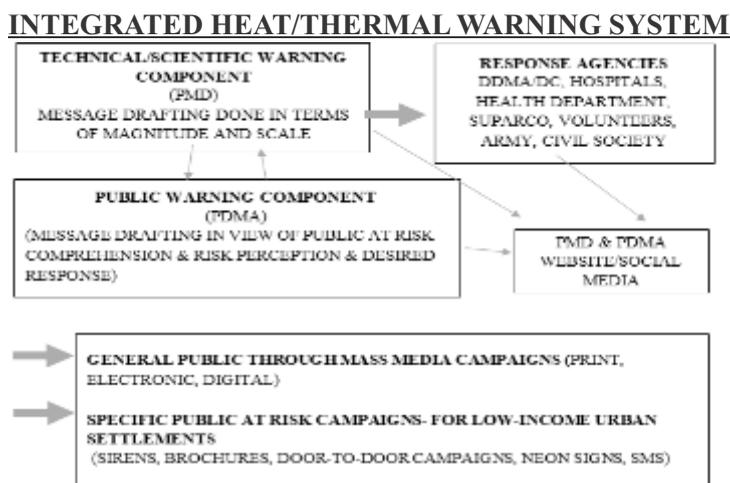
This study proposes an action plan based on the idea of component sharing model, where component of communication strategy development and operations is given to emergency communication experts, both in technical and infrastructure-based risk management and preparedness-based response towards heat warnings done by the disaster management agencies.

Since source of heat wave information is primarily in the form of weather advisory and entails scientific information, they must prepare a warning message entailing the magnitude and possible intensity of the event and communicate primarily to the relevant agencies responsible for managing the heat wave response. Such as Provincial Disaster Management Agency (PDMA), hospitals, concerned district management offices, and other relevant agencies in that urban sectors. Pakistan Meteorological Department must focus on response agencies as prime audience in communicating forecasts so that timely and effective arrangements can be made to facilitate response in case need arises.

Provincial Disaster Management Agency (PDMA) should be the focal agency in simplifying and specifying the warning message, ensuring its dissemination ensuring that the information would be received and acted upon. This can be done through audience mapping of the specific localities of high density, low-income, congested areas, specifically, where load shedding is frequent. They must also target those street localities where generally low-income laborers are stationed for daily earnings. While specific messages are disseminated using various appropriate communication techniques suited to the needs of at-risk audience. Warning messages may also be disseminated using the mass medium and digital medium to ensure the scope is covered or to recruit volunteers in facilitating response.

Policymakers must establish integrated heat/thermal warning system integrating forecasting agencies of heat wave in technical or statistical terms with the agencies responsible for managing the disasters such as provincial disaster management agency. The graphical view of the proposed action plan is depicted below.

Figure 9: Proposed- Integrated Heat Warning System for Pakistan



In addition, following specific communication techniques are suggested in this regard:

- a) The warning system must validate the information through attending phone calls to relatives, friends, or public safety agencies using helpline. Official must substantiate warnings on multiple mediums through radio, and television.
- b) The credibility of warning may be enhanced through context consistency with a condition of urgency.
- c) The specificity of warning should be enforced. Recipients of warning information should get information of a disaster threat and must indicate how the threat will affect them. Sirens can be used readily to alert a large number of people in areas where other mediums are not as much effective.
- d) The governmental authorities, such as the governor, or the local administrator must act as a principal information officer in times of emergencies and issue a warning message (Drabek, 1986).
- e) The government must have a central media cell from which the media can receive official information about the magnitude and intensity of the event. This can help ensure that the public receives is timely, consistent, and accurate.
- f) Emergency managers must assign resources to address the needs of the media under conditions of extreme heat wave situations. Planning and public relations are necessary with the media in decreasing the loss of life and property.
- g) It is also important that potential of media can be utilized to convey instructions to the public as to how they can prepare for possible heat wave incident. Media can also stimulate gathering of donations.
- h) The heat warning mechanism must be in accordance with the literacy level, religious beliefs, and any socio-cultural peculiarity to be more effective.

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