Heat Risk Perception and Communication Strategies for Adaptation within Low-Income Communities in Kampala City, Uganda

By

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Abbreviations

KCCA	Kampala Capital City Authority
EM-DAT	Emergency Events Database
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
ILO	International Labour Organisation
IPCC	Intergovernmental Panel for Climate Change
KIIs	Key Informant Interviews
MAM	March April May
MDAs	Ministries Departments and Agencies
MoH	Ministry of Health
MUCCRI	Makerere University Centre for Climate Change Research and Innovations.
MWE	Ministry of Water and Environment
NGOs	Non-Governmental Organisations
ODK	Open Data Kit
SON	September October November
SOPs	Standard Operating Procedures
SSA	Sub Saharan Africa
UAL	Urban Action Lab
UBOS	Uganda Bureau of Statistics
UHI	Urban Heat Island
UNMA	Uganda National Meteorological Authority
URCS	Uganda Red Cross Society
VHTs	Village Health Teams
WHO	World Health Organisation

Definition of key terms

Adaption	Changing something or behaviour to make it suitable for a new situation
Ambient Temperature	The average temperature of an environment
Climate Change	The long-term shifts in temperatures and weather patterns due to natural or anthropogenic factors.
Climate Variability	Interannual or interdecadal fluctuations in temperature and precipitation
Exposure	The fact or condition of being affected by something or experiencing something.
Global warming	Long-term warming of the planet's overall temperature
Green House Gases	Gases that absorb and emit radiant energy within the thermal infrared range
Hazard	Source of potential damage, harm or adverse effect on someone or something
Heat stress	A condition when the body fails to control its internal temperatures. Factors such as work rate, clothing worn, and humidity may lead to heat stress.
Heatwave	Prolonged episodes of unusually higher temperatures.
Intensity	Degree to which something is difficult or strong
Livelihoods	Means of support or subsistence
Morbidity	Condition of suffering from a disease
Mortality	State of being subject to death
Preparedness	The state of being ready for something yet to happen
Risk	Probability of something bad happening
Sensitivity	The ability of an organism or part of an organism to react to stimuli
Susceptible	The likelihood of a condition happening and affecting the state of anything
UMEME	Electricity in Swahili- It is Uganda's main electricity distribution company.
Urban Heat Island	An urban or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities.
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Executive Summary

Global changes in climate are increasing the frequency, intensity and severity of extreme events such as floods, heatwaves, drought and erratic rainfall among others. Extreme temperature characteristics are manifesting in different regions of the world due to anthropogenically induced warming. Heatwaves are among the deadliest natural disasters that are contributing to loss of human lives and severe effects on livelihoods. Several regions in Africa are already experiencing increases in surface temperature, which has heightened its vulnerability to heatwaves. Moreover, the limited adaptation and economic capacity are compounded with ineffective institutional and governance structures to worsen the effects of climate extremes. Being one of the most urbanising parts of the world, African cities are more expected to be disproportionately affected by heatwaves. Uganda's temperatures have been rising since 1950's and higher warming levels of 0.78℃ have been recorded since the 1990s. With urbanisation growth rate of about 5% per year, cities in Uganda are susceptible to urban heat island effects arising from environmental degradation, housing density and Greenhouse Gases (GHGs) emissions among others. This study was conducted to generate evidence on heat risk perception and communication strategies for uptake of protective/adaptation measures and strategies amongst low-income communities in Kampala city.

Qualitative and quantitative data and information was collected through literature review from secondary data sources, and conducting 382 surveys using standard questionnaires in Kibuye I and Bwaise III parishes, as well as key informant interviews with community members, business operators, civil society organisations (CSOs), and ministries, departments and agencies (MDAs) link to climate change and urban development domains.

The temperatures of Kampala city have increased by 1.5℃ in the last five decades and the urban heat island effects are becoming more significant. The major rise in temperatures across the city have been observed in the last three decades with 2009, 2016, 2019, 2020, 2021 and 2022 recorded as the hottest years. The hottest months are July, June, January and May respectively. Over 90% of the respondents have experienced unusually hot weather or extreme heat, with about 85% exposed to very hot or hot temperatures beyond the average. This increase in temperatures has resulted into more frequent hot days and nights especially between 12:00-16:00HRS and 22:00-03:00HRS respectively. The informal settlements are the hottest part of the city due to congestion and high housing density, lack of vegetation, wetland degradation, atmospheric pollution and concentration of transport corridors with higher vehicular flows. The operation of business enterprise, age, marital status, main income source and monthly income significantly associated results with levels of perception on heatwave knowledge and experiences.

Most (73%) business enterprises and households are vulnerable to heatwaves and are worried about such events occurring in Kampala city. 51% of the respondents believe that heatwaves events are a problem in the city and there is a likelihood of increased hot days. Additionally, 74% reported extreme heat to be severe. 68% said there is an unlikely increase in heatwave events within a year and 74% said hotter days within a month are very likely. The age, marital status, main income source and monthly income social categories indicated significant associations of heatwave exposure and likelihood in Kampala city.

Most of the respondents surveyed (76%) are sensitive to extreme temperatures and yet the majority (94%) of the respondent indicated that their livelihoods are affected by heatwaves. Extreme temperatures pose socio-economic, environment and health threats and effects on low-income communities' population in Kampala. Whereas limited mobility, water scarcity, famine and reduced community gatherings are the main social effects, reduced labour productivity, increased expenditure on health-related complications, reduced or increased business exchange performance and raised electricity consumption for cooling purposes are the predominant economic effects. Besides, dusty roads, air pollution, water sources and vegetation drying are visible environmental implications of heatwaves. In regards to health, extreme temperatures lead to; headache, excessive sweating, prolonged thirst and dehydration, tiredness, dizziness, heat related stress and dehydration among others. Livelihood effects of heatwaves are worst reflected amongst children, pregnant women, babies, the elderly, people with chronic illnesses, the homeless, albinos and people working under direct sun, open spaces and along the streets. However, the priority concerns during heatwave events are; personal health, children and the elderly.

Adaptation and planning for heat risk is still minor and strategies to protect the city and its population from the hazard are very minimal in scope and coverage. The city authorities have created initialised measures to address congestion and its related effect on GHGs and heat emissions. Kampala Capital City Authority (KCCA) has put in place a non-motorised transport corridor to decongest the city centre from automobiles, initiated tree planting along road reserves and greening of surfaces on new road infrastructure. In addition, KCCA is raising awareness about the negative effects of wetland degradation and has started efforts to save the city's tree canopy and green space coverage through restriction of tree cutting and enabling tree planting and greening on both public and private property as well as spaces. However, communities have not been supported and prepared to respond to the socio-economic, environmental and health effects of heatwaves in Kampala. In response to extreme temperatures, individuals predominantly increase consumption of fluids (85%), keep doors or windows open so as to let in fresh air (42%), put on light clothes (35%), cool bodies through using wet cloth (30%), ice cool and showers (21%), carry drinking water when travelling (20%), rest under shades or trees (17%), and use fans or air conditioners (11%). Prioritised community level response preparedness needs identified include; greening of informal settlements and work spaces, steady supply of clean and safe water, setting up open vegetated spaces, incentivising cooling equipment, reducing electricity costs and sensitisation about the risks of heatwaves.

Whereas weather and climate information has recently improved in Uganda, focus has largely been put on rainfall, daily temperature, and flood forecasts. About 61% of the respondents reported to have heard or read about heatwaves but, only 26% indicated to have received information about the recent heatwave event, and these were the educated individuals who had exposure to international media, and weather forecasts. Over 90% reported interest in receiving heatwave related information, awareness of vulnerabilities, effects and adaptation measures or strategies for low-income communities. Conventional media of communication like radios and televisions coupled with local council leaders and community level social networks are the preferred means of heat risk information dissemination. Multi-stakeholder engagement with emphasis on local level governance structures, cultural institutions and social networks

were found to be critical towards building multi-level capacities for information heat risk information dissemination, knowledge sharing and uptake of protective solutions for heat adaptation.

Finally, evidence on urban heat risk in Kampala is limited and yet the contemporary urbanisation trends and levels of environmental degradation are more likely to increase frequency, exposure and severity of heatwave events and urban heat island effect. Comprehensive actions to strengthen appreciation, awareness and response to heat risks in Kampala and vulnerable urban populations require further research on the risk itself, vulnerabilities, effects and coping strategies as a way of informing evidence based urban development policy, planning, implementation and humanitarian response or practice at national and sub-national levels.

1. Introduction and purpose

The world is recently experiencing an increase in temperatures, attributed to climate variability, increased greenhouse gas emissions and concentrations that intensify radiative forcing through natural and anthropogenic processes (Ngarambe et al., 2020). This increase in global temperature is posing adverse impacts on ecosystems, food security, water supply, human health and well-being, with significant effects on poor and vulnerable populations. The occurrence of heat waves defined as prolonged episodes of high temperatures continue to pose definitive and detrimental effects on human health. Along with other climatic changes such as precipitation and atmospheric circulation patterns, temperature increases can affect human health and wellbeing through various pathways, including heat stress, increases in wildfires, spread of vector-borne and water-borne diseases, crop failure and its potential impact on food prices, nutrition, incomes, population displacement and conflict (Ebi et al., 2018; Watts et al., 2018).

As climate change continues to increase both the ambient temperatures, the frequency and the intensity of heat waves or extreme heat events, there exists direct amplification of mortality and morbidity risks though these are overlooked because of the insidious nature of heat waves (Margolis, 2021; Wilson & Black, 2022). To this end, extreme temperature is one of the deadliest forms of climate hazard worldwide and as such, heat and heat exposure is increasingly attracting attention amidst the changing climate (Scott et al., 2017). More than 70,000 people died during the 2003 heat wave in Europe and it is estimated that over 166,000 people died from heat waves in the past two decades (WHO, 2018). Pham et al., (2019) highlighted the increased risk of mortality and morbidity during heat waves in older and vulnerable people.

Whereas the wellbeing of non-urban communities can be severely disrupted during and after periods of unusually hot weather, the effects of heat are exacerbated in cities due to the urban heat island (UHI) effect. With the on-going climate change and rapid urbanisation, exposure to severe heat is expected to accelerate in tropical East African cities (Van de Walle et al., 2022a). The thermal increases in urban areas arise from amplified construction surface area, increased heat retention from man-made materials and environmental degradation due to clearance of plants and vegetated surfaces which generally reduce evapotranspiration. The heterogeneity of urban areas implies that exposure to dangerous heat may also vary in space and time. According to CRED & UNISDR, (2018), slum dwellers are more affected by heat waves. Recent studies in Nairobi and Kampala cities indicate that average temperatures in informal settlements were higher than in other parts of the city, because of lack of trees and vegetation to mitigate extreme temperatures (Scott et al., 2017; Van de Walle et al., 2022a, 2022b). Thus, understanding the heat risks potentially has important implications for the disaster management and public health spheres by creating opportunities for more targeted interventions to reduce the effects of heat exposure now and in future warmer climates (Scott et al., 2017).

The climate of Kampala is generally tropical with a bimodal rainfall regime composed of two major rainfall seasons, March to May (MAM) and September to November (SON) (Nimusiima et al., 2021). The annual rainfall ranges from 1750-2000mm, the average annual temperature is 21.9^0C and the relative humidity ranges from 53-89% (KCCA, 2017). The city's proximity to Lake Victoria however makes it receive rainfall in almost all months of the year due to

land and lake breeze effects. The climate patterns of Kampala have however changed over the past years with more dry spells, less and erratic rainfall. Kampala, like the rest of the world, is experiencing climate change mostly with increased temperatures and more intense rainy seasons which are less predictable, frequent and more erratic. According to KCCA, (2015), recorded temperatures have increased by 1.5^0C over the last 50 years and yet the pattern of precipitation has become more erratic, severe and frequent. The city is thus vulnerable to climate hazards including; drought, rainstorms, heat waves and floods, that are compounded by the urban heat island effect (Arnalsteen et al., 2019). There is a rapid increase in built-up area, extensive encroachment on wetlands and environmental degradation, reduced green spaces and limited physical planning as the main drivers of urban heat and other climate risks. Such risks have been found to have a significant impact on the urban economy and livelihoods of particularly residents of informal settlements and those earning from the informal sector (Twinomuhangi et al., 2021).

Heat stress is a relevant climatic challenge that requires more in-depth fundamental and applied research, especially within informal and low-income urban settlements (Laue et al., 2022). Previous field studies in Kampala have found evidence of warmer urban temperatures in the city and in informal settlements, particularly for minimum and maximum daily temperature, humidity and satellite thermal imagery (e.g., Kabano et al., 2022; Van de Walle et al., 2022a, 2022b). However, there is no study that has engaged the population to understand their heat risk perception and better communication strategies to spread information related to heatwaves. The low-income settlements in Kampala are potentially highly vulnerable and affected by heat risk due to lack of information on heat wave occurrence and risk, inadequate access to routine health services, precarious built environment conditions, unreliable socio-economic circumstances, and lack of adaptation strategies and capacities. This study analyses the heat risk perception and communication strategies to improve uptake of self-protective measures by vulnerable populations living within climatologically hot areas in Kampala city. The study sought to address two main research questions as follows;

1. How do different population groups perceive their risk related to heat?
2. What are the effects of heatwaves on urban communities?
3. How does heat risk vulnerability vary across social groups?
4. What kinds of communication and outreach strategies result in the largest uptake of self-protective measures for vulnerable groups living in ‘’climatologically hot places’’

2. Literature Review

Climate change, in effect, is increasing extreme weather events such as heatwaves, floods, droughts, and intense precipitation. Specifically, the projected rise in global warming due to climate change is likely to increase the severity and intensity of heatwaves (Guo et al., 2018). The world is currently experiencing more hot days and fewer cold days, with heatwaves predicted to become frequent for longer periods (Van Der Walt & Fitchett, 2022). For example, several countries in Europe including; Belgium, France, Germany, Netherlands and the United Kingdom (UK) experienced unprecedented heatwaves with record breaking temperatures, France and the UK recording a high of 46°C and 38.70°C in July 2019 (Strauss et al., 2022). Periods of extreme heat or heatwaves continue to become an unwelcome experience for many and pose several damaging impacts on livelihoods and the environment. Vulnerability to extremes of heat

has steadily risen since 1990 in all regions, with over 220 million people exposed to heatwave events in 2018 (Watts et al., 2019). Studies have indicated that the young and the elderly are particularly susceptible and affected by heatwaves, and yet global crop production has been significantly reduced with substantial effects expected in the future (Arbuthnott & Hajat, 2017; Deryng et al., 2014; Watts et al., 2019; Zampieri et al., 2017). Between 1980 and 2019, the Emergency Events Database (EM-DAT) has listed occurrences of 83 heatwaves in Europe, resulting in over 140,000 deaths and more than US$12 billion damages for only the 2003 heatwave event (Harrington & Otto, 2020). The 2010 Russian heatwave on the other hand approximately led to US$ 15 billion losses (Barriopedro et al., 2011). Moreover, future losses from all extreme weather are projected to rise steeply with each additional degree of global average warming potentially increasing the economic cost by trillions of dollars per year by 2100 (Kompas et al., 2018).

Africa, situated in the climate zone where temperature change signals are expected to rise first from climate variability is among the developing regions facing disproportionately greater impacts from climate related extremes (Mahlstein et al., 2011). Despite insignificant contribution to global warming emissions, Africa's higher exposure to climate change arises from its heightened vulnerability that is exacerbated by limited adaptation and economic capacity, coupled with ineffective institutional and governance structures. Many regions of Africa are already experiencing increases in surface temperatures. According to Ceccherini et al., (2017), the spatial coverage of maximum temperature of Africa's terrestrial surface area has increased from 37.3% during the period 1981-2005 to 60.1% during the period 2006-2015. The occurrence of more intense heatwaves with longer duration and wider extent has been shown in recent years across Africa (Russo et al., 2017). Maximum and minimum temperatures have shown an increasing trend over Ethiopia, Kenya and Tanzania (Gebrechorkos et al., 2019) and Uganda (MWE, 2022). In Africa, the countries that are at risk of heatwaves include; Benin, Ghana, Togo, Burkina Faso, Côte d'Ivoire, Sierra Leone, Niger, Nigeria, Somalia, Chad and Sudan (ILO, 2019). Urbanisation, population increase and fast-growing pressure on land use and landcover is exacerbating the vulnerability of countries to heatwave effects. Consequently, the resulting societal impacts of heatwaves, during and after the events are expected to be much higher with greater effects on livelihoods (IPCC, 2014, 2022). For example; overall projections suggest that 2.3% of the total number of working hours in Africa will be lost to heat stress in 2030 – the equivalent of more than 14 million full-time jobs (ILO, 2019).

Despite experiencing a number of heatwaves and the likelihood of disproportionate impact in future, extreme weather damage reports indicate no significant heatwave impacts in Sub-Saharan Africa (SSA) (Harrington & Otto, 2020). The EM-DAT reports only two heatwave events recorded in SSA between 1900 and 2019, leading to the deaths of 71 people. Whereas scholarly work on heatwaves is increasing especially in cities where urban heat island effects are becoming significant, SSA countries face several barriers to heatwave detection including; poorer governance frameworks, sparse observational networks of climate data and lack of expertise to develop local heatwave metrics which also integrate epidemiological information (Andrijevic et al., 2020; Donat et al., 2013; Gasparrini et al., 2015). Further, Africa has faced severe droughts in past decades causing serious effects on livelihoods but the co-evolution of heatwaves and droughts remain a barrier for the scientific community, humanitarian agencies and decision makers

(Harrington & Otto, 2020). Heatwaves are therefore less recognised amongst other climate extremes and their impacts on livelihoods as well as communication are less represented across Sub-Saharan Africa and Africa at-large.

In Uganda, temperatures have been reported to be rising at a rate of about 0.23℃ per decade since 1950 and such a trajectory is associated with an increase in the frequency of hot days and nights (MWE, 2022). Higher warming levels have been recorded recently at 0.26℃ between 1990 to 2019 and the year 2019 was the hottest with a warming level of 0.78℃ above the long-term mean value for 1981 to 2010 period (UNMA, 2020). The Southern and Western regions of Uganda are reportedly warming faster than the other regions since 1950 with respective warming levels of 2.20℃ and 1.70℃ in 2019 (UNMA, 2020). According to Twinomuhangi et al., (2021), Uganda's climate projections reveal a rise of about 2℃ to 5℃ temperatures in the next 50-80 years. With rapid urbanisation of about 5% per annum, sporadic environmental degradation, and increased coverage of grey infrastructure in Uganda's cities including Kampala, the urban heat compounds traditional climate hazards including flooding and erratic rainfall. Similarly, Uganda's Greenhouse Gas emissions (GHG) have slowly increased from 53.4 MtCO2e in 2005 to 90.1 MtCO2e in 2015 and cities compose major emitting sectors like transportation, energy, waste, industrial processes and land use change (MWE, 2022). There is a general increase in the number of heatwave events in Kampala with future extreme temperatures indicating that the city will experience an increase in warm days and nights (Nsaire, 2021). Kampala has been reported to experience temperatures of over 31℃ from the known average of 27℃. In addition, in-situ measurements have shown significant spatio-temporal variability in temperature with some informal settlements experiencing hotter conditions compared to affluent areas which tend to be vegetated. The livelihoods of majority populations in low-income communities of Kampala city are therefore vulnerable to heatwave events and their effects which calls for early planning of adaptation mechanisms to address the challenge.

Improving knowledge of temperature changes, the occurrence of heatwaves and the time of emergence over natural variability has vital societal importance (Harrington et al., 2017). Like elsewhere across the world, heatwaves can lead to multiple effects including heatstroke, death, water shortage, reduced agriculture productivity, disrupt food supply chains, hunger and famine etc., in Uganda's cities -e.g., Kampala. Lack of reporting on dangerous heat limits awareness, derivation and implementation of actions in response to the risk. It has also remained challenging to integrate heat risk adaptation actions in national and city level planning due to inadequate evidence from the most vulnerable communities. This study contributes to literature by analysing the heat risk perception, effects of heat waves and communication strategies for uptake of self-protective measures amongst low-income communities in Kampala city, Uganda.

3. Approach and Methodology

The study deployed a cross-sectional design with mixed approaches of quantitative and qualitative techniques for primary data collection, targeting the informal sector (i.e., businesses and settlements) in Kampala city. Quantitative data was collected using a standard survey/questionnaire whereas qualitative data was derived from several methods including; review of existing literature, focus group discussions (FGDs) and key informant interviews (KIIs) to capture

heat risk perceptions and communication strategies for meaningful adaptation in amongst the low-income populations in Kampala city.

3.1 Background context of Kampala city and its informal sector

Kampala is Uganda's commercial and economic hub, and a key centre and driver in respect to growth in the Great Lakes Region (KCCA, 2020). It is a rapidly growing city that is home to about 1.7 million people which increases up to 4.5 million through daily commuting from the surrounding region. The city is characterised by low-income settlements, mixed land uses (like residential, industry and commercial activities) and limited planning. It contributes over 60% of Uganda's GDP and accounts for 80% of the country's industrial sector. The majority employment sectors in Kampala are the services sector and sales (46%), and the construction industry (15%) (UBOS, 2018). Urban residents have much better access to basic amenities, with 86% of the population accessing grid electricity compared to only 22% nationally (UBOS, 2018). In regards to housing, most of the urban poor in Kampala live in slum settlements located in flood risk areas, particularly drained wetlands.

Kampala has a very dynamic and growing urban informal sector (both housing and businesses). The informal sector is by far the most important employer in Uganda. Informality is multi-faceted from land tenure insecurity, poor housing, lack of basic services and amenities as well as unregulated economic dealings (Lindell et al., 2019). Informal housing is characterised by contentious squatter status in which houses may be established on land whose ownership is unclear, minimal indoor space which may serve as living and sleeping area, limited aeration due to small sized windows and ventilators, sub-standard building material, shared sanitary facilities which are at times in dire conditions among other traits (Ssali, 2020). The business dealings on the other hand are tax evaders, may lack proper working agreements resulting in poor working conditions, co-exist with living areas or operate outside designated places ranging from marketplaces to streets and verandas. The highest proportion of Kampala's population engages in an informal economy with most activities not taxed or directly regulated by the state (Richmond et al., 2018). It is estimated that more than 1.5 million enterprises operate at micro-small-medium scale in the country employing over 2.5 million people, with over 55% located in Kampala (KCCA, 2014). This means that the informal sector employs about 90% of the total non-farm private-sector workers and its contribution to GDP is more than 20%. Moreover, the informal sector employment is estimated to expand at more than 20% per year. Trade is by far the most important activity with 72% of the informal sector employment, followed by manufacturing 23%, and services 6%. The most significant informal activities include; informal transport (using boda-bodas and taxis/matatus), markets, street vending, hawking and wholesale and retail sale trade and commerce in consumables, plastics, textiles among others.

The majority of the urban population engage in informal activities in a bid to claim their rights to exist and participate in the city economy and spaces, for example they operate on open space outside food markets and malls, streets and road reserves as Vendors, Boda Boda riders and taxi drivers. Others work in built business premises such as food markets, retail and wholesale shops, salons among other enterprises. Similarly, a significant number of people live within the underserved settlements characterised by garbage piles, dilapidated road network, poor housing facilities prone to flooding events, high crime rates when it rains, poor sanitation and hygiene. People living in informal settlements live on improvisation since their settlements are extremely devoid of better waste management, energy

and clean water, better drainage services from the city authorities. Such conditions disproportionately subject the informal sector to heightened heat risk vulnerabilities, worsened by irregular incomes, security risks and limited participation in urban governance.

3.2 Study area

The study was conducted in the Kibuye I and Bwaise III informal settlements of Makindye and Kawempe Divisions respectively of Kampala city (*See Figure 1*). These settlements were selected because they recently recorded the highest temperature-humidity index (with days exceeding 45^0C), densely populated and lack vegetation cover (Van de Walle et al., 2022b). Given their high exposure to extreme heat, the settlements adequately provided evidence and narratives on perception to heat risk and appropriate communication and outreach strategies for uptake of self-protective measures across the different social groups.

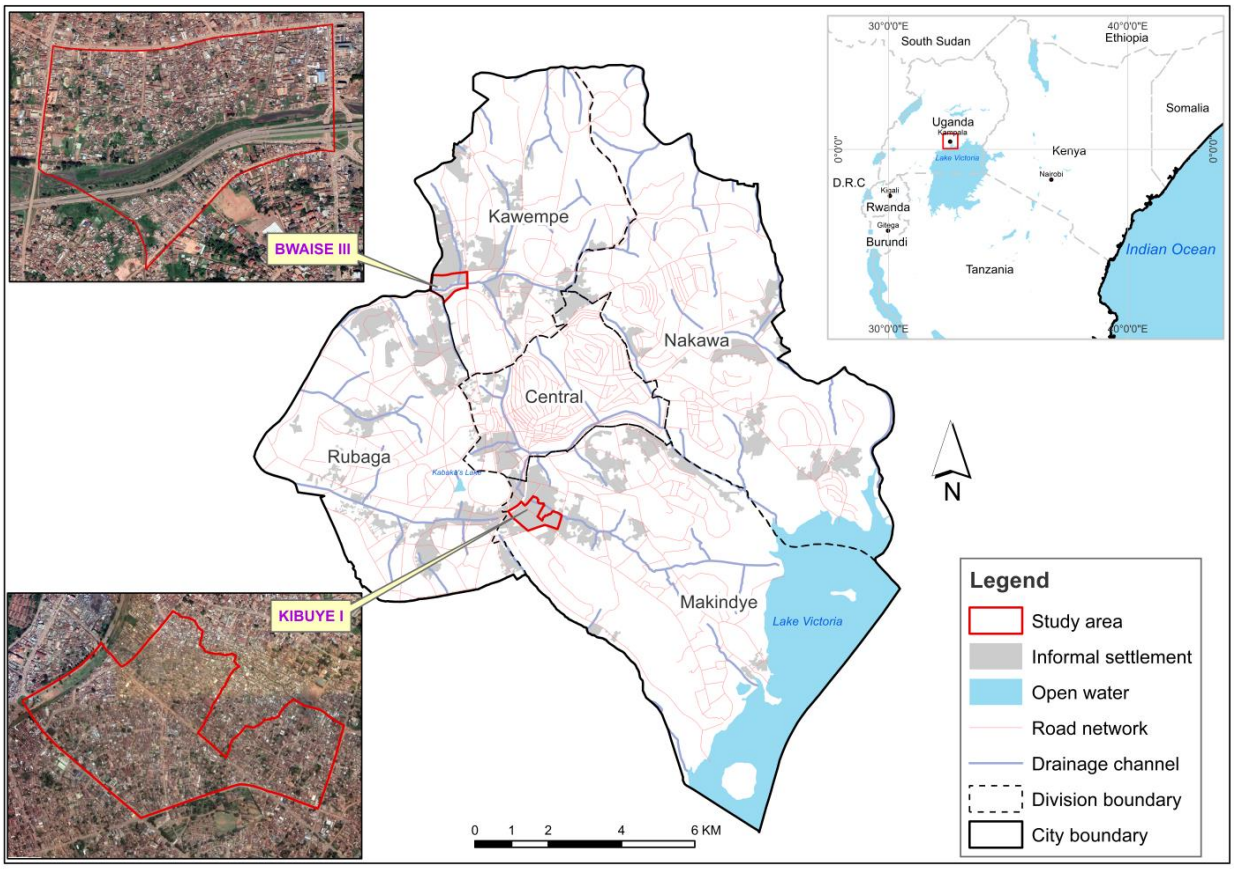

Figure 1: Map of Kampala city showing the study areas

3.3 Target population and sample size determination

The study was specifically designed to analyse perception of heat risk and appropriate communication and outreach strategies for uptake of self-protective measures across the different social groups in the informal sector of Kampala. Given the heterogeneous nature of the informal sector, the mixture of business and housing units were targeted as identical features of the settlements under the study. The total household population under study was 10,799 in both

Bwaise III and Kibuye 1 informal settlements[1]. The household population of Bwaise III was 2446, with a household size of 5, whereas Kibuye I had 8353 households with a household size of 4. The sample size was determined using Krejcie & Morgan, (1970) formula to generate the number of respondents for a random survey during data collection. The equation used to generate the sample size is expressed as follows;

$$s=X2\ NP(1-P) \div d2\ (N—1) +X2\ P(1—P) \quad \text{..... (i)}$$

Where;

s= required sample size.

X2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (0.05 = 3.841).

N = the population size.

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size.

d= the degree of accuracy expressed as proportion (0.05).

The total sample size for the survey was therefore 382 respondents, out of which a proportionate sample was determined for each of the parishes. Accordingly, 290 respondents were drawn from Kibuye 1 settlement in Makindye division and 92 from Bwaise III. To have a representative survey across both settlements, ArcGIS 10.8 was used to map out the parish polygons on a street map. Using the sampling analysis tool for ArcGIS 10.8 called fishnet grids; a 50*50 metre grid squares with centroids on the street map of the parishes (*Figures 2 and 3*) were used to randomly select the households and or business enterprises for survey administration. It was ensured that at least two households or business enterprises were selected from each of the fishnet grids. The respondents for FGDs and KIIs were on the other hand purposely selected from community members, civil society organisations, government agencies and ministries as well as local leaders.

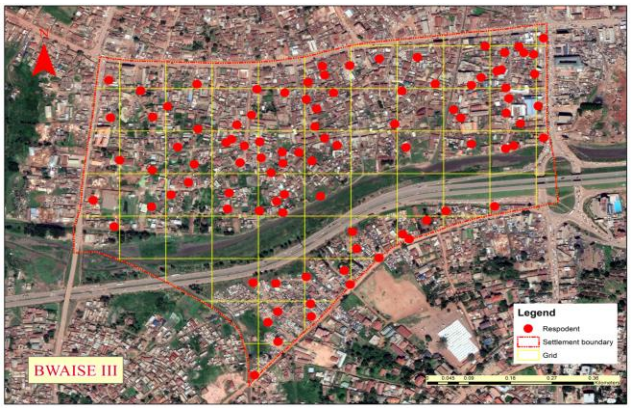

Figure 2: Coordinate points for sampled respondents in Bwaise III

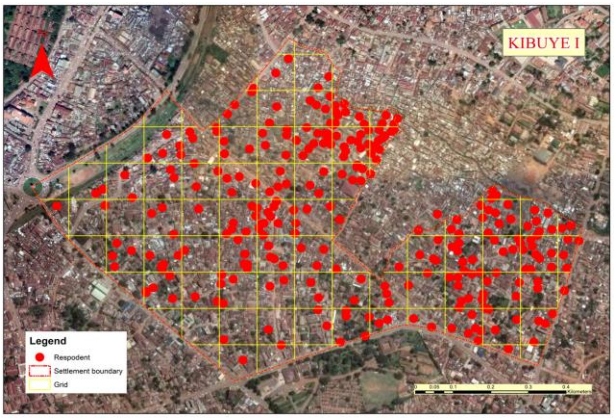

Figure 3: Coordinate points of respondents in Kibuye I

3.4 Methods of data collection

A blend of qualitative and quantitative approaches were used in the study, including a comprehensive review of literature and secondary data sources, survey interviews, key informant interviews (KII) and Focus Group Discussions (FGDs).

[1] https://www.ubos.org/wp-content/uploads/statistics/SAPs_Central_Region.xlsx-2019

3.4.1 Surveys/Questionnaires

Using standard questionnaires (***Annex 1***), 382 face-to-face surveys were conducted involving: 284 respondents that were randomly selected from Kibuye I and 96 from Bwaise III. The questionnaires were designed to capture information on socio-economic and demographic characteristics, knowledge, exposure and perceptions on heat waves, impacts of heat waves and response behaviour as well as information and communication strategies around heat wave awareness and adaptation strategies uptake amongst low-income communities in Kampala. The survey data was collected using already programmed tablets - using the Kobotoolbox and Open Data Kit (ODK) applications. The choice for automated data collection exercise was justified by its cost effectiveness per questionnaire answered, reduced survey and data processing time, elimination of data entry errors, incorporation of completeness and consistency checks as well as its ability to capture photos and geo-locations.

3.4.2 Focus Group Discussions

A total of eight (8) focus group discussions (FGDs) were conducted during the study, whereby four were done in each of the study settlements. The broader categories of FGDs composition included male and female senior citizens and elders, youths, business operators and local leaders. Generally, there were 70 participants in FGDs out of which 35 were female and 35 males, with an average age of 35 and 32 years respectively. Four FGDs, disaggregated by gender, were conducted in each settlement targeting households and business enterprises. The FGDs intended to get a deeper understanding of heat risks and communication strategies and were accordingly structured to capture knowledge, effects and perception of heat risk, responses to heat waves and communication strategies to heat waves. An appropriate FGD checklist was designed to guide the discussions with the group discussions (*see Annex 2*).

3.4.3 Key Informant Interviews

A total of 12 key informant interviews (KIIs) were conducted with strategic respondents purposively selected from government ministries and agencies, civil society organisations, community networks and local leaders whose work centrally focuses on adapting to climate change extremes especially drought and heat risks within Kampala city. One local leader coupled with a business operator were drawn from each of the targeted communities. In addition, civil society key informants were from; Focus for Life Youth Development Link, Tukikirewamu Community Based Organisation, Rising Capital, Sustainable Community Initiative for Empowerment, Uganda Red Cross Society (URCS) and the Red Cross Climate Change Centre, while Ministries, Departments and Agencies (MDAs) included; Kampala Capital City Authority (KCCA), Ministry of Health (MoH), and Ministry of Water and Environment (MWE). The KIIs provided an in-depth understanding of heat risks and communication strategies and were accordingly structured to capture knowledge, effects and perception of heat risk, responses to heat waves and communication strategies to heat waves. An appropriate KII checklist was designed to guide the discussions with the group discussions (*see Annex 2*).

3.4.4 Secondary document review

The study also involved a comprehensive desktop review of heat risk related documents and other secondary data sources that included books and journal articles, technical reports, and policy papers from government, donor agencies, NGOs and Think Tanks. The document review aimed at profiling Kampala's context of heat risk, as well as taking

stock of the information related to the effects, responses, and communication strategies around heat risks. In addition to document reviews, media reviews were conducted to capture relevant information on heat waves in Kampala city. In doing so, social and print media reporting about heat waves and risks were analysed to explore temporal and spatial facets of risks, actors, nature of responses, and target groups across different levels. The personal and institutional (especially Ministry of Health (MoH), Ministry of Water and Environment (MWE). World Health Organisation (WHO) and Kampala Capital City Authority (KCCA) Twitter and Facebook media accounts, online tabloids, and newspapers were reviewed.

3.5 Data collection

Secondary data collection started in May 2022 while primary data collection process commenced in August 2022, involving; survey administration, focus group discussions, key informant interviews. The study team consisted of graduate student researchers from different units of Makerere University i.e., Urban Action Lab (UAL), Makerere University Centre for Climate Change Research and Innovations (MUCCRI), and School including Public Health, Business, Computing and Technology. A total of 12 researchers (i.e., 70% were female and the rest male) were recruited to conduct field data collection in the targeted settlements. The recruited data collectors were trained to go over the study objectives and outcomes of the study, study methodology, interviewing skills, techniques for facilitating, moderation, and recording of responses to enable the collection of quality data. Further, data collectors went through the data collection tools to acquaint themselves with the contents coupled to role plays performed on the different tools. All the data collectors were across the entire data collection period accompanied and supervised by the study lead and some were given an opportunity to participate in data analysis and report writing.

The research tools were piloted in Kasubi informal neighbourhood, near Makerere University. Kasubi was preferred because it possessed similar conditions of informality (i.e., a slum settlement with informal business activities) identical to the study sites. The piloting involved engagement with a total of twenty-five individuals. The pretesting of the discussions and interview tools provided an opportunity to the study team, including data collectors to test the validity of the questions, duration of the interviews, and flow of the questionnaire. In addition, pretesting helped the study team to acquaint themselves with the content of the tools prior actual implementation. Across all contexts, the team held debrief and reflection meetings to discuss observations and experiences that aided in the rectification and validation of the final data collection tools. Final copies of the tools were updated and reproduced by the lead researcher in consultation with the study supervisors at Makerere University.

Before data collection, courtesy call meetings were held between researchers of Makerere University and local leaders in the settlements to introduce the research and share reactions around the different research ideas concerning community experiences and perceptions around heat waves. This was followed by identification of four community members to accompany the data collectors during the data collection process as a way of building trust and securing community penetration. Each of the data collectors was provided with an A3 paper coloured map for each settlement to guide the selection of respondents during the survey. Whereas survey data was submitted on the online server for the study, KIIs and FGDs data was recorded and stored on the lead researcher's personal computer for effective data management and safety. The process of data collection occurred in adherence to the COVID-19 Standard Operating

Protocols (SOPs) from the Ministry of Health and other relevant authorities as a way of containing the risks of exposure to the researchers, respondents, and communities.

3.6 Data processing and analysis

As already mentioned, data was collected using programmed tablets with Kobo toolbox and Open Data Kit (ODK) application. Collected data was submitted to the online server created for data storage and management immediately after each day's field data collection exercise. Such data was downloaded, standardised and imported into SPSS Version 25 software. Descriptive statistical analysis was employed to analyse data using frequencies and percentages, means, standard deviations. Other appropriate quantitative techniques like cross tabulations and chi-square tests were also employed to estimate heat risk perceptions and communication strategies across social groups. The disaggregated data was analysed based on social demographic characteristics. The chi square statistic is defined as; -

$$X^2 = \sum_{i} \frac{(O_i - E_i)^2}{E_i} \quad \text{..... (ii)}$$

Where, X^2, is the chi-square value, O_i is the observed number of cases in category i, and E_i is the expected number of cases in category i.

Qualitative data from KII and FGDs was transcribed and analysed using content analysis and presented thematically. The thematically analysed data was triangulated to inform the interpretation and inferences drawn from other sources. Such analysis aided the examination of words and phrases to ascertain understanding of perceptions, experiences, events, locations and cross-cutting issues around heat waves in Kampala city.

4. Findings and Discussions

This section presents the findings of the study. It begins with providing an overview of respondents' socio-demographic and economic characteristics, followed by knowledge, exposure and perceptions on heat waves, impacts and response behaviour during heat wave events. Further, the communication and outreach strategies result in the largest uptake of self-protective measures for vulnerable groups in Kampala city.

4.1 Socio-demographic and economic characteristics of the respondents

The study was carried out within low-income communities/settlements in Kampala city. The settlements covered were Kibuye 1 76% (290) and Bwaise III 24% (92) parishes in Makindye and Kawempe divisions respectively (*See Table 1*). Generally, 66% (252) of the respondents were households and 34% (130) were business enterprise operators or owners within the low-income communities (*See Figure 4*). Further, Figure 4 shows that 68% (260) of respondents were female whereas 32% (122) were male.

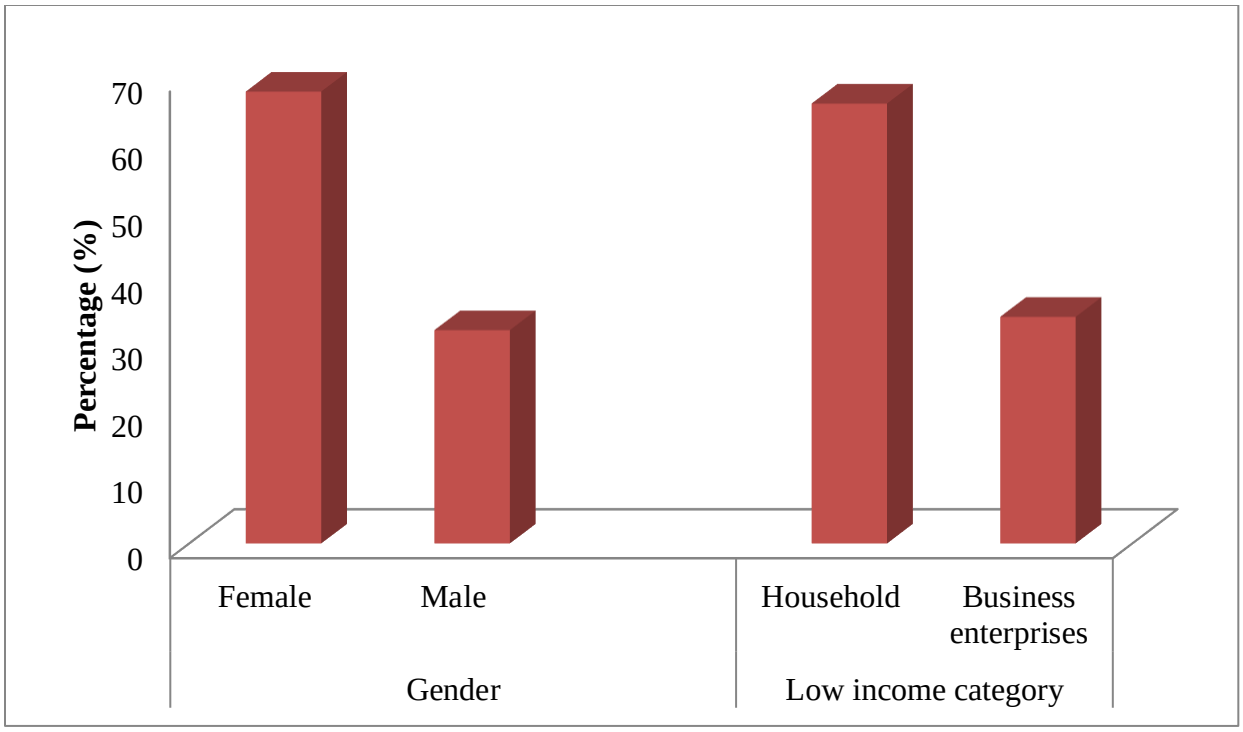

Figure 4: Gender and low-income category of respondents

Table1 portrays the socio-demographic and economic characteristics of respondents distributed across gender. Most of the respondents were youths (59%) aged between 18-35 years followed by middle aged people 37% of ages ranging between 36-60 years and the old (greater than 60 years of age). Majority of the respondents were married (52%), 25% single, 11% separated or divorced, 6% cohabiting and 5% widowed. 69% of the respondents indicated to have between 1-5 children under the age of 5 years, 17% had no children and yet 14% reportedly had between 6-10 children under 5 years of age. In regard to levels of education, 47% revealed to have attended advanced and ordinary secondary education, 32% primary education, and 7% never attended any education. Only 13% (51) of the respondents reported cases of disability including; sensory and mental disabilities, cerebral pulse, albinism and dwarfism.

Table 1 further illustrates that 48% of the respondents had business enterprises as their main source of income, 21% revealed casual labour as the main income source and 20% mainly earned from formal/informal employment. The business enterprises reported included; retail shops, restaurants, hair salons, market vending, motor vehicle and motorcycle spare parts shops, clinics, charcoal kiosks, tap water selling, crafts, beverage shops, agro-produce sales, rentals, boutiques, tailoring and knitting, carpentry, shoe making, bars, electronics and light snacks sales. The different forms of casual labour identified included; laundry services, building and constructions, bar/shop attendants, street vending, taking care of children, cleaning services, hair dressing, hawking, fruit and vegetable selling and outside catering. The respondents employed formally or informally work as clinicians, wardens and politicians under Kampala Capital City Authority (KCCA), electrical technicians with UMEME, hotel attendants, security operatives, waitresses, boda-boda riders and accountants. Other main sources of income (11%) included remittances and support from relatives, friends and family members. 38% of the respondents indicated to work within buildings, 24% work under

direct sunlight, 14% under metallic or wooden kiosks, 5% under temporary shade or verandah and 2% below a tree shade. 12% indicated to operate in a mobile work environment within trucks, street trade and others are hawkers.

Table 1: Socio-demographic and economic characteristics of the respondents (n=382)

Socio-demographic and economic characteristics		**Number of responses (%)**		
		Male	**Female**	**Total**
Location	Bwaise III	9	15	24
	Kibuye 1	23	53	76
Age	18-35	20	39	59
	36-60	11	26	37
	>60	1	3	4
Marital status	Married	16	36	52
	Single	11	14	25
	Divorced/Separated	2	9	11
	Widowed	0	5	5
	Cohabiting	2	4	6
Children Under 18 years	1-5	19	50	69
	6-10	3	11	14
	None	10	7	17
Education level	Never attended formal education	3	4	7
	Primary	7	25	32
	Secondary (A and O) level	17	30	47
	Tertiary	5	8	13
Main source of Income	Formal/Informal employment	8	12	20
	Casual Labor	6	15	21
	Business enterprises	16	32	48
	Other	2	9	11
Nature of working environment	Under direct sun	8	16	24
	Wooden kiosk	3	6	9
	Metallic kiosk	2	3	5
	Below a shade(tree)	1	1	2
	Under a temporary shade	2	3	5
	Within the building	11	27	38
	Verandah	1	4	5
	Other	4	8	12

Table 2 illustrates monthly incomes of respondents. 46% of the respondents indicated to have a monthly income ranging from UGX. 150,000 to UGX. 450,000 (USD. 38.8- USD. 116.60), 20% reportedly earn greater than UGX. 450,000 (USD. 116.60) and 13% revealed to earn less than UGX. 150,000 (USD. 38.8). 21% of the respondents preferred not to reveal their monthly incomes.

Table 2: Monthly income of respondents

Monthly income (UGX.)	**Frequency (n)**	**Percentage (%)**
150,000-450,000	176	46
>450,000	77	20
< 150,000	48	13
Prefer not to answer	81	21

Figure 5 shows the productive assets of respondents in the study area. Majority 40% (154) of the respondents indicated to have mobile phones as productive assets while a significant proportion 28% (106) revealed to have no productive assets. 11% (42) reportedly owned houses, 6% (24) owned land and motorcycles, 5% (18) livestock and 2% (8) had motor vehicles and 2% (6) had bicycles as productive assets.

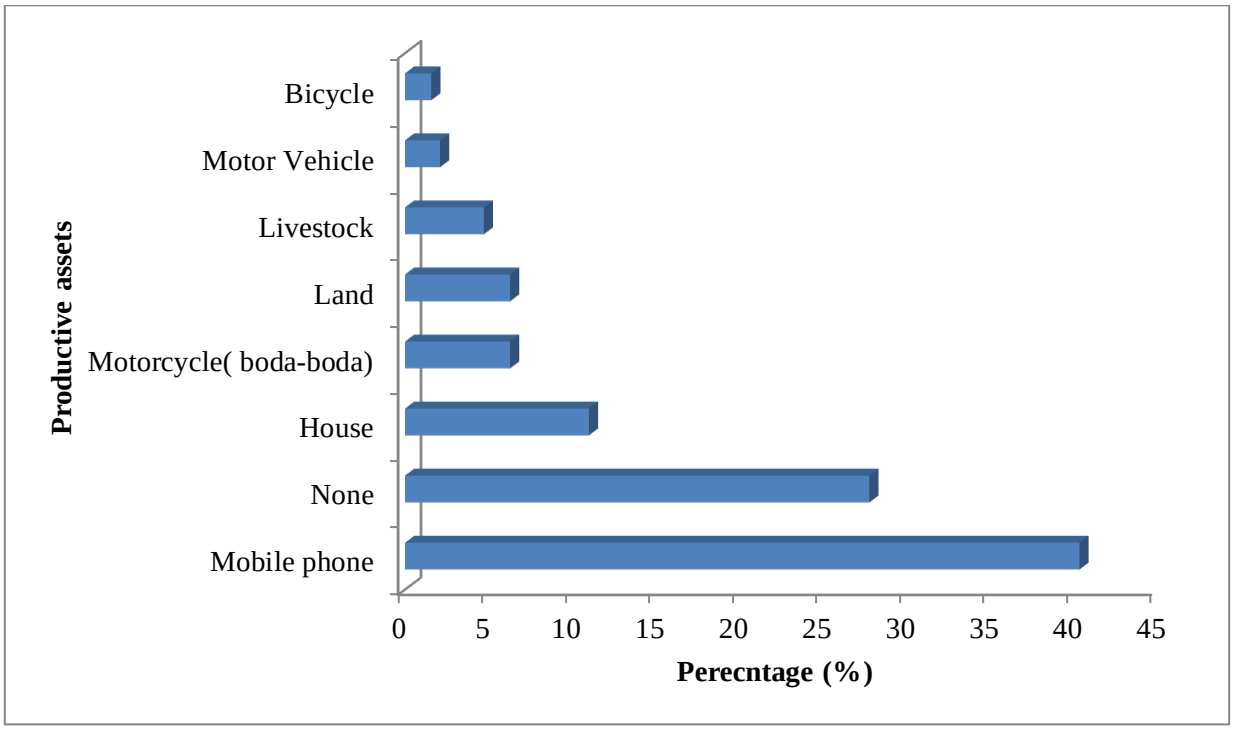

Figure 5: Productive assets of respondents

4.2 Knowledge, exposure and likelihood of heat waves in Kampala

This section presents findings on the perceived knowledge, exposure and likelihood of heat waves within low income settlements in Kampala city. Sections 4.2.1 and 4.2.2 below detail the knowledge on and experience of heat waves and exposure and likelihood of extreme temperatures in Kampala city.

4.2.1 Knowledge on and experience of heat waves

Figure 6 shows the perceived knowledge and experience of extreme temperature events amongst low-income settlements in Kampala city. The results indicated that 93% of the respondents had experienced unusually hot weather or extreme heat. There were however variations in the frequency of experiencing such extreme heat across the respondents i.e 38% of the respondents revealed to often experience hot weather, 35% reported to experience it occasionally, 14% rarely experienced it and only 1% never experienced hot heat waves. The majority of the respondents (57%) reported afternoon times especially early and mid-afternoon hours (i.e., from 12:00-16:00 HRS), and most (47%) indicated experiencing hot temperatures whereas another 38% revealed to have experienced very hot temperatures (*See Figure 6*). Only 9% and 6% of the respondents revealed to have experienced somewhat hot and warm temperatures respectively. The FGDs indicated that hot temperatures are most intense during the day and yet the gradual release of heat from housing, roads and building infrastructure at night (e.g., from 22:00-03:00 HRS) keeps

informal settlements much hotter. Most respondents revealed to have experienced recent heat waves in the month of July 83%, (317), followed by June 57%, (217), January 39%,(150), May 24%, (93), March 17%, (66), April 16%, (60), February 13%, (50), August 12%, (12), December 8%, (32), September 6%, (23), November and October 3%, (11) each **(**See Figure 7**)**.

> *"It is on record that 2009, 2016 and 2020 have been the warmest years across the country…..however, there have been variations in temperature increase with urban areas like Kampala becoming more warm". Says respondent from the Ministry of Health (MoH) Climate Change Department.*

The occurrence of heatwaves was attributed to multiple factors including; deforestation, overpopulation and high housing density, weather changes, wetland degradation, urban sprawl, high vehicular density, increased impervious surfaces through housing and infrastructural development, limited vegetation cover, as well as atmospheric pollution. Key informant interviews revealed that buildings, roads and urban infrastructure absorb heat leading to hotter temperature in urban areas through the urban heat island effect than peri urban and rural areas. The mostly highlighted hot areas in Kampala city included; Katanga, Kibuye, Nanganda, Mukilombe, Luwafu, Kawempe-Mukiswera, Kabusu, Nakulabye, Bukoto, Mengo, Kasubi, Owino market, Kalerwe, Nakivubo, Nakasero market, Katwe, Ndeeba, Nanganda, Kilombe, Luwafu. The common unique aspects about such areas is that they are higher population and economic activities concentration zones, sites for dense housing and settlements within the city and lack vegetation cover compared to areas like Kololo, Nakasero, Lubiri, Muyenga, Ntinda, Naguru, Munyonyo, Makerere University, Nakasero among other affluent settlements that were indicated to be fairly planned, located on hilltops that are associated with cool breeze, inhabited with people that are conscious about the benefits of environmental protection and still have vegetation cover in form of trees. The industrial areas and transport hubs (i.e., tax! parks) across the different parts of the city were also reported to be warmer compared to residential areas. The FGDs revealed indicators that lead to extreme temperatures in low-income communities as follows;

> *"Low-income communities are mainly covered by informal and unplanned settlements due to overpopulation, increasing higher chances of heat absorption and generation……such areas have limited vegetation cover and also have inadequate space for planting trees which limit micro-level climate modification……. housing units and business spaces are congested which limits aeration, they are transportation corridors with higher number of vehicles emit Greenhouse Gases (GHGs) which increase temperatures". Says respondent from Ministry of Water and Environment.*

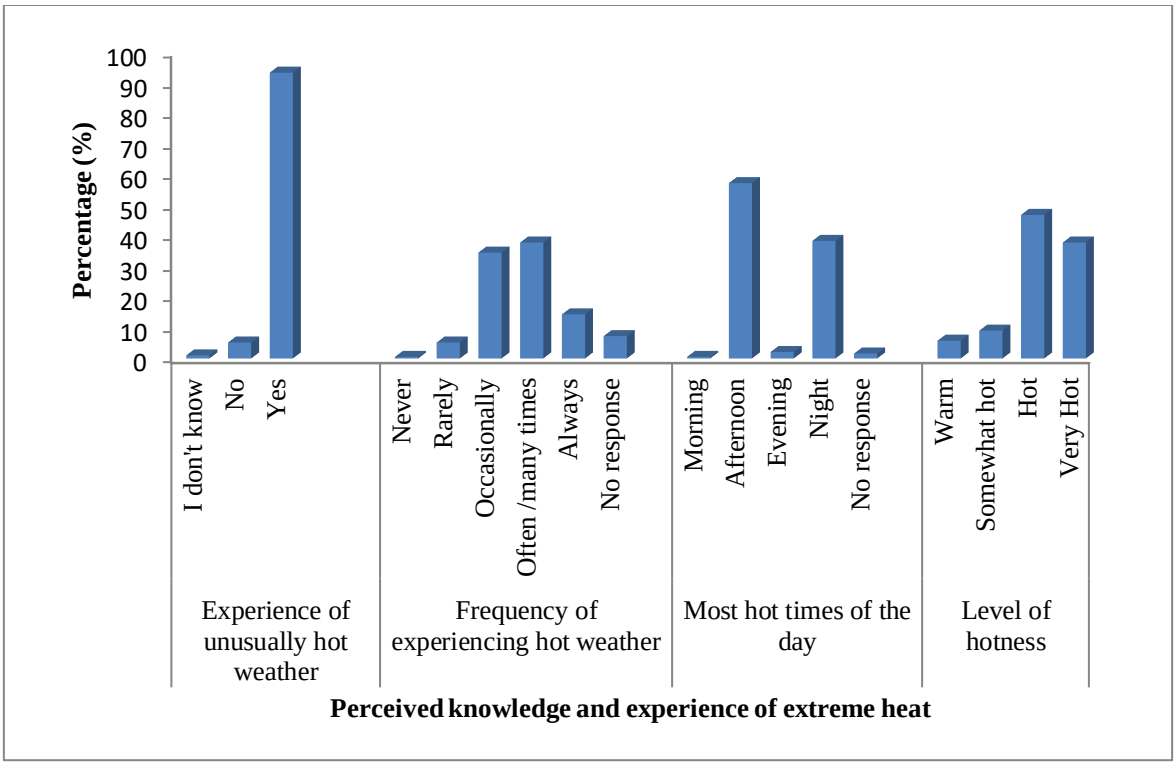

Figure 6: Perceived knowledge and experience of extreme heat in low-income communities

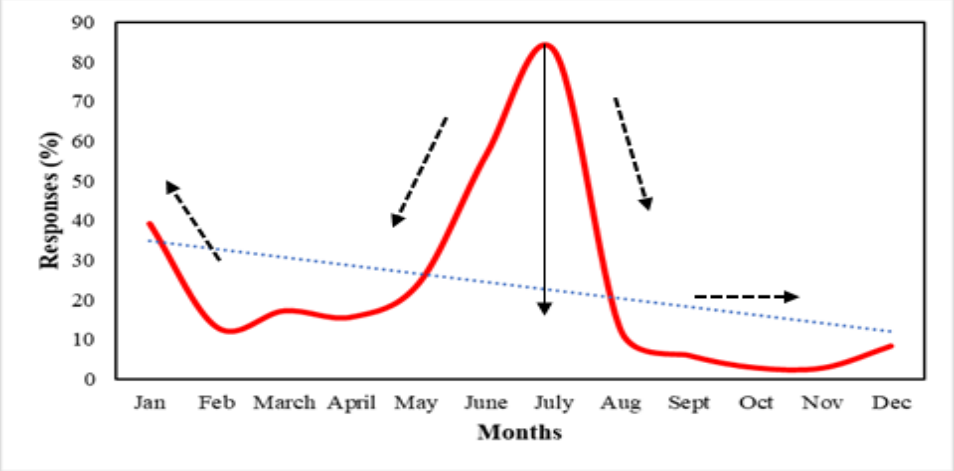

Figure 7: Monthly extreme heat experience in Kampala city

Results of association of respondents' social economic factors with perception on knowledge and experience of heat waves are shown in Table 3. Generally, the association of knowledge on and experience of extreme heat waves with socio-economic categories indicated stronger association with extreme heat experiences amongst business enterprises within low-income communities. Further, age, marital status, main source of income and monthly income significantly associated with results on heatwave knowledge and experience.

In regard to perception of unusually hot weather experience, there was significant statistical association with study areas with Pearson's chi-square of (X^2=13.6, df=1, n=382), P=0.004. Kibuye depicted a high number of responses

with 72% compared to Bwaise III with 22%. This could have been due to the representative population and sample sizes that varied with Bwaise III having a smaller number compared to Kibuye I. In addition, age of the respondents recorded significant association with responses on perceived frequency of experiencing hot weather with (X^2=26.7, df=2, n=382), P=0.003). In particular, the majority 22% of the respondents aged between 18-35 years of age perceived that hot days occurrence is becoming more often, followed by those aged between 35-60 years (21%). Furthermore, age was a significant factor to influence perception on the level of hotness by the heat wave events in Kampala X^2 (15.5, df=3, n=382), P=0.04. Respondents aged between 18-35 years highly perceived heat wave events as very hot with 26% and the 22% perceived them as very hot. This was followed by 20% of those between 35-60 years who perceived the waves as hot and 15% as very hot. The predominance of youth populations (aged between 18-25 years) and middle to older persons (aged between 35-60%) in low-income settlements and informal business enterprise operations explains such level of significance in experiential events and level of hotness of heatwaves in Kampala city.

In regard to perceptions on the hottest times of the day, marital status, responses varied significantly across these social categories with chi square values of X^2 (28.9, df=4, n=382), P=0.02 as seen in Table 3. Of the respondents living a single life, 27% perceived afternoon hours as the hottest while 17% perceived night hours as the hottest times. 23% of the married people perceived afternoon hours as the hottest. The nature of housing in the settlements probably compels the roof structures and walls to absorb alot of radiation during the day which is emitted at night hence making indoor temperatures higher than those outside.

The findings revealed that the respondents' main source of income was significantly associated with perception on most hot times of the day during heat wave events in Kampala X^2, (29.93, df=3, n=382), P=0.003). Majority of the respondents with businesses as the main source of income 31% were biased on the afternoon hours as the periods with the hottest temperatures especially between 12:00hrs to 15:30hrs. The FGDs and key informant interviews with business enterprise owners or operators and local leaders portrayed that most of the buyers and clients reduce movement to retail shops, markets amidst hot temperatures. Further, it was highlighted that businesses mostly operate under direct sunlight or within premises that absorb temperatures and this at times compels buyers and sellers to seek refuge under shades as a way of protecting themselves from dangerous heat. Accordingly, business activity significantly reduces during hot times of the day with direct impact on transactions, income and exchange of goods and services.

Monthly income also showed a statistically significant association with perception of the level of hotness amidst the heatwave periods in Kampala X^2 (31.2, df=3, n=382), P=0.002. Majority (37%) of the respondents who earn a monthly income of more than UGX 150,000 (USD. 38.8) perceived heat waves experienced in Kampala to be hot and yet 34% perceived extreme temperatures as very hot conditions. The nature of business enterprises such as shoe shiners, vegetable sellers, hawkers, charcoal kiosks and small retail shops determined individual perception on the level of hotness in Kampala. Most businesses in low-income communities are informal and operate in open places or under wooden walls, plastics, old iron sheets makeshift shelters that are susceptible to heat adoption and emission respectively.

Table 3: Perceived knowledge and experience of extreme heat (n=382)

Perceived knowledge and extreme heat experience		Social categories of low-income communities																								
		Study sites		Sex		Age (years)			Marital Status					Highest Education level					Main source of income				Monthly income ('000) Ugx		
		Bwaise III	Kibuye I	Male	Female	18-35	36-60	>60	Single	Married	Separated	Cohabiting	Widowed	No education	Primary	Secondary	Tertiary	Formal	Casual	Business	Others	<150	150-450	>450	No response
Experience of unusually hot weather	Don't know	0	0	1	1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0
	No	2	4	2	4	4	2	0	3	2	2	0	0	0	1	3	1	1	2	2	0	0	2	3	0
	Yes	22	72	30	64	53	37	3	48	24	10	5	6	6	32	44	12	18	19	47	10	13	43	35	3
	X^2	**13.6** (0.004)**		1.5 (NS)		6.1 (NS)					8.01 (NS)				7.1 (NS)				10.7 (NS)				4.87 (NS)		
Frequency of experiencing hot weather	Never	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rarely	1	4	2	3	7	1	0	2	2	0	0	1	0	2	2	1	1	1	3	0	1	2	2	0
	Occasionally	8	26	12	26	19	13	2	19	9	4	2	1	2	12	17	4	9	7	13	3	5	17	12	1
	Often	10	35	11	30	22	21	1	19	9	5	2	4	3	17	21	5	6	7	24	5	5	18	15	1
	Always	2	13	5	9	7	7	1	7	4	1	1	1	1	4	7	3	2	2	8	2	2	6	6	0
	X^2	8.5 (NS)		3.5 (NS)		**26.7** (0.003)**					27.2 (NS)				6.7 (NS)				14.9 (NS)				8.18 (NS)		
Most hot times of the day	Morning	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Afternoon	13	47	20	38	35	22	1	27	17	6	2	5	4	16	30	7	7	13	31	6	7	26	23	1
	Evening	0	2	1	1	1	1	0	1	0	0	0	1	0	1	1	1	0	1	1	0	1	0	1	0
	Night	11	29	10	29	21	16	2	23	7	5	3	1	2	15	16	5	11	7	16	4	6	18	13	2
	X^2	2.6 (NS)		8.3 (NS)		6.6 (NS)					**28.9* (0.02)**				14				**29.93** (0.003)**				8.5 (NS)		
Level of hotness	Warm	1	5	1	5	4	1	1	3	2	1	0	0	0	3	2	1	2	1	3	0	1	2	3	0
	Somewhat hot	2	7	3	6	6	3	0	6	3	1	0	1	0	3	6	1	2	2	5	0	2	5	2	0
	Hot	13	33	15	33	26	20	1	24	12	6	3	1	3	16	22	7	11	8	24	5	8	24	13	2
	Very Hot	7	31	12	26	22	15	1	19	10	3	2	4	3	11	19	5	6	10	18	6	3	14	20	1
	X^2	3.6 (NS)		1.4 (NS)		**15.5* (0.05)**					14.5 (NS)				16.3 (NS)				17.2 (NS)				**31.2** (0.002)**		

X^2 (Pearson's chi value), *(p<0.05), *(p<0.01), NS-No significant statistical association

4.2.2 Exposure and likelihood of heat waves in low-income settlements

Figure 8 illustrates the perceived exposure and likelihood of extreme heat in Kampala city. It was established that 51% of the respondents agree that extreme temperature is a problem in Kampala and another 51% also indicated that the number of hot days in Kampala is more likely to increase. (*See Figure 8*). The study revealed that 46% of the respondents were often worried about experiencing unusually hot temperatures in Kampala and 27% indicated to be occasionally worried about hot temperatures. In general, 74% of the respondents rated the extreme temperatures in Kampala as severe, with July being mentioned as the hottest month followed by June, January, May and March. The months of April, February, December and August were also indicated to be hot. 2022 was mostly cited as the hottest year with serious effects on low-income communities. Interactions with various stakeholders indicated that the changes in temperature have been significant more than one decade ago. The focus group discussions and interviews also revealed that there is an observed increase in extreme temperatures since 2019, through 2020, 2021 and currently 2022. Such trajectories are reflected in the responses from interviews as follows;

> *"…….I have been in Kampala since 1985, the place used to be cool until 2010 when things have changed…….we have been experiencing heat waves because the wetlands and trees have been cleared and the population has increased"..... "in the 1990s the temperatures were cool but in the last five years there has been a significant increase in the heat waves yet people are ignorant about preserving the environment". Said the local leaders of Bwaise III and Kibuye I respectively.*

> *"…….my observations are that heat waves have greatly increased in the past five years, and 2019 was extremely hot compared to other years…. In 2022, months that have been so hot include January, February, June, and July. During the daytime, extreme temperatures are relatively higher than during the night…..However the impact is highly felt in the night and the severity is really high". Indicated by the respondent from Uganda Red Cross Society (URCS).*

While 68% revealed that it is unlikely that heat waves will be occurring more frequently within a year, about 31% of the respondents reported that the frequency of extreme heat occurring within a year is likely *(See Figure 7*). Besides, 74% of the respondents indicated that there is a likelihood of an increase in the number of hot days within a month. Such is attributed to current sporadic urban and infrastructure development and expansion, environmental degradation and increase in settlement density. The respondents indicated likelihood of extreme heat in Kampala city as follows;

> *"….from the scientific data about climate change, the heat waves are likely to increase because all factors that are attributing to extreme temperature events are on the rise for example the cutting down of trees, use of fossil fuels, buildings are sprouting everywhere…..I think there will be too much heat in the next 20 years…" Says respondent from the Ministry of Health (MoH) Climate Change Department.*

"Several analyses have been done around Kampala and it is clear that it is experiencing an increment in temperatures due to GHGs emissions which are not necessarily coming from the city alone but as a result of global warming..... climate projections show that temperatures are increasing for example it is predicted that temperatures will increase from 1-3℃ under the worst case scenario....the intensity, magnitude and severity is on the rise at different scales per decade....heatwaves correspond with increase in temperatures and these have commonly been experienced in the informal settlements of Kampala ". Says the respondent from the Ministry of Water and Environment (MWE), Climate Change Department.

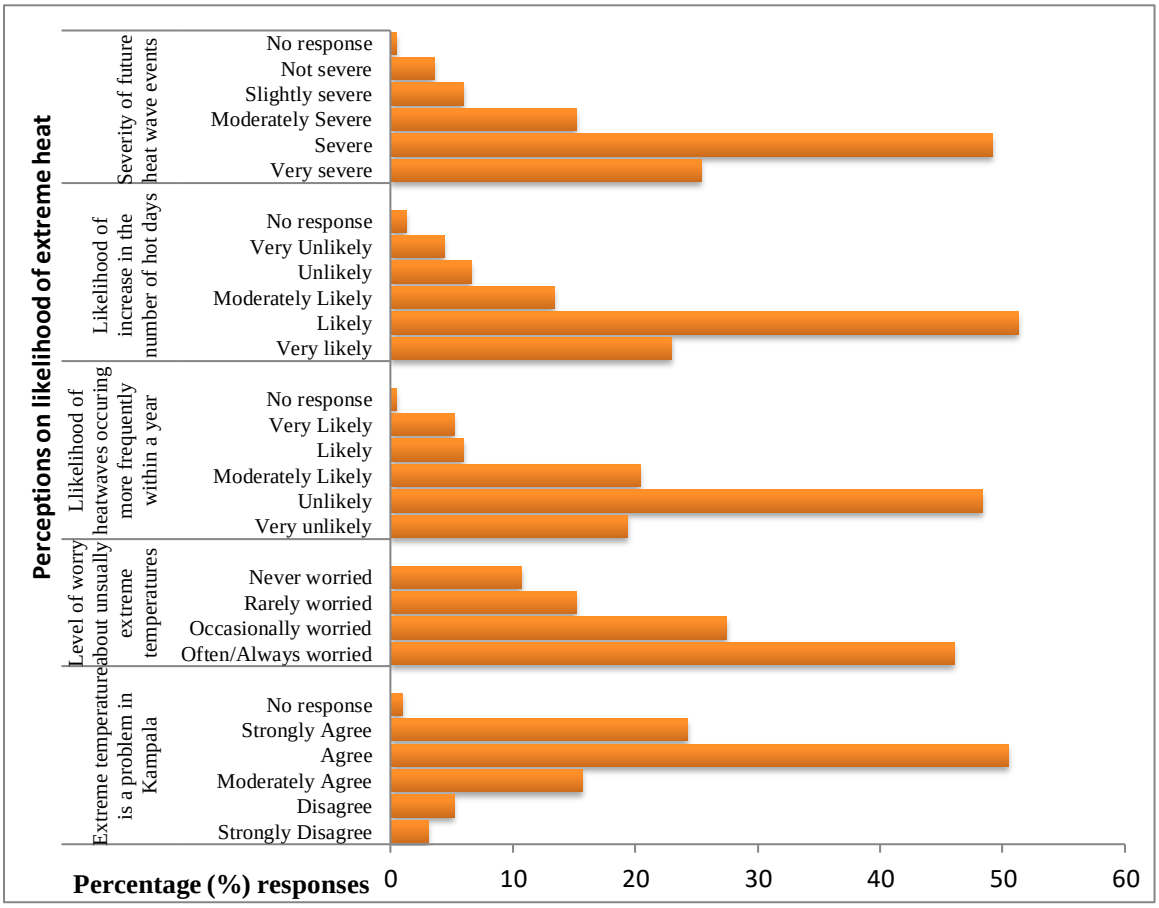

Figure 8: Perceived likelihood of heat risks in Kampala

Table 4 presents results on the perceived exposure and likelihood of heat waves across the social categories. Generally, several social categories were significantly associated with the different perceptions on exposure to dangerous heat and its likelihood of occurrence in Kampala. The main source of income as a social category revealed a stronger significant association with perceived worrying levels about unusual extreme temperatures (X^2 (34.9, df=3, n=382) P=0.002). Majority of the respondents (25%) relying on businesses were always worried about the unusual extreme temperatures compared to the (6%) for formal and informal income sources. Concerning perception on severity of heat wave and main source of income, results also show that the majority of respondents with business (26%), were severely affected by heat waves as compared to the 2% for informal and formal sources of income with a significance

statistical association of X^2 (26.9, df=3, n=382) P=0.029. In addition, the main source of income significantly influenced responses on the perceived increase in the heatwave within a year X^2 (36.6, df=3, n=382), P=0.001. Majority (24%) of the respondents with business enterprises perceived the increasing occurrence of heatwave to be unlikely and 10% very unlikely to occur within a year.

In relation to severity of heatwaves, age was significantly associated with varying severity of heat waves depicted by X^2 (23.7, df=2, n=382), P=0.008. For example, the majority (14%) respondents aged between 18-35 years of age followed by those between 36-60 years with 11% revealed heatwaves to be very severe. Besides, the highest number of respondents 29% between 18-35 years reported heat waves to be severe followed by 20% of those aged between 36-60 years of age. Age therefore significantly influenced the perceptions on extreme heat temperatures being a problem in Kampala city X^2 (19.8, df=2, n=382), p=0.03. Majority 30% of respondents aged between 18-35 years of age agreed that heat waves are a problem to Kampala followed by those aged between 35-60 years (20%). Moreover, only 12% of respondents strongly agreed that extreme temperatures are a problem in Kampala.

Marital status significantly influenced responses on heatwave severity perceptions with X^2 (41.9, df=4, n=382), P=0.003. Majority of respondents (29%) who were single (Not married) perceived heatwave to be severe and 12% perceived it as very severe. This was followed by the married ones who also attested that heat waves are severe and very severe reflecting 12% and 6% respectively. Similarly, marital status influenced perception on the number of hot days in Kampala X^2 (37.6, df=4, n=382) P=0.01. Still, the majority (28%) of the single (not married) respondents perceived that hot days were likely to increase, and 10% perceived a very likelihood of hot days increasing. Married respondents followed with 12% who perceived a likelihood in hot days occurrence increment.

Monthly income as a social economic factor also significantly influenced the respondents' perceptions on the severity of dangerous heat in Kampala, showing a significant association of X^2 (29.4, df=3, n=382) P=0.014. For example, the majority (22%) of the respondents who earned >450,000 UGX were always worried, followed by those who earned between 150000-450000 UGX (18%). KIIs revealed that business respondents were always worried about hot temperatures due to the fear of making losses, damage of stock before it reaches expiry date, reduction in customers among other factors. However, a higher number (23%) of respondents who reported to earn between 150000-450000 UGX perceived that hot days were likely to increase in a month compared to only 8% for those who earned more than 450,000 UGX with X^2 (33.5, df=3, n=382) P=0.004).

The age of the respondents significantly influenced perception on likelihood of increase in the hot days within a month X^2 (37.4, df=2, f=382), P=0.000). Majority (30%) of the youths aged between 18-35 years perceived an increase in hot days followed by middle aged persons (20%) between 35-60 years of age. Such findings were attributed to the decreasing vegetation cover and tree canopy, destruction of wetland corridors, heavy vehicular flows and increased impervious surfaces as well as factories which leads to warmer temperatures in the city. The FGDs revealed that investors, entrepreneurs and urban populations have encroached on wetlands for industries, housing and commercial activities hence increasing the susceptibility of Kampala to urban heat island effects for several days in the coming years.

The respondents' age also influenced their perception on the likelihood of the heat waves occurring in a year X^2 (20.2, df=2, n=382), P=0.027. Most respondents (31%) aged between 18-35 years of age perceived that heat wave occurrence is likely to increase in a year followed by 17% of those aged more than 60 years. A few 11% for 36-60 and 8% for 18-36 perceived a very high likelihood of heat wave occurrence within a year. These findings correlate with future climate models that predict an increase in anthropogenic GHGs emissions that will increase the warming of the earth, with more effects to be disproportionately felt in urban areas.

Table 4: Perceptions of likelihood of extreme heat in Kampala(n=382)

Perceptions on likelihood of extreme heat		Study sites		Sex		Age (yrs)			Marital Status					Highest Education level				Main source of income				Monthly income ('000) Ugx			
		Bwaise III	Kibuye I	Male	Female	18-35	36-60	>60	Single	Married	Separated	Cohabiting	Widowed	No school	Primary	Secondary	Tertiary	In/Formal	Casual	Business	Others	<150	150-450	>450	No response
Extreme temperature is a problem in Kampala	Strongly Disagree	.1	3	1	2	2	1	1	1	1	0	1	0	0	2	2	1	2	0	1	0	0	1	2	0
	Disagree	2	8	1	4	5	1	0	3	1	0	0	0	1	2	2	1	2	1	2	1	1	2	2	0
	Moderately Agree	6	10	5	11	10	6	1	7	5	3	1	1	1	5	7	3	3	4	6	3	3	7	5	1
	Agree	11	40	16	36	30	20	2	27	13	6	3	2	3	18	25	6	9	10	28	5	6	27	17	1
	Strongly Agree	5	20	9	16	12	12	0	14	6	1	1	3	2	6	13	4	4	5	13	2	4	9	11	1
	x2	7.4		2.9		**19.8* (0.03)**			29.7					11.2				16.6						17.8	
Level of worry about unusually extreme temperature	Never worried	3	8	3	7	7	3	1	5	4	1	1	0	1	5	4	2	5	2	3	1	1	4	6	1
	Rarely worried	4	11	6	9	9	5	1	8	4	2	1	1	2	5	7	1	3	4	7	1	3	8	4	1
	Occasionally worried	8	19	10	18	18	10	1	16	8	4	1	0	2	8	14	4	5	6	14	3	4	17	7	1
	Always worried	9	39	13	34	25	20	2	24	11	4	3	5	3	14	24	7	6	9	25	6	6	18	22	2
	X^2	6.28 (NS)		5.7 (NS)		9 (NS)			27.1 (NS)					10.8 (NS)				**34.9** (0.002)**					**29.4* (0.014)**	
Severity of future heat wave events	Very severe	5	21	8	17	14	11	1	12	6	2	2	4	2	7	13	3	3	6	12	5	2	8	14	1
	Severe	14	37	16	33	29	20	1	29	12	7	2	1	3	17	25	6	10	10	26	4	8	26	15	1
	Moderately Severe	4	11	5	10	11	4	1	8	5	2	1	0	1	6	6	3	5	3	6	1	2	8	4	1
	Slightly severe	1	5	1	5	4	2	1	3	2	0	1	0	0	3	3	0	1	2	3	1	1	3	2	0
	Not severe	1	3	1	3	2	1	0	2	1	0	1	0	0	1	2	1	2	0	2	0	0	1	3	0
	X^2	6.2 (NS)		2.2		**23.7** (0.008)**			**41.9** (0.003)**					14.9 (NS)				**26.9* (0.029)**					**37.9** (0.001)**	
Likelihood of heat waves occurrence within a year	Very unlikely	3	16	7	13	8	11	0	9	5	2	1	2	1	5	10	3	2	4	11	3	2	7	9	1
	Unlikely	12	36	16	33	31	17	2	29	11	6	1	2	3	17	24	5	10	11	24	4	7	24	17	1
	Moderately Likely	6	14	6	14	13	7	1	10	7	2	1	1	1	8	8	3	5	4	10	2	3	10	7	1
	Likely	2	5	2	4	3	2	1	3	2	1	1	0	1	2	3	0	1	1	3	0	1	4	2	0
	Very Likely	1	5	1	4	4	1	0	2	2	0	1	0	0	2	2	1	2	0	2	1	0	2	4	0
	X^2	6.7 (NS)		2.9		**20.2* (0.027)**			30.6 (NS)					13.6 (NS)				**36.6** (0.001)**					19.6 (NS)	
Likelihood in the increase in the number of hot days	Very likely	7	17	8	15	11	11	0	10	7	3	1	2	2	7	10	5	4	4	12	3	3	9	10	1
	Likely	12	42	16	35	30	20	1	28	12	5	2	4	3	18	25	6	9	13	25	6	8	23	19	1
	Moderately Likely	3	11	4	9	9	4	0	8	4	1	0	0	1	6	6	1	3	3	7	1	2	7	4	0
	Unlikely	2	5	2	5	4	2	1	3	1	1	1	0	1	2	4	0	2	1	3	1	0	5	2	0
	Very Unlikely	1	4	1	3	3	1	0	2	2	0	1	0	0	1	2	1	2	0	2	1	0	1	3	0
	X^2	3.5 (NS)		1.8 (NS)		**37.4** (0.000)**			**37.6* (0.01)**					13.3 (NS)				17.6 (NS)					**33.5** (0.004)**	

Note: X^2 (Pearson's chi value), *(p<0.05), *(p<0.01) ; NS-No Significant statistical association

4.3 Sensitivity, effects and response behaviour to heat waves amongst low-income communities

4.3.1 Sensitivity to and effect of heat waves on livelihoods

The results on the sensitivity of the people in low-income settlements to heat waves are shown in Figure 9. It was revealed that 50% of the respondents are sensitive to heat waves, 26% are very sensitive, 11% are somewhat sensitive and 8% of the respondents are slightly sensitive (See Figure 9). Further, only 5% of the respondents reportedly revealed that they are not sensitive to the heatwaves.

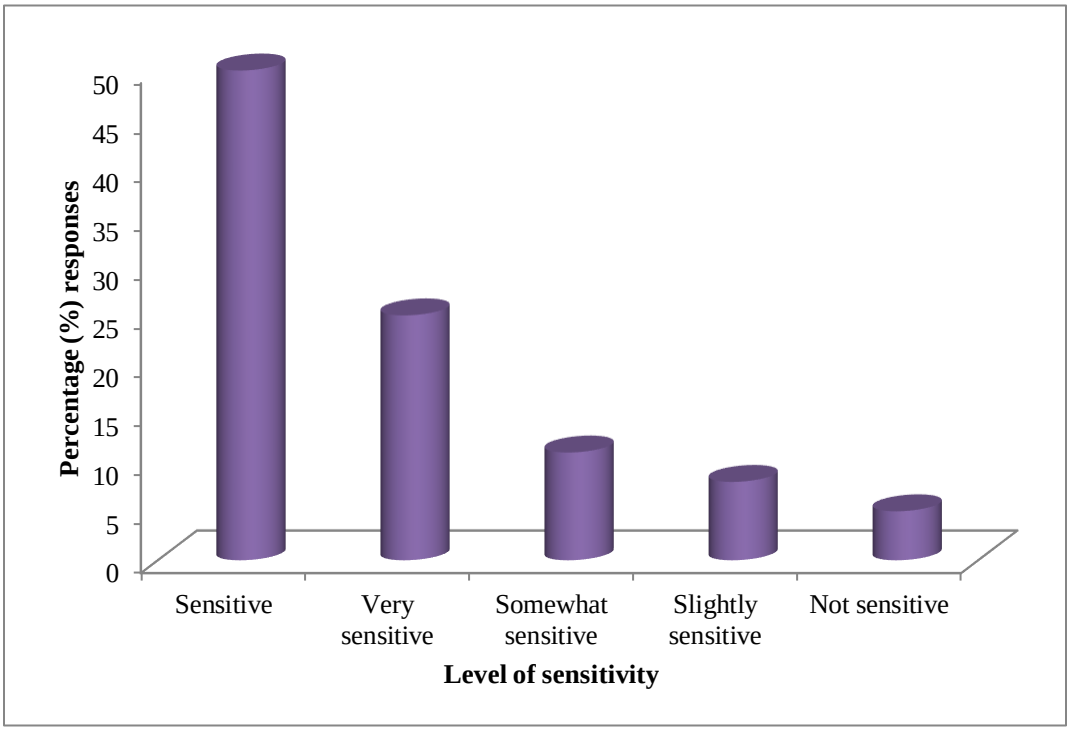

Figure 9: Level of sensitivity to heat waves

The effect of extreme temperatures on heat waves was also explored during the study. The findings indicated that slightly above average (51%) of the respondents' livelihoods are affected by heat waves, 23% strongly affected and 14% moderately affected (See Figure 10). In addition, 6% reported to be slightly affected by heat waves and another 6% revealed not to be affected by extreme temperatures. The effect of heatwaves on livelihoods was substantiated as indicated below;

> *"The heat waves were not as high as they are now because the environment was still intact and the population by then was low. We didn't have much housing density with tenants and every home at least had a tree and some lawns in their compounds or plot of land.....but now rentals are everywhere and these people either use charcoal or firewood which leads to increase in the hot temperatures that in turn affect livelihoods in all forms of wellbeing".* ***Says the respondent from the Uganda Red Cross Society (URCS).***

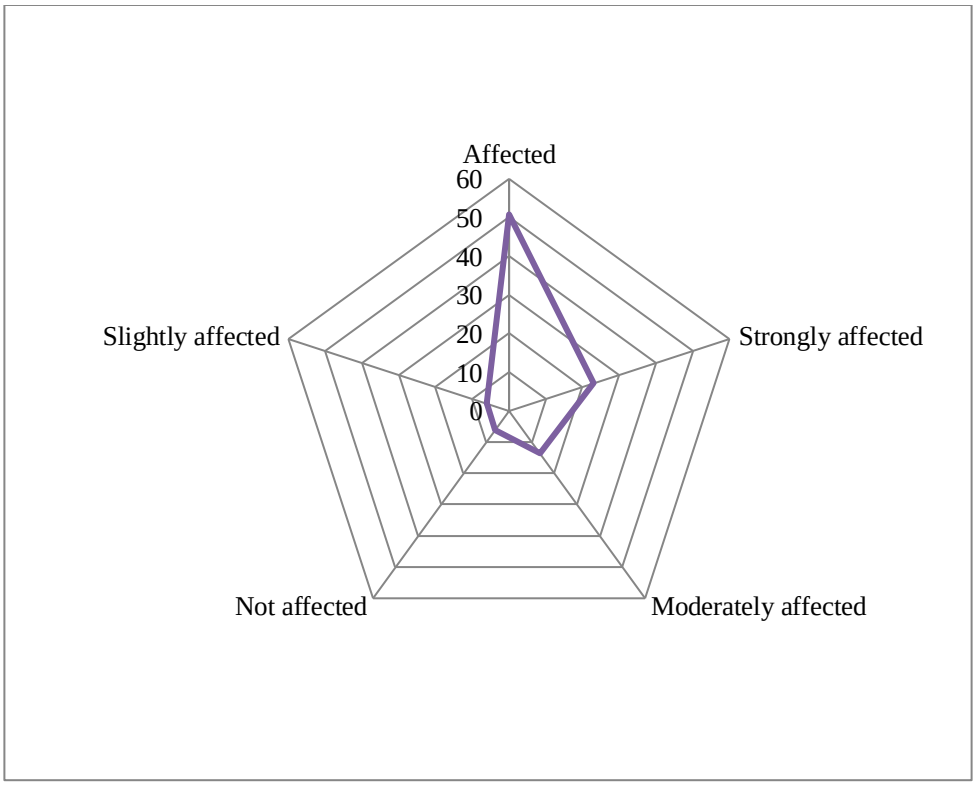

Figure 10: Effect of heat waves on livelihoods

4.3.2 Socio-economic, health and environmental effects of heat waves

The study identified the socio-economic, health and environmental effects of heat waves on the livelihoods of people in low-income communities within Kampala city (See Figures 11, 12, 13 and 14). Figure 11 portrays the social effects of extreme temperatures in Kampala city. A significant number of respondents (65%) indicated less human mobility as the main social effect of extreme temperature events, followed by water scarcity (54%), famine (44%), and reduced community gatherings or meetings (30%). The respondents also revealed that electricity black outs (6%) and some mortality or death (5%) cases amongst low-income communities are attributed to the rising temperatures. Other (5%) social effects of heat waves included; increased stress and substance abuse and starvation. The respondent from a local community-based organisation - Focus for Life Youth Development Link revealed the social effects of heat stress in low-income communities as follows;

> *"Social gathering tends to reduce because people limit their movements during heat periods and there are no verandas or shades where they can seek refuge….this reduces social cohesions and wastes time since some functions and activities like sports get postponed".*

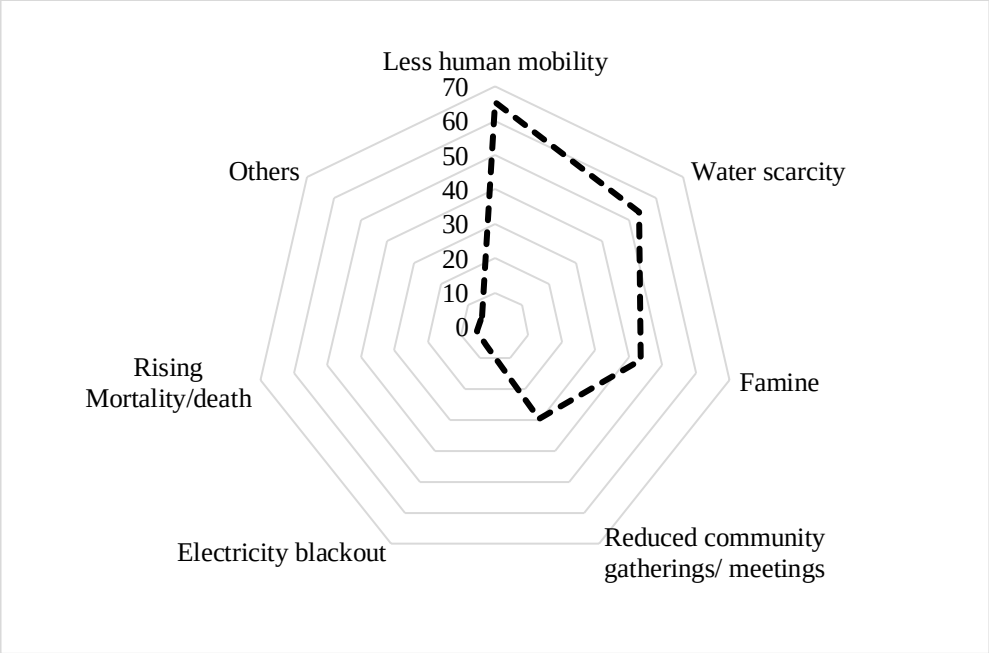

Figure 11: Social effects of extreme temperatures in low-income communities

Figure 12 presents the economic impacts of heat waves in low-income communities. The study revealed that increased expenditure on cold drinks and reduced labour productivity in form of work time and output per person (each 56%) are the major economic effects of heat waves. The increased expenditure on health-related complications (41%), reduction in customers (31%), reduced sales of warm/hot drinks and food products amongst business enterprises, increased cost of power used for cooling (each 10%) and increased cost of starting business (9%) were also mentioned as economic effects of heat waves amongst low-income settlements. Other (11%) economic effects of extreme temperatures include; damage to perishable goods, increased expenditure on food, body fatigue during work, increased prices of consumables, increased power consumption and respective costs, reduced supply of agricultural produce and animal deaths. From a positive point of view, some business enterprise respondents revealed increased sales of cold drinks, whereas others selling fruits like avocados and yellow bananas. The FGDs revealed economic effects of hot temperatures as follows;

> *"The costs of treating chronic illnesses become so high…people with albinism incur alot of expenditure on their skin products……..businesses selling perishable produce make losses since goods get spoilt under hot temperatures…..makes people more fatigued and less productive…..increase expenditure on cooling systems and electricity bills to run such systems".*

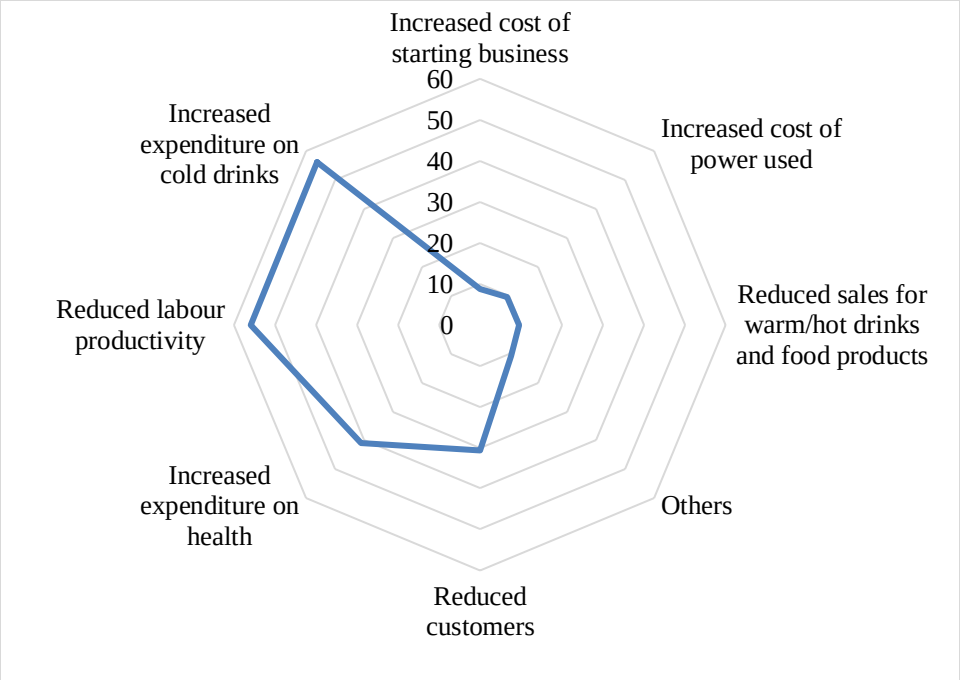

Figure 12: Economic effects of extreme temperatures in low-income communities

In regard to the health effects of heat waves in informal settlements, majority of the respondents reported to have mainly experienced headache (59%), extreme sweating (49%), extreme thirst and dehydration (each 41%), tiredness (30%), dizziness (27%), heat related stress (25%) and dehydration (21%) (See Figure 13). The results in Figure 12 also indicated that heat rashes and body itching (each 16%), sun burns or peeling of the outer skin (14%), reduced vision and heat exhaustion (each 9%), mental disturbances (7%), heart attacks and fainting (6% each), accelerated pulse or heart beats (5%), swollen feet and nausea (4%), muscle cramps (3%), and heat strokes (2%) as health impacts of heat waves amongst populations in low-income communities. The other (9%) reported included; chronic coughs, skin rashes, increased malaria cases, poor respiration, eye inflammations, nose bleeding, allergies, discomfort, flu, fever, and breathing difficulties. Despite absence of direct mortality effects of heatwaves, FGDs and KIIs revealed that there are greater potentials of extreme temperatures worsening pre-existing illnesses amongst the most affected populations like the elderly, Albinos and babies, leading to death. The health effects of heat waves were reported as indicated below;

> *"The health of people with chronic disease conditions like asthma worsens during heat waves……skin problems usually emerge most especially in babies and the albinos….some have developed eye defects and dehydration during hot temperatures". Says respondent from Focus for Life Youth Development Link*

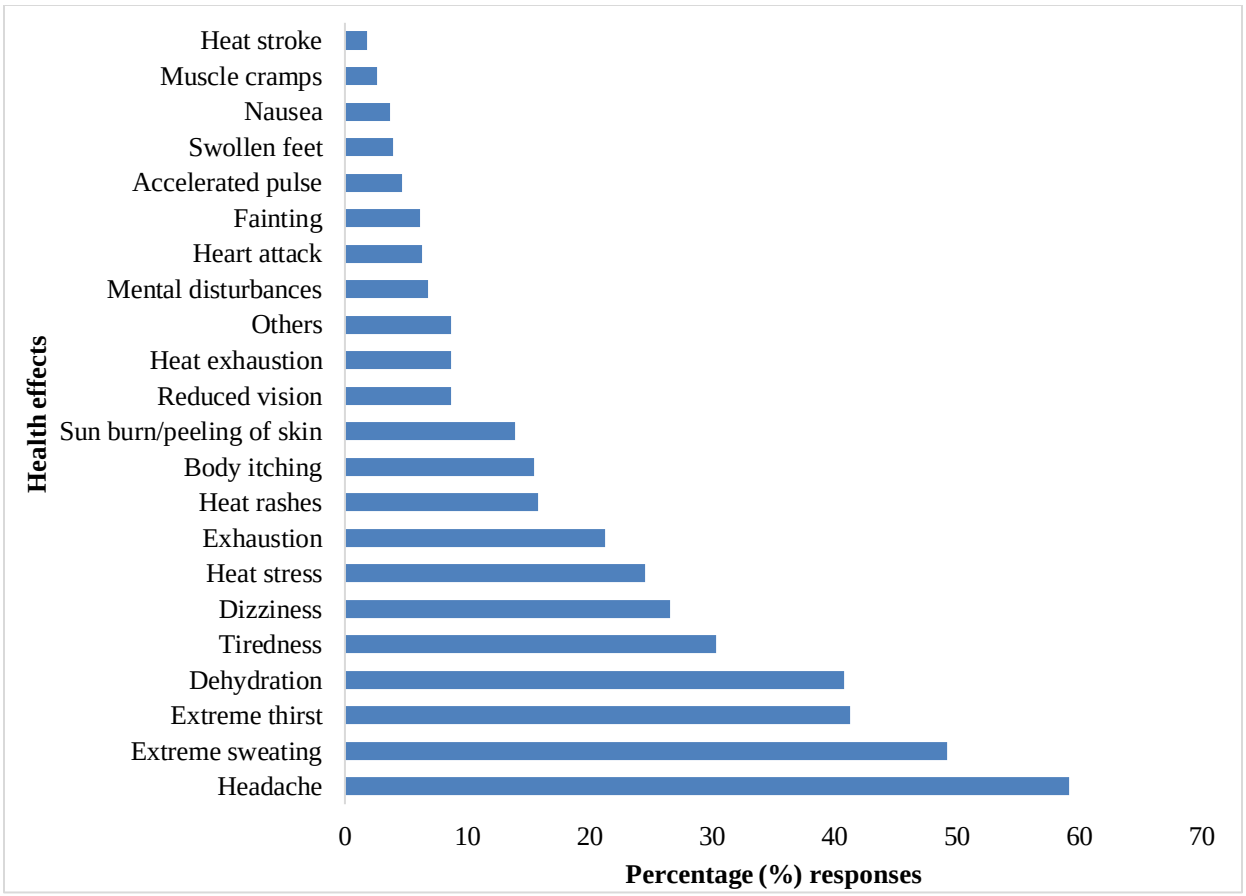

Figure 13: Health effects of extreme temperatures in low-income communities

The study also found out the environmental effects of heat waves within low-income communities in Kampala city (See Figure 14). The findings revealed that 79% of the respondents indicated that roads become dusty during heat wave periods and 76% revealed increased air pollution during extreme temperature episodes. The study also established that drying out of water sources especially wells (33%), drying of vegetation (31%) and stunted vegetation growth (12%) are effects of heat waves in low income settlements. The other (3%) effects identified included; strong winds, prevalence of hot air, emergence of rare insects and bad stench from sanitation facilities and trenches.

> *"Heat waves have caused the vegetation to dry up and extinction of species of great importance on human health for example the medicinal herbs…there is always limited supply of water for urban farmers- these spend alot of money on water for animals and poultry". Says respondent from Focus for Life Youth Development Link*

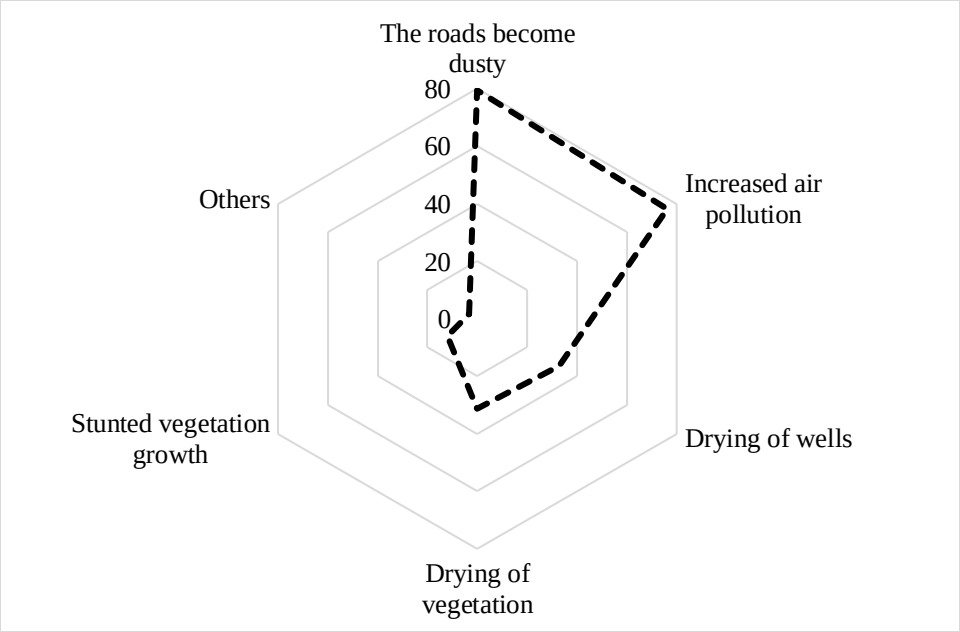

Figure 14: Environmental effects of extreme temperatures

The socio-economic, health and environmental effects of dangerous heat in Kampala city was highlighted by key informants and FGDs as follows;

> ***"****Heatwaves greatly contribute to stress, fatigue, dehydration, and stunted growth….. Economically, it leads to less productivity due to less hours of work which affects income generation….. On the positive side, most people who sell cold drinks benefit from heat waves since their sales increase because people try to keep hydrated….. But, heat waves affect some businesses based on the nature of the business, especially those operating under direct sunlight and open spaces like markets, hawkers and street vendors……..In the environmental aspect, some species cannot adapt to heatwaves, therefore they end up destroyed. Socially, heatwaves affect vehicles by wearing away the car tyres, the water table gradually reduces…..and electricity blackouts become more frequent during hot periods." Says the respondent from the Uganda Red Cross Society (URCS).*

4.3.3 Social groups worst affected by heat wave events

The study investigated social groups worst affected by heat wave events (See Figure 15). It was revealed that children and pregnant women (72% each) are the most affected social groups during heat waves, followed by babies (53%) and older persons (50%) (See Figure 15). Further, people with chronic illnesses such as diabetes (28%), physically ill people (18%), the mentally handicapped (13%), the homeless and street children (11%), people performing alot of physical works (5%) like construction workers, landscapers, industrial workers, and migrants were also reportedly disproportionately affected by extreme temperatures. The other (10%) social groups affected by extreme temperatures include; albinos and hawkers. The FGDs substantiated on the effects of heatwaves on social groups as follows;

"Babies normally develop rashes on their bodies…..pregnant mothers get a lot of heat stress leading to discomfort most of the times…….those with blood pressure almost faint, and people that are Human Immune Virus (HIV) positive normally get stressed due to intense itching all the time". Responses from FGDs

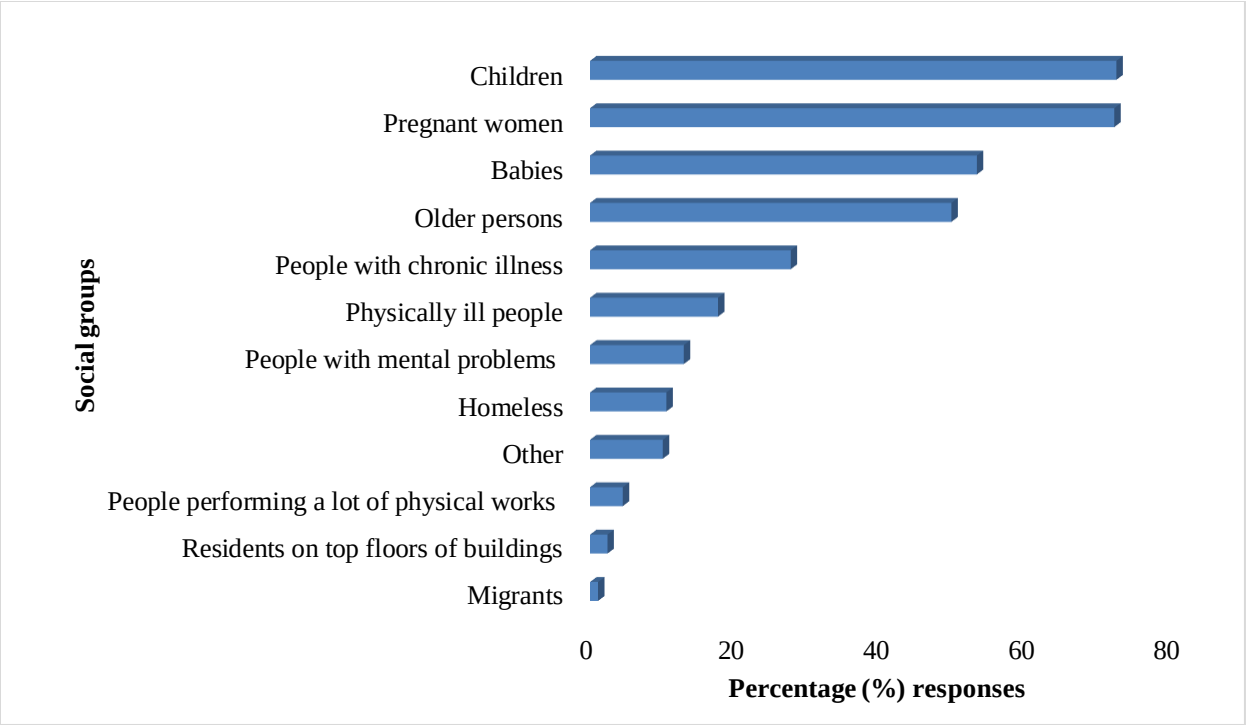

Figure 15: Social groups worst affected by extreme temperatures

The study also established the single most concern amongst respondents during the heatwave events (See Figure 16). The findings revealed that 25% of the respondents were more concerned about personal health and children (25% each), and 15% about the elderly. Some respondents further indicated being concerned about the life community members (12%), financial implications (8%), personal comfort (6%), outdoor activities (2%) and others (5%) concerned about economic shocks like price volatility of foods, reduced incomes and high costs of power arising from frequent use of cooling equipment like funs and refrigerators. The KIIs revealed that they are mostly concerned about the boda-boda operators because they work directly under the sun. Further, it was established that people working alongside roads are greatly affected and attract concern. Other categories highlighted to be prioritised included babies, the elderly and people with chronic illnesses such as diabetes and high blood pressure among others.

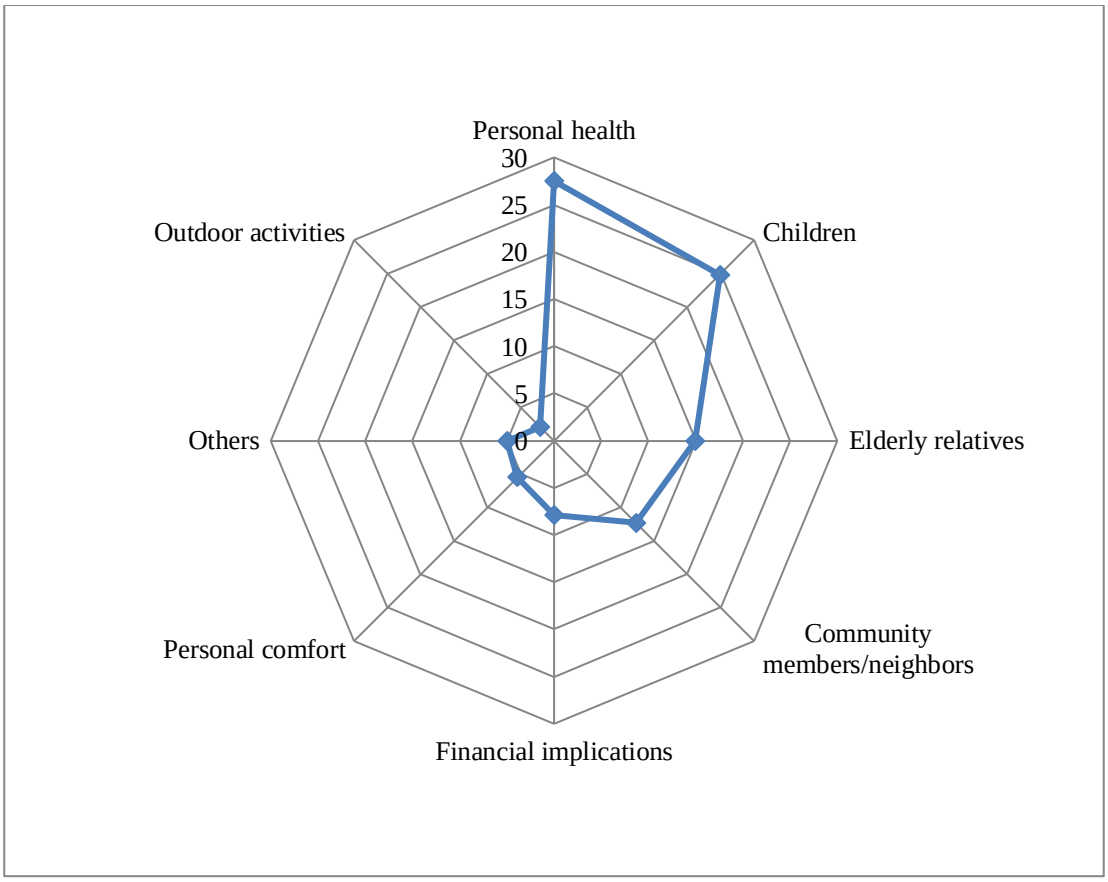

Figure 16*: Single most priority concern during heat wave events*

4.4 Response strategies for coping with heat wave events

4.4.1 Behavioural strategies implemented during extreme temperature events

The study also identified behavioural strategies implemented in response to extreme temperature events (See Figure 17). The results in Figure 16 indicated increased consumption of fluids (85%) as the main response to heat wave events by people in low-income settlements. Besides, keeping doors or windows open so as to let in fresh air (42%), putting on light clothes (35%), body cooling through having cold showers and using wet cloth to cool bodies (30%), ice cooling and showers to reduce temperatures (21%), carrying drinking water while moving (20%), resting under shades or trees (17%), using fans or air conditioning (11%), staying inside premises/indoors (9%), wearing caps, huts or sun glasses (7%), keeping doors and windows closed, and avoiding physical activity (6%), and use of sunscreen, assisting those at high risk and struggle to keep cool like children and the elderly (3%) as well were also indicated as coping behavioural practices during heat waves. 9% of the business enterprises reported that they increase preparation of cold fluids for sale to community members and passers-by. The other (11%) response strategies included; buying some medicine, frequent bathing, covering with light beddings or not covering oneself in the night, use of cosmetics to reduce heat rash, shifting working hours to cool hours of the day, turning off lights, applying lotion to moisten the skin, walking under umbrellas, taking warm water, and sleeping on the floor.

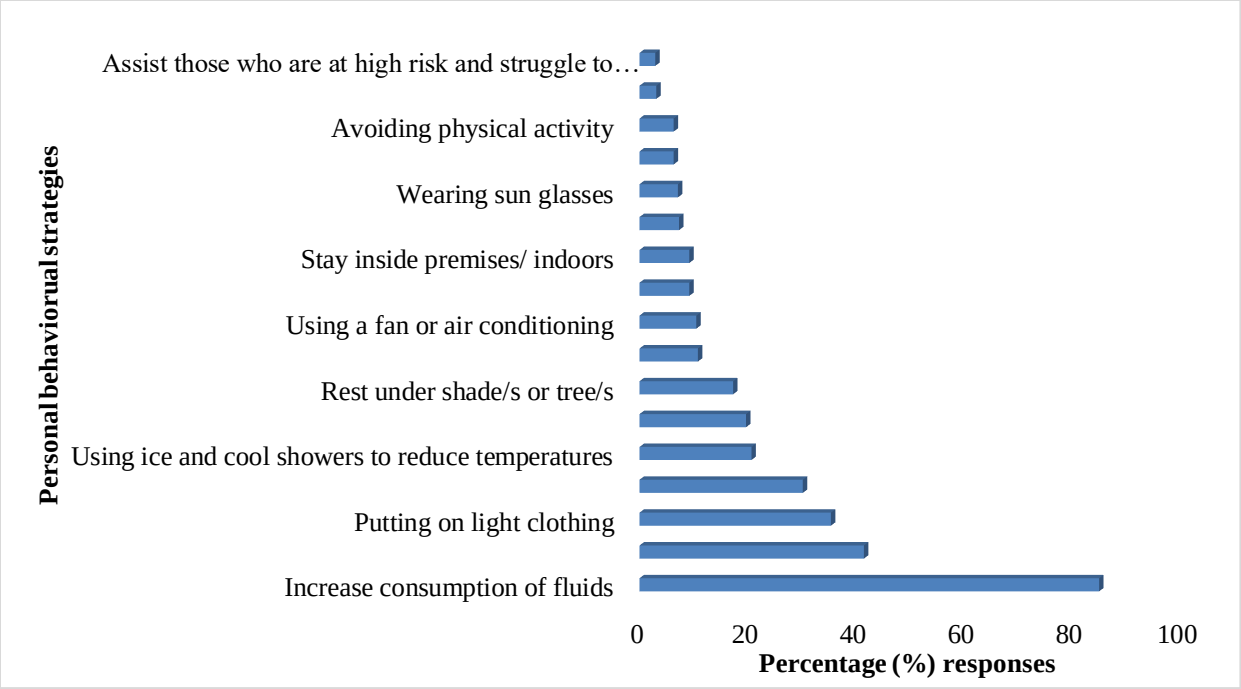

Figure 17: Personal behavioural strategies in response to heat waves

Table 5 shows results of behaviour strategies being used by individuals in coping with heat waves in Kampala cross tabulated with the social categories. Sex of the respondents highly associated with water consumption. Majority of the respondents who could increase fluid consumption were women with 58% compared to male respondents with 27%. Further, the majority of the respondents aged between 18-35years of age (48%) reportedly increased their fluid consumption rate during heatwaves periods, followed by respondents aged between 36-60 with 34%. The other behavioural strategy that depicted high numbers across the social categories was putting on light clothes and this was reported by majorly youths (20%) and married (21%) respondents (See Table 5). The respondents from KCCA indicated that the city authority has in partnership with the private sector tried to construct shades on some public transport onboarding and offboarding points on major roads, piloted an eco-friendly non-motorised transport corridor along Namirembe road in the city centre, installed heat detectors and air quality monitors across the city and carried out the tree audit in Kampala city. In addition, the city authorities are emphasising creation of green spaces and planting of tree species along roads being constructed in Kampala city. Although such efforts are aimed at improving air quality, facilitating a safe and clean environment for the city and its inhabitants, there are no deliberate efforts to scale out such initiatives in low income communities in Kampala. Further interventions done by KCCA were indicated as follows;

> *"As KCCA we have tried to do tree planting wherever we find space in the different parts of Kampala…..we continue to encourage people to plant trees on their property spaces…..areas like Kololo, Nakasero and Makerere have been gazetted for tree planting….A by-law has been put in place to enable greening of 60% for any areas covering about 2000 square metres…efforts are underway to limit deforestation in the city whereby any cutting down of a tree shall have to be authorised by the authorities".*

Table 5: Extreme heat coping strategies across social groups (n=382)

Extreme temperatures coping strategies	Socio-demographic variables																		
	study sites		Sex		Age (Years)			Highest educ level				Monthly Income in '000'(Ugx)				Marital Status			
	Bwaise III	Kibuye I	Male	Female	18 - 35	36 - 60	>60	No education	Primary	Secondary	Tertiary	<150	150 -450	>450	No response	Married	Single	Divorced	Widowed
Increase consumption of fluids	20	65	27	58	48	34	3	6	28	40	11	12	39	32	2	45	25	10	5
Prepare more fluids for sale	1	8	3	6	6	3	0	0	3	5	1	1	5	3	0	5	3	1	0
Stay inside premises/ indoors	2	7	2	7	6	3	1	0	4	5	1	1	5	3	1	5	3	1	1
Keep doors or windows closed	1	5	2	4	3	3	0	0	1	4	1	0	3	3	0	5	1	1	0
Keep doors or windows open	9	33	11	31	23	17	1	2	14	20	6	7	18	15	1	24	10	5	2
Putting on light clothing	9	26	11	24	20	14	1	1	10	18	6	4	17	14	1	21	10	4	1
Rest under shade/s or tree/s	5	12	5	12	10	6	1	1	4	11	2	2	6	7	1	9	5	4	0
Body cooling	7	23	10	20	18	10	2	3	10	14	3	3	15	10	1	18	10	3	1
Using a fan or air conditioning	2	8	4	6	6	5	0	1	1	7	3	0	5	6	0	8	3	0	0
Avoiding physical activity	2	5	3	3	3	3	0	0	2	3	1	1	4	2	0	4	1	1	1
Using sunscreens	0	3	1	2	2	1	0	0	1	2	1	0	2	1	0	2	1	0	0
Wearing sun glasses	2	6	3	4	3	4	0	0	1	5	2	1	4	3	0	5	1	0	1
Wearing a cap or hat	1	6	4	4	4	3	0	1	1	5	1	1	3	4	0	5	2	0	0
Assist people at high risk and struggle to keep cool	1	1	0	3	2	1	0	0	1	2	1	0	2	1	0	3	1	0	0
Carrying water/fluids while travelling	6	14	7	13	11	8	1	1	6	10	2	3	11	5	1	11	5	2	1
Using ice and cool showers to reduce temperatures	6	15	7	14	13	7	1	1	7	9	4	3	12	6	0	11	6	3	1
Others	3	8	3	7	7	3	0	1	3	4	2	2	4	5	1	6	4	1	1

4.4.2 Priority community level strategies to prepare for or adapt to heat waves

The study also identified prioritised community level preparedness strategies for heat wave adaptation (See Figure 18). The respondents indicated that carrying out community awareness (41%), planting more trees at neighbourhood level (40%), steady supply of clean and safe water (35%), construction of community shades (33%) and setting up open spaces with vegetation cover (30%) were the priority interventions to better prepare community response to heat waves. Further, easing access to green spaces (26%), providing incentives for cooling equipment (11%), reducing cost of electricity (9%), steady supply of electricity (5%) and putting in place green rooftops (4%) were also mentioned as potential strategies to enhance low-income communities' adaptation to extreme heat. Other (11%) preparedness strategies identified included sensitization by health officials, controlling spaced construction, decongestion, nature protection, road upgrading and supply of heat to communities. The community leaders in Bwaise III and Kibuye I indicated that there should be tree planting campaigns across the entire city to enrich modification of micro-climate systems through the cooling capacity potential of trees. It was reported that working with communities at local level and the landlords offers opportunities for enforcement of urban greening initiatives through multiple strategies like tree planting, wetland conservation and urban agriculture. The FGDs also suggested that proper disposal of solid waste should be done by KCCA to deter people from burning rubbish- a process that increases carbon emissions in the atmosphere. Finally, proper policies like reducing the costs of cooling equipment and incentivisation of alternative energy appliances and sources like solar panels and gas cookers were called for as a way of facilitating responses to heatwaves.

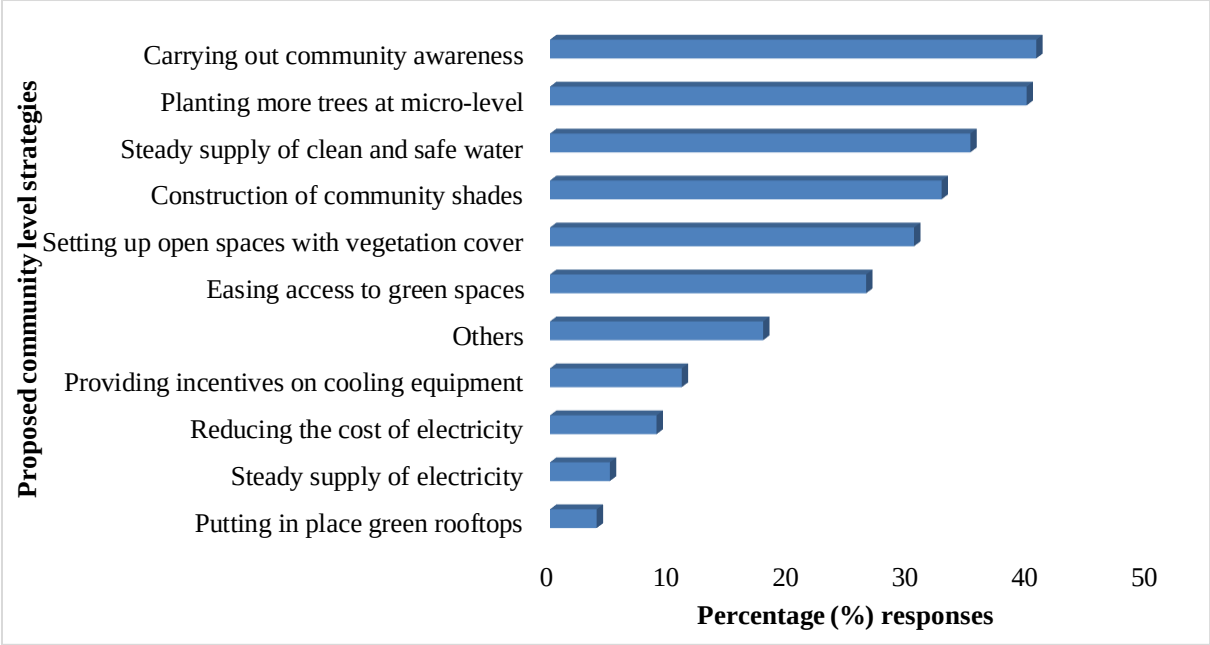

Figure 18: Community level preparedness strategies in response to heat waves

4.5 Information and communication for heat wave adaptation strategies uptake in low-income communities

4.5.1 Access to weather and climate information

The study found out the various sources of weather and climate information (See Figure 19). Results indicated that respondents mainly accessed weather and climate information from radio (49%) and television (42%). In addition, community members (15%), relatives/friends (11%), newspapers and local council leaders (8%) and social media (6%) were also found to be useful sources of weather and climate information in low-income communities. Some respondents also indicated access to weather and climate information from online materials (3%), health professionals, village health teams (VHTs), and Uganda National Meteorological Authority (UNMA) (2%) and Kampala Capital City Authority (1%). Other (1%) sources of weather and climate reported include; geographical magazines. conferences and workshops, and judgement from prevailing weather conditions. While the predominant social media platforms used to get weather and climate information include Facebook, WhatsApp, telegram, Tiktok and Twitter, online materials reported were google and Youtube. Indeed, radio and television are the largest media for information dissemination in Uganda and Kampala particularly which UNMA relies upon to disseminate weather and climate information. Social interactions at local level and uptake of digital technologies like mobile phones, computers and laptops are also increasing awareness of climate and weather issues especially among the educated in low-income communities. However, FGDs revealed that dissemination of climate and weather information in Kampala is mostly reflected in rainfall and flood events weather forecasts.

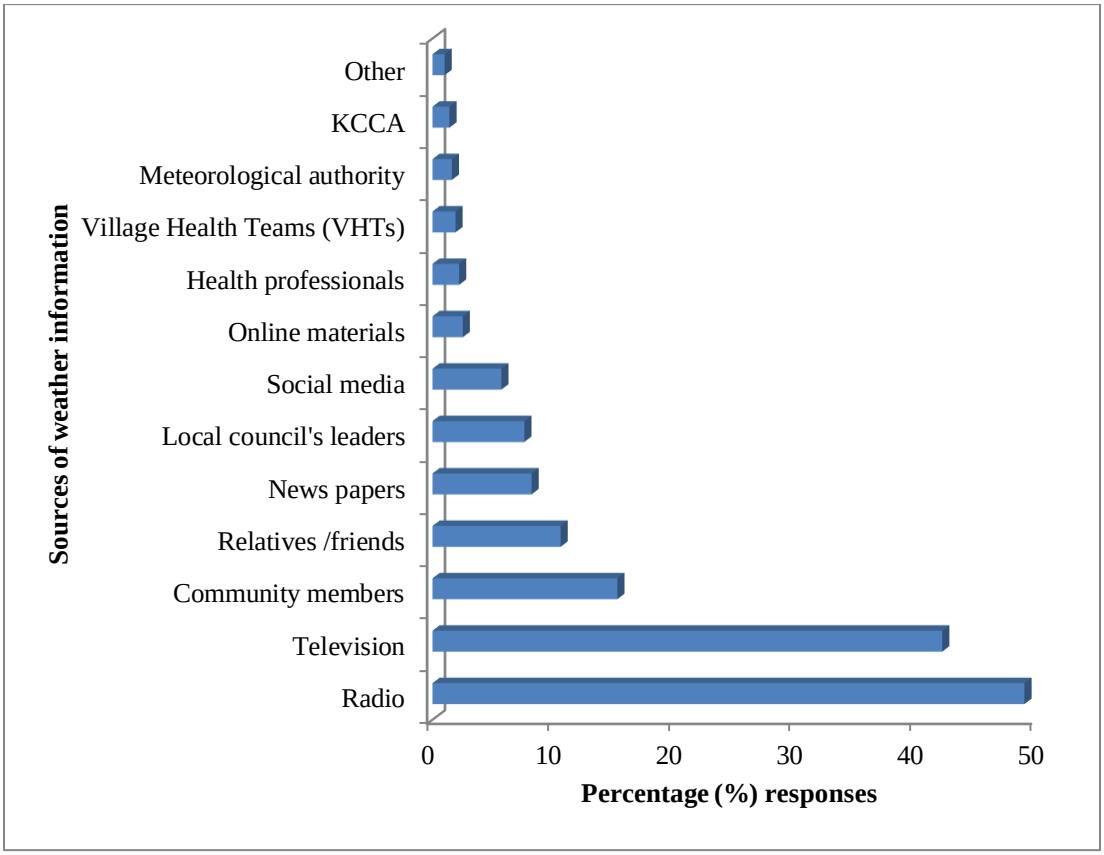

Figure 19: Sources of information on weather and climate

In regard to hearing information about heat waves, 61% of the respondents reported to have heard or read information on heat waves, 35% have never heard or read information on heat waves while 4% are not sure (See Figure 20). The respondents' level of awareness was also identified during the study and 37% indicated to be slightly informed about heat waves, 20% well informed, 18% somewhat informed, 8% very well informed whereas 18% were not informed at all (See Figure 21).

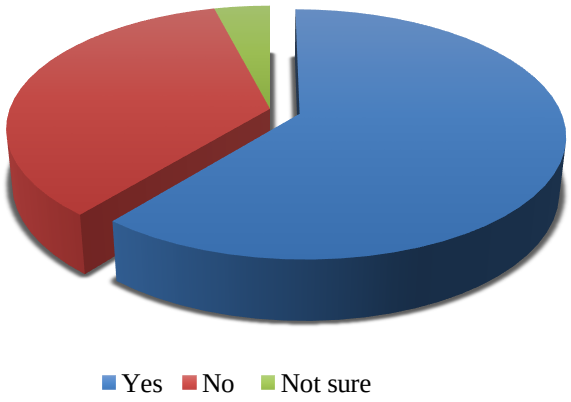

Figure 20: Ever heard or read information on heat waves

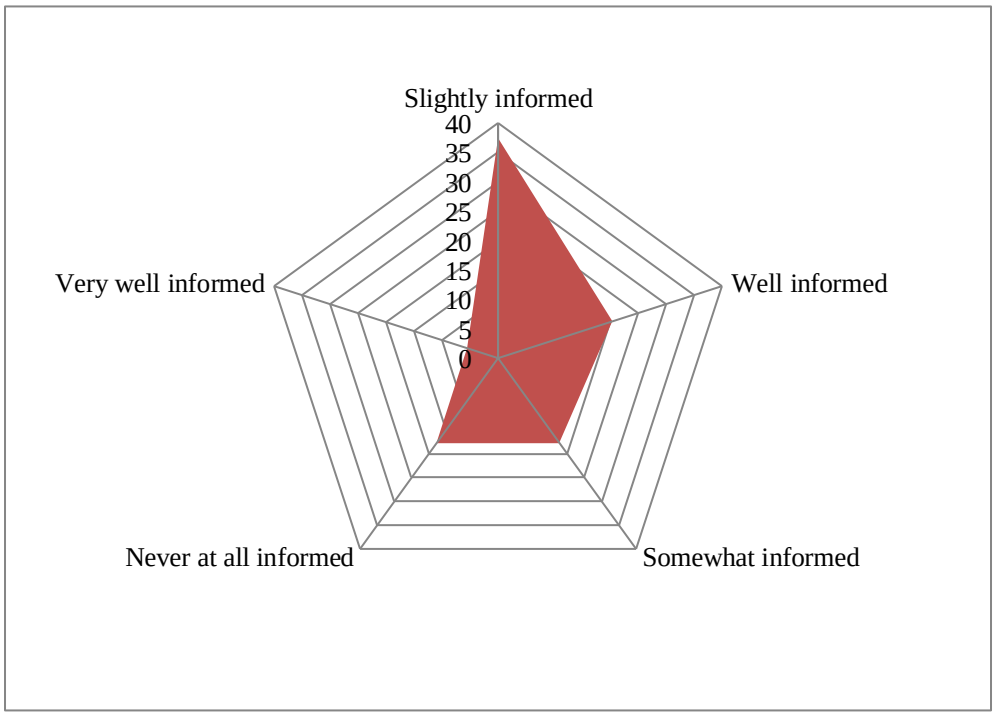

Figure 21: Level of awareness on heat waves

The study explored whether respondents received information on recent extreme temperature event (See Figure 22). Majority of the respondents (70%) had not received any information regarding the recent extreme temperature event

making up and 26% indicated to have received information on the heat wave events. Respondents who revealed to have received information on the recent heat waves indicated television and radio weather forecasts as the main sources of such information, followed by social networks, especially friends, and KCCA and the local Non-Government Organisation (NGO) called Network for Active Citizens (NAC). The limited availability of information on the recent heatwave was due to prevalence of multiple shocks like COVID-19 pandemic and floods that were presumed to have greatly affected people's livelihoods compared to extreme temperatures and also absence data and information regarding the hazard in Uganda. The respondent from the Ministry of Health substantiated as follows;

> *"…heatwaves have not been an issue to have public concern since there have been several crises stressing people recently….In addition, heat waves are given less attention and it's also lacking research and evidence in Uganda contrary to other countries like India, United Kingdom (UK), China and United States of America (USA) among others where it has been an issue every year".*

The respondents also found out that respondents had consulted different sources of information during the recent heat wave event (See Table 6). Majority of the respondents indicated to have consulted radios (44%) followed by television (34%), relatives/friends (16%), community members (13%) and local councils (9%). In addition, newspapers, social media, health professionals, online materials, VHTs, UNMA, KCCA and brochures or posters were also consulted by low-income community members during the recent heat wave event. The other (20%) sources of heatwave information included; GeoPoll application, use of indigenous knowledge and experiential discovery. The FGDs participants and KIIs revealed hearing about some information on heat waves from weather forecasts made by UNMA on radios. These were reportedly read out at the end of morning news bulletins, but most respondents indicated that this information usually prioritises future situations hence being inaccurate and not trusted by community members. In addition, there are no scientifically proven temperature thresholds to justify a heatwave event in Uganda and Kampala in particular so as to guide communication and outreach strategies for communities across the city. Besides, FGDs and KIIs also indicated that local knowledge systems in the form of bird sounds, flowering of specific plants, withering of vegetation cover and appearance of stars were highlighted to have been observed to foretell hot temperature events in Kampala city. It is therefore essential to create synergies for local knowledge integration with scientific forecasts so as to necessitate meaningful information creation and communication for easy diffusion amongst communities.

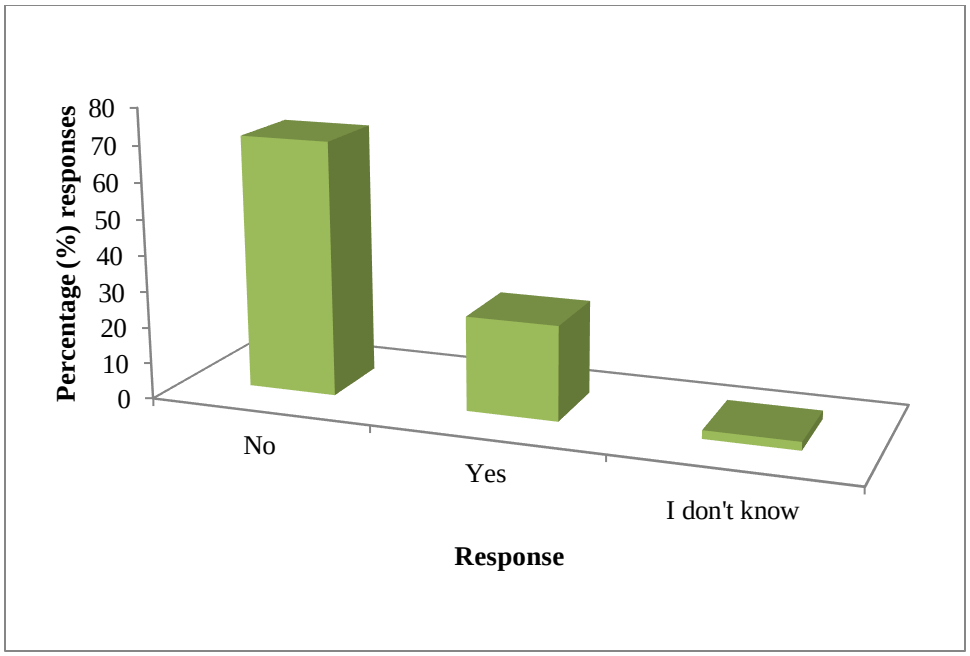

Figure 22: Receipt of information on recent extreme temperature event

Table 6*: Information sources consulted during the recent heat wave event*

Information sources consulted	Frequency (n)	Percentage (%)
Radio	168	44
Television	130	34
Relatives/friends	61	16
Community members	50	13
Local councils	34	9
Newspapers	29	8
Social media	18	5
Health professionals	10	3
Online materials	9	2
Village Health Teams (VHTs)	9	2
Meteorology authority	8	2
KCCA	4	1
Brochures/posters	2	1
Other	77	20

4.5.2 Preferred communication modalities for update of heat adaptation strategies

The study explored preference to receive communications about heat waves and adaptation strategies for low income communities. Figure 23 shows preference to getting notified about future heat waves in Kampala city. The results indicated that 92% of the respondents prefer to be notified about future heatwave risks and 5% do not want to be not notified about future heatwaves. The findings further revealed that most of the respondents preferred radios (66%) and televisions (63%) as essential media of communication about heat risks and adaptation strategies (See Table 7). The local council leaders (26%), community members (25%), relatives/friends (15%), newspapers and social media (12%), VHTs (6%), health professionals and meteorological authority (4%), online materials and KCCA (3%) as well as brochures or posters (1%) were also mentioned as potential media of communication on heat wave related issues.

Other (6%) media of communication suggested include; mobile phone text messages, and community radios. Indeed, most respondents reported limited availability of information on heat risk in Kampala city and therefore showed interest to know more about heat waves, their effects and response strategies amongst low-income communities across the city. Sharing information is therefore likely to raise people's awareness about the risk and increase uptake of self-protective measures especially for the most vulnerable populations.

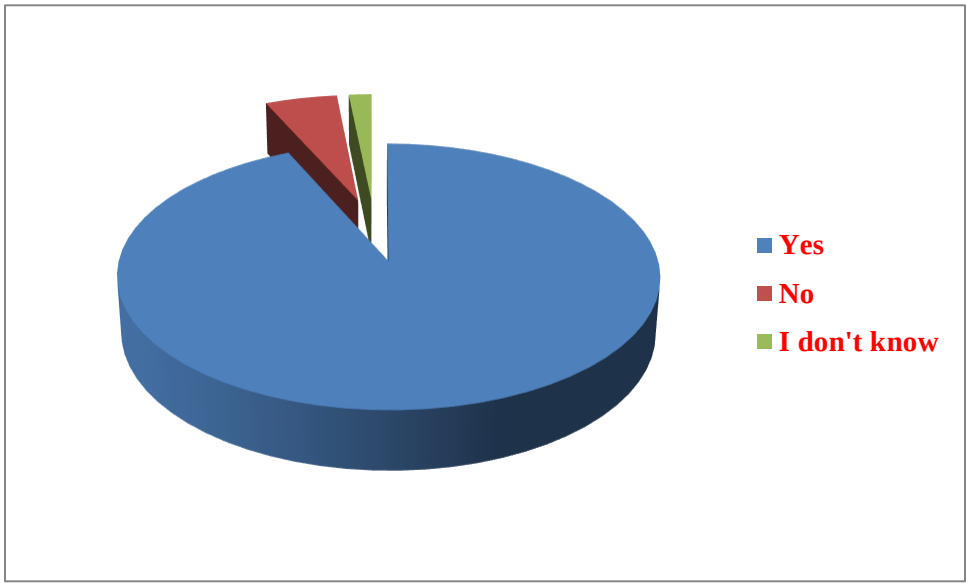

Figure 23*: Preference to getting notified about future heat wave risk*

Table 7: Preferred media of communication on heat wave risks and adaptation strategies

Preferred sources of information	Frequency (n)	Percentage (%)
Radio	253	66
Television	239	63
Local council leaders	101	26
Community members	95	25
Relatives/friends	56	15
Newspapers	47	12
Social media	44	12
Village Health Teams (VHTs)	23	6
Health professionals	17	4
Meteorological authority	17	4
Online materials	13	3
KCCA	12	3
Brochures/posters	3	1
Other	24	6

The study also found out community level communication strategies for heat risk adaptation (See Figure 24). The findings revealed that 52% of the respondents preferred frequent television and radio programs and adverts, 38% opted for mass sensitization through community gatherings and 2% indicated use of VHT structures and proper use of social media apps. The other (6%) communication strategies reported include; community radios, megaphones, local

leadership structures and mobile phone messages. The FGDs revealed that there should be continuous sensitisation about wetland conservation to maintain ecosystem health in the city and its neighbourhood. The KIIs on the other hand indicated that multi-stakeholder engagement with emphasis on local level institutions and governance structures need to be engaged to build their capacities in information dissemination and knowledge sharing as well as facilitating adoption of nature-based solutions for heat adaptation. The Buganda kingdom cultural institution was strongly commended for its efforts in raising awareness about heat waves, civic engagement activities targeting environmental conservation and restoration through tree planting, and protection of sensitive ecosystems like wetlands and forests. Such revelations were reported as follows;

> *"There should be involvement of the local authorities to disseminate the information through the mega microphones every morning to update the people about the daily weather conditions…….such efforts enable people to prepare for the effects of heatwaves and accordingly respond to sustain livelihoods". Says a respondent from the Ministry of Water and Environment.*

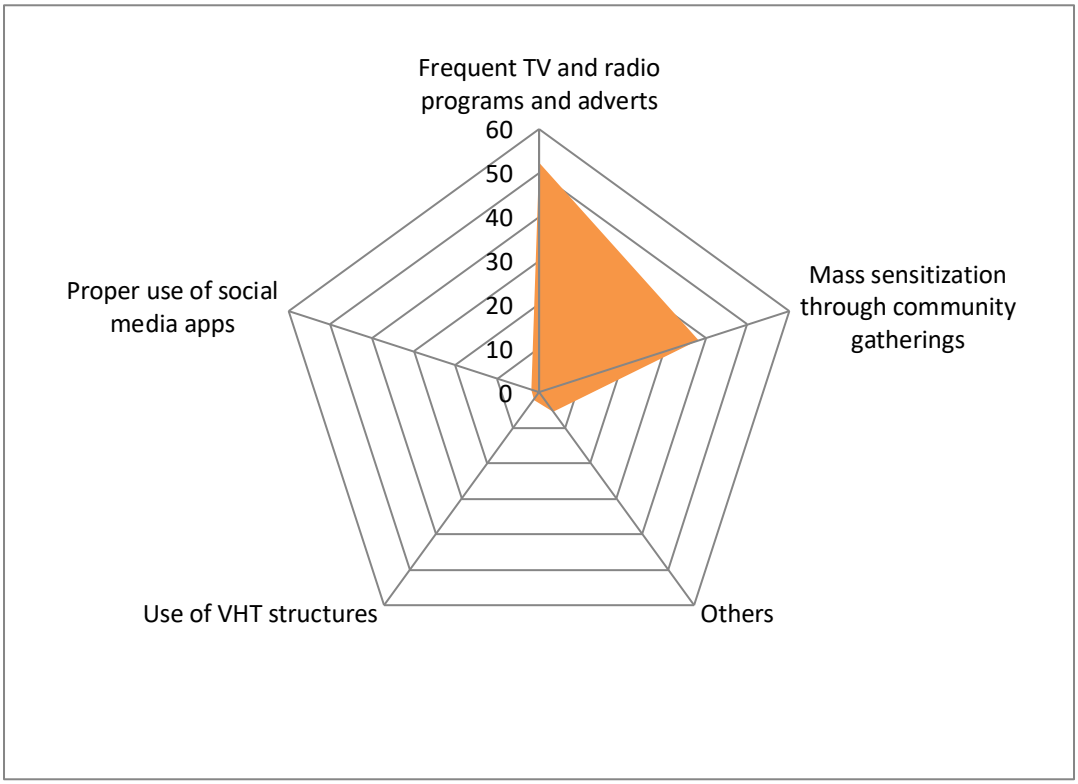

Figure 24: Community level communication strategies for adaptation

5 Conclusions and Recommendations

5.1 Conclusions

This study analysed heat risk perception and communication strategies for adaptation within low-income communities in Kampala city, Uganda. The study revealed that heatwaves are an extreme problem occurring mainly in the months of July, June, January, May and February, and a significant number of people are worried about/of hot temperatures that have been rising over time. Given the rising temperature and the decreasing green infrastructure (wetlands, forests, trees and other green spaces) that reduces the ability of the city to regulate temperatures, the risk to heatwaves is likely to worsen in the future.

The study showed variations in perception of the population to heatwaves depending on employment or nature of work, marital status and age. Heatwaves risk exposure and vulnerabilities were more perceived by business operators and workers in industrial establishments, married individuals and youths aged between 18-35 years. This is because businesses and employment operate under direct sunlight in open spaces and streets, and within industries whose production systems emit heat, while married families reside in congested housing units with materials having greater heat absorption potentials. Thus, the industrial areas, informal settlements or slums, transport corridors and spaces for markets are critically warmer zones across the city because of limited green vegetation or tree cover to regulate the thermal discomfort generated from the activities occurring in such places.

The study established that most populations in low-income contexts are sensitive to heatwaves and the exposure to extreme temperature events affects their livelihoods. The main socio-economic, health and environmental effects of heatwaves on livelihoods identified were; limited mobility, water scarcity, famine and reduced civic engagements; reduced labour productivity and business operations, increased costs of health-related complications and electricity as well as increased cold drinks and fruit sales; headache, excessive sweating, prolonged thirst, tiredness, dizziness, heat related stress and dehydration; and dusty roads, air pollution, drying up of water sources and vegetation. The worst affected social groups include; children, pregnant women, babies, the elderly, people with chronic illnesses, the homeless, albinos, public transport operators, hawkers, street and market vendors.

The study further revealed that local level adaptation is still low and strategies to enhance response are very limited across Kampala. Individual level adaptation was reportedly through increased consumption of fluids and indoor aeration. City level initiatives include; promotion of the non-motorised transport corridor in the city centre, tree planting and green infrastructure protection. The plans to legislate tree cutting in the city have also reportedly taken shape as a way of controlling tree canopy maintenance on both public and private property and/or spaces.

Weather and climate information has recently improved in Uganda, with about 60-70% accuracy levels, but heat waves rarely feature within the main media and local level forums for information exchange. The main communication and outreach strategies on heat risk were found to be online platforms, social and international media, traditional institutions, indigenous knowledge systems forums and social networks. Low-income communities indicated to prefer local level awareness raising campaigns and communication platforms like local radios, mega-phones, community meetings or gatherings and village health teams (VHTs) practitioners for dissemination of heat risk information and adaptation strategies.

Finally, urban heat risk is still not well documented and appreciated as a critical challenge for urban Kampala since wetland degradation continues to occur and there are no targeted efforts for increasing the city's green infrastructure and regulating informal sector development. The urban heat island effect is expected to increase amid the changing climate but there's hardly any existing literature on heatwave characterisation, vulnerability mapping and opportunities for adaptation across different scales to inform policy and planning.

5.2 Recommendations

The challenge identified in this study points to the urgent need to understand heatwaves better and how adaptation might be achieved especially amongst the most vulnerable populations. Focusing on the vulnerable groups most affected by heat stress would help to identify specific priority actions that should be undertaken by governments, civil society, academia, communities, and the private sector. In addition, deeper research will generate evidence and generation of knowledge products on heatwave risks continuously to inform urban targeted policy and practice at national, local and community levels.

Fostering inter-agency and inter-ministerial coordination and cooperation on all climate change hazards affecting urban areas including heatwaves. Heatwaves affect all domains of society i.e., social, economy, environment, health and energy hence pose serious and complex effects on livelihoods. To enhance coherent policy making and engagement on urban heat island issues and their complexities, a common platform or forum should be formed and operationalized to enhance coordination of migration in government MDAs, with the active involvement of development partners, academia and civil society.

Social protection systems including provision of social insurance and social assistance can help business enterprises and families to adapt to the consequences of heat stress.

City authorities and communities should be supported to put in place measures for the protection for vulnerable individuals in affected communities and for addressing the needs of the worst affected through increasing capacity for providing community shades and open green spaces. Continued investment into disaster risk reduction (DRR) in heat risk hotspots is essential.

Identification of vulnerable populations and creation of heat preparedness plans that target all urban communities increase response to extreme heat and adoption of heat stress standards to the benefit of low-income communities.

Government technical staff at national and local levels as well as civil society actors need to be trained and skilled in heat risk management. Capacity enhancement tools and manuals should be developed for training on a continuous basis.

Infrastructure related measures such as building standards that emphasise environmental protection, restoration as well as surface greening should be adopted to enhance the protection of communities and workers. Further, urban green spaces need to be properly maintained and opened to the urban populations.

City wide greening of informal settlements should be prioritised through strategies like tree and lawns planting, and urban agriculture as a way of proofing populations from dangerous heat and regulating the microclimate.

Social dialogue with communities should be considered to develop an understanding of needs, priorities and aspirations for heatwave adaptation by different urban groups so as to facilitate localisation of urban planning and implementation. Further, social dialogue enables derivation of fit for purpose strategies for heatwave response as well as meaningful communication and awareness raising initiatives.

6. Limitations of the study

The study was challenged by the absence of a universally accepted definition for heatwave. This presented issues on specific temperature thresholds to be considered heatwaves during conceptual level, data collection and report writing. However, since most literature indicates notions around intense heat experienced over a period of days, this study considered community and individual level experience of unusually hot temperatures as a description for a heatwave event. Such narrative was easily understood by communities, which consequently enabled them to provide feedback during data collection.

Although previous studies have analysed urban heat using soil temperature determination, in-situ temperature and humidity measurement, and local climate zoning coupled with geospatial mapping, there has not been any study that engaged communities regarding the subject matter. The research appeared alien to the targeted communities and many respondents were surprised about what interested the researchers to carry out such research on urban heat. The implication here was that most community members didn't see any utility in doing such kind of research amid the several socio-economic and livelihood challenges that have immediate and long-term impacts on them. This challenge was addressed by providing justification for choice of such settlements which stems from previous in-situ measurements that indicated that the communities were the warmest across Kampala. By explaining such, community members were able to triangulate the scientific justification of study area choice with everyday experiences of hot weather. Consequently, this not only led to the appreciation of the research but also bridged awareness with what has previously been researched regarding heat risk in the communities.

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Annex I: Standard Questionnaire for Heat Risk Perception and Communication Strategies in Kampala City

CONSENT

Do you agree to participate in this survey?

1. Yes
2. No

If no, TERMINATE the survey.

SECTION A. Background Information

A.1 Date of Interview: (dd,mm,yr)
A.2. Name of interviewer:
A.3 Questionnaire No:

A.4 Location:

a) Bwaise III
b) Kibuye I 1

A.5. GPS coordinates:

SECTION B. Basic Information

B.1. Gender of respondent

a) Male
b) Female

B.2. Age (in years):

a) 18-35
b) 36-60
c) >60

B.3. Gender of household head?

a) Male
b) Female

B.5. What is your current marital status?

1. Married
2. Single
3. Divorced/Separated
4. Widowed

B.6. Number of children in household

a) <1
b) 1-5
c) 5-10
d) >10

B.7. Total household size

a) <5
b) 5-10
c) >10

B.8. What is your **highest level of education** attended?

1. Never attended formal education
2. Primary
3. Secondary (O&A level)
4. Tertiary

B.9. What is the **MAIN** source of income for the household?

(a) Formal employment (job)- (Specify)
(b) Casual labor (Specify)
(c) Business (Specify)
(d) Other (specify)

B.10. Please indicate other sources of income for your household

……

B.11. What is the nature of working environment?

a) Under direct sun
b) Wooden kiosk
c) Metallic kiosk
d) Below a shade (tree)
e) Under a temporary shade i.e umbrella
f) Within the house
g) Verandah
h) Other (Specify)

B.12. What productive assets does the household have (for generating income)? (Tick all that apply)

(a) Land
(b) Bicycle
(c) Motorcycle (boda-boda)
(d) Motor vehicle
(e) Livestock
(f) House
(g) Mobile phone
(h) Others, specify.

B.13. What is your household's monthly income?

a) < 150,000
b) 150,001 - 300,000
c) 300,001 - 450,000
d) 450,001 - 600,000
e) 600,001 - 750,000
f) 750,001 - 900,000
g) 900,001 - 2,000,000
h) 2,000,000 - 5,000,000
i) >5,000,000
j) Prefer not to answer

B14: Disability if any

a) Physical disability
b) Sensory disability
c) Mental disability
d) Dwarfism
e) Albinism
f) Cerebral pulse
g) Others (specify)

SECTION C. Knowledge, Exposure and Perceptions on Heat Waves

C.1. Have you ever experienced periods of unusually and uncomfortably warmer and hot weather in this area?

a) Yes
b) No
c) I don't know

C.2. If yes, how often do you experience periods of unusually and uncomfortably hot weather?

a) Always
b) Often/many times
c) Occasionally
d) Rarely
e) Never

C.3. In which month/s and year did you last experience extreme temperatures?

……

C.4. Are you always worried about experiencing unusually hot periods/heat waves?

a) Always worried
b) Often worried (many times)
c) Occasionally worried
d) Rarely worried
e) Never worried

C.5. Which months of the year do you usually experience hot weather? (Select multiple)

a) January
b) February
c) March
d) April
e) May
f) June
g) July
h) August
i) September
j) October
k) November
l) December

C.6. Which times of the day do you mostly experience heat waves?

a) Morning
b) Afternoon
c) Evening
d) Night

C.7. Do you agree that heat waves/extreme temperatures is a problem in Kampala city?

a) Strongly Agree
b) Agree
c) Moderately Agree
d) Disagree
e) Strongly Disagree

C.8. How hot are heat waves or extreme temperatures period in Kampala city?

a) Very hot
b) Hot
c) Somewhat hot
d) Warm
e) Not hot

C.10. What is the likelihood of heat waves occurring more frequently/regularly (within a year) in Kampala city?

a) Very likely
b) Likely
c) Moderately Likely
d) Unlikely
e) Very unlikely

C.11. What is the likelihood of heat waves increasing (number of hot days) within Kampala city?

a) Very likely
b) Likely
c) Moderately likely
d) Unlikely
e) Very unlikely

C.12. What do you think will be the severity of heat waves or extreme temperatures in Kampala?

a) Very Severe
b) Severe
c) Moderately Severe
d) Slightly Severe
e) Not Severe

C.13. What do you think causes heat waves or extreme temperatures in Kampala (***multiple causes***)?

……

SECTION D: IMPACTS OF HEAT WAVES AND RESPONSE BEHAVIOR

D.1. Please rate the impact of heat waves/extreme temperatures on your livelihoods?

a) Strongly Affected
b) Affected
c) Moderately Affected
d) Slightly Affected
e) Not Affected

D.2. What and who are you ***MOST*** concerned about during heat wave periods in Kampala? (Select one)

a) Personal health
b) Children
c) Elderly relatives
d) Community members/neighbours
e) Personal comfort

f) Financial implications (specify)
g) Outdoor activities
h) Others (Specify)

D.3.. Which of the following are the socio-economic, health and environmental effects of heat waves on you and/or your community?

Health effects

a) Headache
b) Dehydration
c) Sunburn/peeling of skin
d) Exhaustion
e) Extreme thirst
f) Dizziness
g) Extreme sweating
h) Accelerated pulse (rapid/fast heart beats)
i) Muscle cramps (muscle strain-due to inadequate blood supply)
j) Reduced vision
k) Heat stress
l) Heat rashes
m) Heat exhaustion
n) Heat Stroke
o) Nausea/Uneasiness of the stomach
p) Fainting
q) Confusion
r) Tiredness
s) Heart attack
t) Body itching
u) Swollen feet
v) Others (Specify)

Social effects

a) Rising Mortality/death
b) Water scarcity
c) Infrequent electricity supply
d) Famine
e) Reduced community gatherings/ meetings
f) Less human mobility
g) Others (specify)

Economic effects

a) Reduced labour productivity (work time and output)
b) Increased cost of power used
c) Reduced sales for warm/hot drinks and food products
d) Reduced customers
e) Increased cost of starting business
f) Increased expenditure on cold drinks
g) Increased expenditure on health
h) Others (specify)

Environmental effects

a) Reduced water table
b) Drying of vegetation
c) Stunted vegetation growth
d) Increased air pollution
e) The roads become dusty
f) Others (Specify)

D.4. Which social groups are worst affected by warmer temperatures or heat waves in Kampala city? (Multiple responses)

a) Older persons
b) Babies
c) Children
d) Pregnant women
e) People with chronic illness i.e. diabetes, asthma, high blood pressure etc.,
f) Physically ill people
g) People with mental health problems i.e. dementia
h) Homeless
i) Migrants (specify)
j) People performing a lot of physical works (in sports and construction)
k) Residents of top floors of buildings
l) Others (Specify)

D.5. Please rate your sensitivity to heat waves?

a) Very sensitive
b) Sensitive
c) Somewhat sensitive
d) Slightly sensitive
e) Not sensitive

D.6. What behavioural adjustments do you implement during periods of heat waves or extreme temperatures?

a) Increase consumption of fluids
b) Prepare more fluids for sale
c) Stay inside premises/indoors
d) Keep doors or windows closed
e) Keep doors or windows open
f) Putting on light clothing
g) Rest under shade/s or tree/s
h) Body cooling i.e., taking a shower/using a cold soaked cloth
i) Using a fan or air conditioning
j) Avoiding physical activity
k) Using sunscreens
l) Wearing sun glasses
m) Wearing a cap or hat
n) Assist those who are at high risk and struggle to keep cool i.e. older persons and/or diabetic persons/babies
o) Carrying water/fluids while traveling
p) Using ice and cool showers to reduce temperatures
q) Others (specify)

D.7. How can your community be best prepared to respond/adapt to heat waves?

a) Construction of community shades
b) Setting up open spaces with vegetation cover
c) Putting in place green rooftops
d) Steady supply of clean and safe water
e) Steady supply of electricity
f) Reducing the cost of electricity
g) Planting more trees at micro-level
h) Easing access to green spaces
i) Providing incentives on cooling equipment
j) Carrying out community awareness
k) Others (Specify)

SECTION.E. Information and Communication on Heat Waves

E.1. Do you recall hearing or reading information about heat waves or extreme temperatures?

a) Yes
b) No
c) Not Sure

E.2.Where do you look for information about weather?

a) Social media (specify)
b) Brochures/posters
c) Television
d) Online materials (Specify)
e) Radio
f) Newspapers
g) Health professionals
h) Village Health Teams (VHTs)
i) Meteorological authority
j) KCCA
k) Relatives/friends
l) Local council's leaders
m) Community members
n) Other (Specify)

E.3. How are you informed about the heat waves and extreme temperatures?

a) Very well informed
b) Well informed
c) Somewhat informed
d) Slightly informed
e) Never at all informed

E.4. Did you receive any information about the occurrence of the recent heat waves/extreme temperatures?

a) Yes
b) No
c) I do not know

E.5. If yes, who provided such information?

……

E.6. Would you prefer getting notified about heat waves/extreme temperatures in the future?

a) Yes
b) No
c) I do not know

E.7. Which of the following sources did you consult on measures to protect yourself from heat waves or extreme temperatures?

a) Social media (specify)
b) Online materials (Specify)
c) Brochures/posters
d) Television
e) Radio
f) Newspapers
g) Health professionals
h) Village Health Teams (VHTs)
i) Meteorology authority
j) KCCA
k) Relatives/friends
l) Local councils
m) Community members
n) Other (Specify)

E.8. Which of the following sources would you prefer getting information about heat waves or extreme temperatures?

a) Social media (specify)
b) Brochures/posters
c) Television
d) Online materials
e) Radio
f) Newspapers
g) Health professionals
h) Village Health Teams (VHTs)
i) Meteorological authority
j) KCCA
k) Relatives/friends
l) Local council's leaders
m) Community members
n) Other (Specify)

E.9.How best can information on heat wave be spread to your community?

a) Mass sensitization through community gatherings
b) Frequent TV and radio programs and adverts
c) Proper use of social media apps
d) Use of VHT structures
e) Advert on billboards
f) Others (Specify)

The End
Thank you

Annex II: Focus Group Discussions and Key Informant Interview Guide

The group discussion or Interview facilitator(s) steers an interactive discussion to get a deeper understanding of heat risk and communication strategies. The main issues to be covered include: (i) Knowledge, Effects and Perception of Heat risk; (ii) Response to Heat Waves; (iii) Communication Strategies to Heat Waves.

A. Knowledge, Effects and Perception of Urban Heat Risk

1. Understanding of heat waves; Exposure and experience of heat waves.
2. Possible sources of heat waves?? {perceptions here]
3. Present conditions
    a. Spatial extent
        i. Hotter parts of the city and reasons for heat waves
        ii. Heat wave occurrence in the city- cooler and hotter parts of the city and reasons for this differentiation;
    b. Temporal extent
        i. Historical experiences of heat waves……experiences?
        ii. Periods of the year/seasons and daily times when heat waves are experienced or occur;
        iii. Duration,
        iv. Frequency,
        v. Severity
        vi. Intensity of heat waves
4. Likely change/conditions
    a. Increasing duration, frequency, severity and intensity of heat waves
5. Social groups who most at risk to heat waves i.e., Elderly, Babies, Children, Pregnant women, older persons and people with chronic illness i.e. diabetes, asthma, high blood pressure etc., Physically ill people, People with mental health problems, Homeless, Migrants, People performing a lot of physical works (in sports and construction).
6. Effects/ problems/ challenges of heat waves on health; social; economic and environmental aspects
    a. Emphasize health related impacts
    b. Costs of adaptation at household and community level/city level
    c. Costs of infrastructure adaptation

B. Responses to Heat Waves

1. Responses to heat waves – explore responses at household level, for specific social groups, neighbourhoods and planning authorities
2. Strategies to be put in place to adapt to heat waves (Probe- individual, community, city and government level strategies)
3. Effectiveness of heat waves responses, and if not, effective what should be done to enhance effectiveness.
4. Response support i.e., information, funds etc.,
5. Sources of response support at different levels

C. Available/potential Heat Waves Communication Strategies

1. What kind of heat wave information is available on heat waves?
2. Who produces the information/knowledge on heat waves?
3. In what format is it produced and disseminated?
    a. Heat wave knowledge products e.g., reports, brochures, flyers, posters, documentaries etc. Who produces and uses these products
4. Heat wave information accessed.
5. Targeted audiences for heat wave information
6. Medium through which information is circulated
7. Level of accuracy and reliability of information
8. Existence of indigenous knowledge on weather, climate and adaptation – who is responsible and how is it collected and used/treated, disseminated. Is it valued?

The End