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Tomorrow's Cities is the UKRI GCRF Urban Disaster Risk Hub

Comprehensive Assessment of Dynamic Risk and Vulnerability and Impact of Road Infrastructure on Risk in Mukuru Informal Settlement, Nairobi City, Kenya

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About Tomorrow's Cities

"Our mission is to reduce disaster risk for the poor in tomorrow's cities."

Tomorrow's Cities is the UK Research and Innovation (UKRI) Global Challenges Research Fund (GCRF) Urban Disaster Risk Hub – a five-year global interdisciplinary research hub. Our aim is to catalyse a transition from crisis management to multi-hazard risk-informed and inclusive planning and decision-making, for cities in low-and-middle income countries. Globally, more than two billion people living in cities of low-to-middle income countries are exposed to multiple hazards such as floods, earthquakes, landslides, volcanoes and fires, which threaten the cyclical destruction of their lives and livelihoods. With urban areas expanding at unprecedented rates, this number is expected to reach four billion by 2050. Failure to integrate multi-hazard disaster risk into urban planning and decision-making presents a major barrier to sustainable development, including the single greatest global challenge of eradicating poverty in all its forms. But this global challenge is also major opportunity: as ~60% of the area expected to be urban by 2030 remains to be built, we can reduce disaster risk in tomorrow's cities by design. We are one of 12 UKRI GCRF Hubs funded by a UKRI Collective Fund Award, as part of the UK AID strategy, putting research at the heart of efforts to deliver the United Nation's Sustainable Development Goals (SDGs).

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Executive Summary

In Nairobi, impacts of disasters are increasingly felt at the local level, especially in the informal settlements where a majority of the city's households and communities live and are equally vulnerable. As part of upgrading living standards for the urban poor in Nairobi's informal settlements, the Nairobi City Government and the National Government have adopted community-driven infrastructure planning and development as a way of promoting quality service delivery, ensuring safety and resilience for informal settlements. The Special Planning Area (SPA) is an infrastructure-led planning process aimed at improving residents' services and living standards. The SPA process has been held up nationally & internationally as a progressive example of community-informed, government-led slum upgrading and is a key reference point for future slum upgrading in Nairobi and further afield. Despite being an important process, the implications for risks, especially at households and community level, is not well known. The aim of the risk and vulnerability assessment (RVA) was based on the need to understand how households in these settings perceive risks, whether such infrastructure development approaches could help reduce risks or otherwise, and what lessons can be drawn to inform more-risk informed, pro-poor urban planning in Nairobi city and beyond. The key highlights from the study include:

- Demographic characteristics defines how the community can prepare for, respond to and recover from hazards in Mukuru, with a majority of the respondents being within the 25-45 years age group. This group is generally considered relatively able-bodied with the capacity to respond and provide support to the community in case of a hazardous event.
- Flood and fire are the major hazards affecting the community living in Mukuru Informal settlement. All households have been exposed to these hazards in one way or the other.
- The new road infrastructure intervention has triggered economic activity, attracted shops, services and increased residents' identity with their place of residence, bringing an enhanced sense of security and orderly development.
- The massive investment on upgrading an informal settlement breaks up an informal settlement into a more urban set-up, permitting cohesion and coherence among the residents.
- The new road infrastructure has enhanced development of other infrastructures such the sewerage network, electricity, construction of level 2 hospital, repair, and

construction of water pipes, upgrading the electricity connection, construction of streetlight, digging of boreholes among others.

- The new road infrastructure is perceived to have enhanced the adaptive capacity of the community members in Mukuru. Improved access to amenities and services is vital to improving community livelihoods and the stimulation of business activities. Diversifying activities satisfy the demand for services, products, and goods, connecting to multi-activities at the grassroots level. Issues like inadequate water impeded the extinguishing of fires when they occurred, thus leading to loss of life and properties.
- The infrastructure development and the slum upgrading are somehow socially exclusive as the voices of the various social groups are not exhaustively included in the planning and implementation.
- Building and having new roads theoretically impacts flood and fire propagation risk. There is general feel that the road network upgrading has reduced the fire risks in Mukuru but has somehow contributed to transferring the flood risks from one place to another due to poor drainage and residue dumping in water ways and riverbanks without proper plans. The influence of the organizations (Appendix 1), CBOs, community leaders, churches, and schools aligns with the Sendai Framework for DRR 2015-2030 on active stakeholder participation to support the development and implementation of DRR policies and plans standards.
- Community confidence in handling disasters varies depending on the available infrastructure and their ability to access the grassroots level of social amenities. Strengthening the social network, improved access to social amenities, and the ability to get emergency support are critical factors that can be attributed to change in the community's perception.
- The massive investment breaks up an informal settlement into a more a more conventional urban configuration permitting enhanced cohesion among the residents. New social groups have emerged, and the existing ones have become more assertive in implementing projects. This transformation has led to spatial heterogeneities reducing inequality and exclusion in the informal settlement in Mukuru. Ultimately, it indicates that Mukuru kwa Reuben is transforming into a more sustainable society.
- The community in Mukuru perceives they are more able to handle disaster at the individual and community level after the road intervention.

- Mukuru Residents are knowledgeable on the possible causes and potential impacts of risks but have been more vulnerable and less capacitated until the slum upgrading program. Most feel they are better placed to handle possible disasters but need more support to enhance this capacity. Concerns around the following raise questions on infrastructure planning and implementation process: displacement of social amenities and transfer of current and future risks from one neighbourhood to another.

List of acronyms

NRH:	Nairobi Risk Hub.
RVA:	Risk and Vulnerability assessment.
DRR:	Disaster Risk Reduction.
CBOs	Community-Based Organisations
SPA:	Special Planning Area.
KPLC	Kenya Power and Lighting Company
APHIA PLUS A:	A-Aids; P-Population; H-Health; I-Integrated; A-Assistance; P-People led, people owned; L-Leadership in all structures; U-Universal access to services; S-Sustainability ¹ .
NMS	Nairobi Metropolitan Services

¹ <https://mildmaykenya.wordpress.com/our-programs/aphia-plus-western/>

Definition of terms

Key terms and definitions around the RVA

Risk refers to the anticipated losses from a certain hazard to a certain element at risk, over a predetermined timeframe. Risk may be measured in terms of the extent of physical damage to property, or in terms of numbers of lives lost or in terms expected economic loss.

Risk assessment entails the use of data to scientifically quantify risk to better understand the processes involved.

Vulnerability is multi-faceted. It is the proclivity of things to be destroyed by a hazard. People's lives and wellbeing are at risk from the effects of the hazard. Each sort of danger puts a to some degree distinctive set of components at hazard. Vulnerability has ended up a critical concept used to guide the design, assessment, and targeting of programs.

Vulnerability assessment can offer assistance to structure successful disaster mitigation to diminish risk levels. Most of disaster mitigation work is centered on lessening vulnerability, and in order to act to diminish vulnerability, development planners need an understanding of which components are most at risk from the principal risks which have been recognized [1] .

Capacity refers “*Capacity refers to all the strengths, attributes and resources available within a community, organization or society to manage and reduce disaster risks and strengthen resilience.*” [2]

Hazard refers to a source or a situation with the potential for harm in terms of human injury or ill-health, damage to property, damage to the environment, or a combination of these or a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation [3]

Exposure refers to a situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas or are/is prone to hazard [3].

Impact evaluation refers to Systematically and empirically investigates the impacts produced, or contributed to, by an intervention and seeks to determine what difference the intervention has made.

Impact refers to Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.

INTRODUCTION

Vulnerability to a hazard is the probability of a certain level of damage that may arise in the event of the hazard. Knowing how exposed a place or community is to disaster helps develop effective mitigation measures to reduce the likelihood of the event occurring, behaviour of the people, and the negative effects of the hazard. Several factors accelerate the damage caused by a hazard; anthropogenic activities trigger most of these factors. Important vulnerability factors include physical factors such as poor planning, which results in poor construction, socio-economic factors such as poverty and marginalisation and environmental factors [4].

Understanding the underlying vulnerabilities of communities is crucial to addressing the adverse consequences of disasters. The IPCC (2001) [5] developed six major indicators that can be used to assess vulnerability. These include settlement/infrastructural sensitivity; food security ecosystem sensitivity; human health sensitivity; water resource sensitivity; and economic capacity. Building an adaptive capacity and resilience of the informal settlers against vulnerabilities and risks would require a critical examination of the interaction of populations with these variables. As a result, vulnerability assessment is increasingly seen as a fundamental stepping stone to effective risk reduction and the promotion of a culture of disaster resilience [6]. However, it is conventional wisdom that assessing vulnerability is a more complex process owing (in part) to the lack of a universally accepted definition of vulnerability [7]. For example, according to Jagmohan Sharma (2019) [8] “[v]ulnerability refers to a relative incapacity to endure the effects of an unfavourable environment.” Similarly, the fourth assessment report (AR4) of the International Panel of Climate Change (IPCC) defines it as the ‘the degree, to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

Additionally, the presence of myriad and diverse significant variables that can be used to assess issues of vulnerability further complicates the process of assessing vulnerability in urban informality. The Total Vulnerability Index (TVI) purports to provide a comprehensive assessment of vulnerability [9]. The TVI presents the indicators that can be used to assess vulnerability at local, national, and regional levels. However, more tools have arisen to help measure vulnerability to date.

As examples of hazards in urban informality, most literature indicates that climate change-induced flood hazard is one among the frequent hazard types posing the highest risk in most African informal urban settlements [10]. As much as all populations are vulnerable and at risk

of natural hazards in terms of exposure, a consensus is that the impacts of climate change-related hazards will disproportionately increase the vulnerability of the urban poor as compared to other groups of urban dwellers [11]. Another hazard is COVID-19, which is compounding the severe health vulnerabilities and inequalities facing the urban poor. It is further reversing the minimal gains that have been made to strengthen the resilience of communities. For most informal settlement residents, even the most basic COVID-19 prevention measures, such as washing hand (limited water supply), social distance (high-density living), and working from home (informal sector employment) [12], due to the high rates of poverty.

Effective implementation of the SPA requires a systematic risk and vulnerability assessment as the entry point to understand the state of the informal settlement in Mukuru. Most of the research in Nairobi, especially in the informal settlements, focuses on single hazards with little concentration on quantitative evaluations, limiting a sense of understanding disaster risk reduction in the city and the basis for decision-making. The methodologies have not been efficient in determining effective long-term solutions. Most evaluations have been based on single hazards and largely descriptive. Furthermore, the segmentation of the study area into cluster with similar conditions did not provide a concise conclusion. Most of these studies primarily focused on specific issues that were related. Still, these did not communicate associated knowledge like standards, norms, or indicators that decision-makers can integrate into policy development. This should not detract from the fact that the frequency and impact of disasters in informal settlements are disproportionate to that in formal settlements [13]. Besides, various findings concurrently indicate that policy formulation and implementation mainly focused on reactive methods rather than proactive hazard management measures. Therefore, there is a need to understand, control and reduce the risk and inform the SPA of 2019, which will be reviewed after two years.

The interactions between these social pathways to risks in slum settings, and by extension, the whole of Nairobi, create compounding vulnerability of slum dwellers. More specifically, the social nature of hazard drivers in the city also means that risks and their impacts are socially differentiated, with gender as an important underlying driver. Women, children, and the elderly are often particularly vulnerable to multiple hazards and their impacts. Despite the pronounced role of social drivers of risks in the city's slums, there is lacking evidence and empirical information on the detailed context of these drivers. Further, interactions between social drivers and physical hazards, and their impacts, remain poorly understood, thus undermining the City

County's aims and efforts towards more integrated development planning and risk preparedness.

Mukuru is characterised by inhabitants with no land tenure security. Most informal settlements face unequal infrastructure development and basic services, with the structures mushrooming without regard to urban zoning and regulations. Besides, the settlement is characterized by poor security, limited access to essential services, poverty, and they are daily exposed to eviction, flooding, fire, epidemics, pandemics. Extensive growth of informal settlements is a policy issue in developing countries. The urban poor in the city is the most vulnerable to disaster risks from hazards due to their exposure to multiple hazards and disasters and the lack of buffer capacity to cope with and recover from disastrous events.

In order to achieve a risk-proof city, the city is expected to pursue participatory and holistic disaster risk management at all levels, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons, in ways that minimises death and economic losses. Thus, the RVA within the informal settlement of Mukuru Kwa Reuben helps understand the state of urban poor in relation to the prevailing disasters. Understanding how vulnerability varies temporally before and after the upgrading of infrastructure is a key dimension of dynamic vulnerability and reflected within the study.

About Tomorrows' Cities

The Nairobi risk hub is part of the larger Urban Disaster Risk Hub (Tomorrow's Cities). It is a five-year global interdisciplinary research hub funded by UK Research and Innovation (UKRI) Global Challenges Research Fund (GCRF). The vision for the Nairobi hub is of a city able to manage disaster risk, in particular for the socially or physically disadvantaged residents. The goal is to support city-led processes that enables a transition from reactive emergency response to more integrated, proactive urban planning to enhance disaster risk preparedness and management. The need for this is recognised at the Nairobi city-county government level, reflected among others in the Nairobi Disaster Management Act 2019 (under development).

Specifically, Nairobi Risk hub seeks to provide Nairobi with the capacity and policy framework that enables a shift from crisis response towards integrated development planning for enhanced disaster risk preparedness and management. The Nairobi City-Hub utilise interdisciplinary research as a tool for convening stakeholders from across sectors and local communities to facilitate collective action towards addressing the drivers and impacts of multiple hazards. Its programmes of work seek to establish a new integrated evidence base on the city's most

prominent hazards and risks, their drivers, uncertainties, root causes and potential solutions, as well as to build greater capacity for collecting and applying this evidence in disaster risk management.

Literature review

a. Risk in Urban Context

According to the UN report on World Urbanization Prospects, it is projected that 50% of the world's population will be living in cities and that this constant growth of the global population will especially be absorbed by the urban areas of the global south between the years 2000 and 2030 [14]. Rapid urbanization and the constant increase in population in the urban areas creates opportunities for socio-economic development and leads to an increase in risks, especially in occasions where urbanization is rapid, poorly planned, and occurring in widespread poverty. UNISDR (2015) [15] additionally notes the overlap in urban areas - between the economic activities and the growing concentrations of people - with areas of high-risk exposure. As a result, it opines that approximately 90% of people living in urban areas in the Global South live in unsafe environments and exposed housing, increasing the risks and vulnerabilities in those areas. The increase in disaster risks due to rapid urban growth stifles development. In this regard, Sustainable Development Goal 11, “make cities and human settlements inclusive, safe, resilient and sustainable,” calls for better planning and management to make urban areas more safe, inclusive, and sustainable [16].

UNDP (2021) observes that risks in urban areas are mostly an interaction and interplay of two main factors: first, location and exposure to hazards; and second, increased vulnerability due to poor local governance, environmental degradation, and the overstretching of resources. As observed in the IPCC 2014 Report, the vulnerability to risks in the urban context goes beyond mere exposure to disaster/climate risks because many cities in developing countries “are caught in a `perfect storm of population growth, escalating adaptation needs and substantial development deficits created by a shortage of human and financial resources, increasing levels of informality, poor governance, environmental degradation, biodiversity loss, poverty, and growing inequality” [17].

Urban settings are faced with myriad risks that range from natural hazard-induced disasters through hazards related to human activities such as fires, building code violations, as well as social risks as arising from insecurity. The interaction of these risks often requires them to be dealt with comprehensively, interactively, and in an integrated manner – and not in isolation. As a result, the identification, assessment, and management of multiple risks have led to the development of the concept of “risk governance” – which provides integrative and comprehensive tools to deal with the many manifestations of risks. Hazards and vulnerability

interact to create specific dynamic risk conditions, geographically and socially specific [18] - extreme poverty, inadequate social services, insecurity, crime, high level of unemployment are vital characteristics that interact within urban informality [19].

In their 2009 Global Assessment Report on Disaster Reduction 2009, UNISDR introduced key terms “*intensive risk*” and “*extensive risk*” to better understand the severity and spatial scope of risks [20]. Intensive risk is the likelihood of being affected by a large-scale energy-intense disaster: more than 10 people being killed and more than one million economic losses. On the other hand, extensive risk refers to the probability of being damaged or injured from a small event, which is not recorded by the international and sometimes national system [21]. Moreover, the extensive risk is “the risk layer of high frequency, low severity loss that manifests as a large number of recurrent, small-scale, low severity disaster” [15] and has more cumulative and direct effects on the urban poor and concentrated in an informal settlement [21]. Twigg (2015) [22] adds that people living in rural areas are similarly exposed to the risk of such hazards. However, he notes that those in densely populated urban settings, especially informal settlements, are disproportionately affected.

Developing countries face policy constraints mainly due to inadequate and scattered data on hazard incidences, causes, effects and limited available resources to conduct research. The existing policies are not well guided. Weak regulation of the policies has hampered implementation driving new pattern of regular hazards experienced in urban areas [23]. The cumulative impacts of a hazard in the urban area can be attributed to a lack of public awareness, environmental vulnerability and low community capacity, poor urban zoning, and the inhabiting hazard-prone areas. Response and recovery to disaster have not been optimized since it is mostly inclined based on the incident of the event. Furthermore, despite rapid urbanization, most of cities in developing countries are characterized by unequal access to infrastructure development, including Nairobi, Kenya [24].

Disaster risks in developing cities such as Nairobi cannot be underestimated. As cities in developing countries grow, so does their population leading to increased exposure and vulnerability to disaster. Urban centres are known to be complex socio-technical systems, made up of communities, institutions, the built environment, the natural environment, infrastructure (such as transport, communications, water, sewerage and power), services (such as healthcare, education, police and waste collection) and economic and social activities. The city systems are interconnected and inter-dependent. Disasters disrupt such systems by interfering with the

usual flow of activities. There is therefore a need to consider the multi-hazard nature of risks in city risk management.

The increase rate of urbanisation coupled with migration of people to the urban areas seeking better life and medication has a direct link to increased cost of living which has rendered many people to opt for relatively affordable places to live. The demand for better housing in the city and available resources has forced most people to look for alternative affordable housing. The increased population in Nairobi city has also led to increased population density. Overcrowding has prompted the majority of the people to inhabit land not designated for residential use. This phenomenon has led to the growth of informal settlements within urban areas of developing countries. Historically, the case of Nairobi informal settlements is linked to land issues where no one owns the land and thus people will construct a semi structure for living.

Moreover, informal urban settlements are spaces where the neighbourhood-level impacts of poor sanitation, overcrowding, poor housing, physical hazard, pollution, and poverty expose the dwellers to everyday health risks and keep them in a “risk trap” [21]. Such impacts affect a community regardless of individual household factors and include pervasive effects existing across the living area of a community [25]. The inadequate sanitation and lack of potable water create an environment with risks of infectious diseases like water-borne disease and vector-borne diseases [26]. Moreover, because of the lack of good sanitation, these risks are higher and more intense in urban settlements.

House structures in the informal urban contexts are made with materials that can burn easily, such as wood, thatch, cardboard. All these can generate risks of domestic fires, especially when homes are packed tightly together [22]. Also, the unsafe water, unsanitary conditions, poor housing, overcrowding, and hazardous location are living and working conditions of these poor urban areas. This can also create health vulnerabilities, particularly among women, the elderly, the disabled, and children [26].

There are poor drainage systems in the streets and lanes, which are often muddy and/or feature stagnant water. These pose not only risks of contracting diseases and the occurrence of floods but also hampers the ease of movement of critical services [25]. Due to lack of better education, employment opportunities, and income, the areas are constantly exposed to crime and violence, and residents live in constant fear of eviction and insecurity, which create stress [27]. Many accidental injuries are attributed to poor quality and overcrowded housing; accidental fire, burns, and scalds occur in overcrowded shelters [28].

b. Risk and Vulnerability in Urban Informality

The rapid and unprecedented rate of urbanization brings with it opportunities for better urban governance. However, it also compounds risks and vulnerabilities upon the urban poor, exposing them to natural and man-made hazards, especially in the global south. According to the UN-HABITAT (2016) [29], more than half of the global population, which is (55%), reside in urban areas, a figure that is projected to rise by 68% by 2050 at a growing rate of 65 million urban dwellers annually. These projections are in tandem with UN-DESA (2019) [30] statistics that indicate that through urbanization, mobility of the human population from rural to urban areas, coupled with the overall growth of the world's population, an additional 2.5 billion people will move to urban areas by 2050. Of this projection, approximately 90% will be in Asia and Africa [30].

In the past and most recent decades, Sub-Saharan Africa (SSA), considered the world's fastest urbanizing region, has been at the forefront in experiencing these high rates of urbanization – owed to the substantial rural-to-urban migrations and the naturally ever-growing urban populations [31]. Currently, the urban areas in SSA have approximately 472 million people, projections that are expected to double in the next 25 years [32]. These statistics are further confirmed by the World Population Prospects findings, the 2018 revision, produced by the Population Division of the UN Department of Economic and Social Affairs (UN-DESA). They note that the share of African urban residents in the world is projected to increase to 20.2% by 2050 from 11.3% in 2010 [30].

With these conversations of an ever-increasing urban population and expanding cities to accommodate growth, discussions on informality have found their way back to the discourse of international development and urban planning. As a result, there is growing recognition that not only is urban informality constituting significant proportions of urban economies, but it is also leading to the introduction of high-level policies by Global South city governments and international organizations to manage such informality. In Africa, the rapid urban growth is coupled with limited formal planning, characterized by poor and uncontrolled land use, resulting in an urban sprawl that poses significant challenges to not only sustainable land development but also general sustainable development [32], [33]. These processes have resulted in the rise of informal urban settlements in cities, which characterizes what urban informality is. In highlighting some of the negative impacts of informal urbanization, Swapan

et al. (2017) [34] notes that the creation of disorganized land-use distribution on public land has resulted in intense environmental degradation.

In the projections of UN-HABITAT (2010) [35], it was estimated that approximately 33 percent of the world's population lived in informal settlements, adding that the largest proportion of these were in the low-income and developing countries of Africa and Asia. Additionally, recent estimates by UN-HABITAT (2016) [36] indicated that the absolute number of informal urban settlers in the developing world increased to 880 million in 2014 from the initial 689 million recorded in 1990 – this represented an increase of 28 percent in the absolute numbers of informal settlers over the past 24 years at the time. SSA exhibited a steep rise of 72 million new informal urban settlers, accounting for 56 percent of the total increase in the number of slum dwellers among developing regions between 1990 and 2014 (ibid). These increasing statistics of people living in informal settlements in the global south partly demonstrate the urban governance failure of cities to cope with rapid urban growth. These expanding and overpopulating cities, as Swapan et al (2017) [34] observe, “exert pressure on infrastructure and leads to a vulnerable urban environment with fragile urban governance systems.” (p. 3).

Often, these informal settlements are dependent on almost non-existent risk-reduction strategies or services. Scholars and researchers alike have opined that the low-income populations are often the most vulnerable in these areas [37]. The disasters and hazards encountered by those in urban informality intensify the state of poverty, thereby blocking any constructive opportunities for growth and development in these populations [38].

The term informal settlement is often used synonymously with the term “slum”. Understanding risks and vulnerabilities within urban informalities would thereby require an understanding of the definition of this. According to the UN, a slum is a;

“contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services, a slum is often not recognized and addressed by public authorities as an integral part of the city” [39]

Additionally, the UN describes a slum household as “a group of individuals living under the same roof lacking one or more of the following conditions [39] : (i) access to improved water; (ii) access to improved sanitation; (iii) insufficient-living area; (iv) durability of housing; and (v) security of tenure” (ibid). The assessment of risks and vulnerabilities in urban informality would therefore require understanding the interaction of these variables and how through that

interaction, risks and vulnerabilities arise. Myers (2016) [40] also opines that slums provide a reasonable proxy for the study of informal settlements.

Informal urban settlements are disproportionately more vulnerable to the risks of natural and human-made hazards and disasters. This is due to their greater exposure associated with their geophysical location, lack of access to the above-mentioned variables, and under-investment in proper and sustainable infrastructural facilities. The growth of urban informality is often characterized by illegality, unplanned settlements, and significantly, urban poverty. It is within this context that John (2020) [32] argues that whenever rapid urbanization is mismanaged and allowed to thrive in a state of resolute multidimensional poverty, the global south increases the risks in these areas, thereby depleting the resilience and adaptive capacity of the vulnerable populations to respond to different hazards and disasters.

The occurrence of disasters in these areas is significantly accelerated by the interplay of three key variables; the hazards within the communities, the exposure of the populations and their economic assets, and vulnerability. Vulnerability and risk can be minimized by strengthening the resilience and adaptive capacity of these populations to cope with exposure to hazards such as floods, pandemics, or fires. A potential hazard could easily escalate into a disaster depending on the extent of exposure of the populations and their physical or economic assets. The higher degree of exposure and vulnerability of both people and infrastructure within cities is a driver behind why hazards have a greater socio-economic impact in informal urban areas than in rural areas [41]. Risk and vulnerability can be influenced by physical attributes (such as structural qualities of housing or infrastructure) and qualitative attributes (for example, age, health, and poverty). The adaptive capacity of households and communities in the urban areas to respond to disasters is also unequal, with low-income urban residents in the informal settlements having poor or no access to information and fewer safety nets to cushion them.

The three traditional components of risk (vulnerability, hazard and exposure) is increasingly considered with respect to a fourth component emerging from the various responses to risk itself (IPCC 2022). Planned responses to risk have the capacity to ultimately undermine the future risk context, reinforce other vulnerabilities or shift risk to other locales. Within this context the potential for infrastructural development to address one set of vulnerabilities while exacerbating others or redistributing risk spatially or temporally ought to be considered. The role of such interventions in shaping risk can be explored through a dynamic assessment of the perceptions of risks held by those exposed and vulnerable to them. Risk perception is a concept with a rich tradition within the broader disaster risk management literature.

c. Demographic characteristics and vulnerable groups in the context of infrastructure upgrading

Vulnerability is socially distributed in myriad ways. The vulnerability of certain social groups is not considered an inherent characteristic of the group *per se*. Rather, it is recognized that vulnerability results from interdependent societal stratification processes that result in various dimensions of marginalization [42]. The basis of the vulnerability of key vulnerable groups in the context of infrastructure upgrading in informal urban settings is outlined in Table 1.

Table 1: Basis of vulnerability in the context of infrastructure upgrading

Vulnerable group	Basis of vulnerability in the context of infrastructure upgrading
Female-headed households	Gender is an important determinant of urban vulnerability. Female-headed households tend to have a higher dependency ratio as well as lower and more precarious incomes and fewer assets. This erodes coping and adaptive strategies in the urban informal context. there is a paucity of literature on gender in the context of slum upgrading.
Large households	Household size is related to vulnerability insofar as larger households tend to have a higher dependency ratio than households of smaller size, leading to a lesser availability of income and assets. Larger households also tend to have greater numbers of children and older people (see next row of table).
Age: children and older people	Age is a key characteristic influencing susceptibility to disaster risk. Children and older people in particular tend to be dependent on others to anticipate and mitigate risks as well as engage in adequate response activities such as evacuation. Infrastructure improvement can serve to enhance the capacity to evacuate prior to and during the onset of hazards.
Renters	inadequate land tenure has been considered an important but often overlooked anticipator of vulnerability to disasters [46,47]. However, the relevance of tenure security to reducing vulnerability has been

	recognized by its inclusion as an indicator for the achievement of United Nations Sustainable Development Goal (SDG) 1, which is focused on poverty eradication. Research has suggested that those who rent rather than own their dwelling within urban informal settlements can under certain circumstances be more likely to be adversely affected by hazards such as fire and floods.
Households with low levels of education	Higher levels of education are related to better preparedness and response to disasters, lower negative impacts, and quicker recovery in the aftermath [43].
New residents	There is an established link between the length of the period a household is living in a locality/informal settlement and exposure/vulnerability to hazards. The length of time an individual or household has lived in a locality has been associated with the quality of housing and its resilience to hazards [44]. Experience of disasters and social attachments are also strongly related with preparedness and risk mitigation [44]–[46].

d. Access to livelihoods and key goods and services in the context of risk

The availability and accessibility of livelihoods and key goods and services is a major challenge in rapidly urbanizing contexts [47], informal settlements tend to be poorly integrated with the economic core of cities.

Although an important objective of slum upgrading, livelihoods are rarely considered as an outcome in the evaluation of such programmes [48]. Improved infrastructure in urban informal settings nonetheless has the potential to enhance the accessibility of livelihoods through reducing time spent travelling from place of residence to place of work and to markets. Facilitating travel therefore expands the livelihood options of the urban poor. improved infrastructure may have a disproportional impact in this respect on marginalized groups such as women and older people due not only to reduced travel times but also the improved security brought about by infrastructure upgrading.

Livelihoods provide the basis for income and assets that allow for self-protection at the household level and to engage more productively in reciprocal relationships of mutual aid with friends, neighbours and family members outside the household [49], [50]. Such access enhances both the coping and adaptive capacities of households. Income and assets are considered key sources of coping in the context of shocks and stressors, including in the context of hazards such as fire and floods, and allow households to recover more quickly.

Evidence is scarce about how slum upgrading impacts upon employment. What evidence does exist indicates that self-employed activities have increased, with proximity to the improved roads an important factor [48]. Gonzalez-Navarro and Quintana-Domeque (2016) [51] analyzed the impact of paving streets in Acayucan (Mexico). No impact was found of surfacing roadways on the number of hours each adult works and on their earnings.

While little literature exists on the relationship between infrastructure projects and urban livelihoods, there is a better evidence base that explores the extent to which such projects have the potential to increase accessibility to a wide range of essential goods and services that directly inform risk. The relationship between the accessibility of key goods and services and risk in the urban environment are outlined in Table 2.

Table 2: Relationship of accessibility to essential goods and services with risk

Accessibility of essential goods and services	Relationship of accessibility to essential goods and services with risk
Accessibility of adequate water and sanitation	Accessibility and availability of adequate potable water and sanitation are key determinants of well-being, in particular to the reduction of communicable diseases, including Covid-19. Through the importance of water and sanitation to well-being this sector is closely bound up with vulnerability more broadly [52].
Accessibility of education	Education is widely regarded as an important determinant of disaster risk management as it underpins individual cognitive capacity and learning skills as well as access to information [53]. See Households with low levels of education in Table 4.

Accessibility of food and water	While there are few studies concerning the consequences of infrastructure on food distribution within communities, there is increasing attention to the possibility that the relationship between disaster and food security is mediated by critical infrastructure [54].
Accessibility of healthcare	Accessibility of healthcare is subject to disruption through disaster risk. Accessibility of healthcare also provides the basis for improved well-being, which enhances livelihoods and reduces vulnerability at the individual level.
Accessibility of energy sources	Energy use is both a driver of risk as well as a source of coping and adaptive capacity.

e. Infrastructure development and adaptative capacity

UNFCCC defines adaptation is the process of adjusting to real or anticipated climate and its consequences in order to reduce harm or seize advantageous possibilities which feasible through human intervention. The climate change impacts are observed affecting different sectors in the urban setup. This impact is exemplified by non-climatic hazards such as fire and other hazards which are socially driven. The impact of such compounding risk in much felt in the informal settlement in the urban setup. For instance, despite they are exposed to climate hazards, weather conditions such as temperature, wind, humidity, and rainfall tend to influence other hazards such the fire behaviour, vector and water borne diseases. As such the social risk among the urban dwellers could be associated with the social economic development since adaptation disparities appear among populations with low-income earners. Thus, this means adaptation differs across the city depending on the social cluster [55].

There is a correlation between increased infrastructure development and better availability and accessibility of social services. By making formerly inaccessible locations more accessible, such initiatives improve the quality of life for residents, the community's confidence handling disaster and recovery capacities is bolstered [56]. According to IPCC report of 2022[55], it is evidenced that more emphasis on physical infrastructure development and less concentration on social infrastructure. Ultimately, the resilience of an urban dwellers is determined by their

level of capacity and culture which will determine their response, preparation and influenced by some other factors (Table 3) in anticipation to disasters.

Table 3: Adaptive capacity of the urban dwellers

Factors	Community adaptive capacity
Capacity building	Developing strategies for disaster mitigation and building the capacity of the community to deal with disasters and recover quickly from these adverse events is key in an urban setup [57].
Participatory decision making	Inclusive participatory in the planning process to integrate different facets of ideas to develop a risk proof plan thus enhancing an infrastructure that is resilient.
Community support in handling disaster	Community response to disaster varies at different scales defined by the community setup [58].
Strong partnership with the actors in the DRR ecosystem	Integrating informal community participation in DRR is instrumental in city project development, thus developing stringent mitigation strategies.
Disaster early warning and preparedness	Community awareness knowledge on anticipation for hazardous events prompts for an effective plan in preparation to handle the event [57].

Study Area

The informal sector accounts for approximately 56% of the total population in Nairobi with Kibera being the largest slum. Other slums include Mathare, Kayole, Dandora, Baba Ndogo, Fuata Nyayo, Huruma, Kawangware, Kangemi, Kariobangi, Parts of Githurai, Githuguri, Githogoro, Mukuru kwa njenga, Mukuru kwa Reuben, Mukuru Kayaba, Korogocho, Deep Sea, Kware, Kayole Soweto, Kahawa Soweto, Kiambio, Matopeni, and Kiangombe (Figure 1).

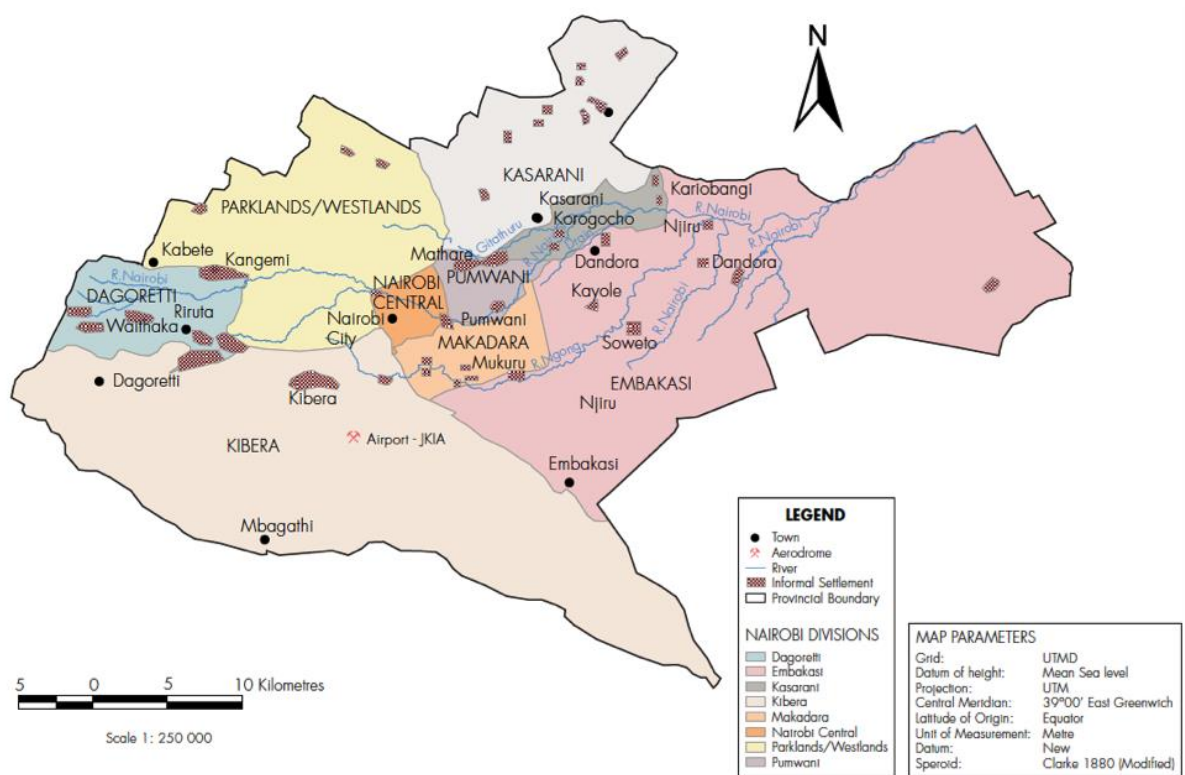


Figure 1: Map of Nairobi City County

f. Mukuru as a Special Planning Area

Mukuru SPA (Kwa Njenga, Reuben and Viwandani) has an area coverage of 650 acres hosts over 300,000 residents and over 150000 households who face myriad problems because of under-development and densification. Through the Mukuru Special Planning Area work, the community has been divided into 13 segments consisting of 30 villages (Figure 2). The households in these villages are further divided into sub-cluster of 10 units (Nyumba Kumi initiative) headed by an elected chair who acts as a representative in forums discussing matters associated with Mukuru. The forum comprises a consortium covering water, sanitation, and energy; finance; land and institutional arrangements; health services; education, youth and culture; environment and natural resources; housing, infrastructure and commerce; and community organization, coordination, and communication. Through collaboration and partnership, the Muungano Alliance, composed of Muungano wa Wanavijiji, Akiba Mashinani Trust, and Slum Dwellers International, community has emerged and participated in most of the development and research strides in Mukuru. Despite all the good strides, there is still slow development in the areas. Special Planning Areas was formed as a tool that the Government of

Kenya, through the Nairobi County Government and the current Nairobi Metropolitan Services, intend to use to upgrade the lives of the urban poor in the area.

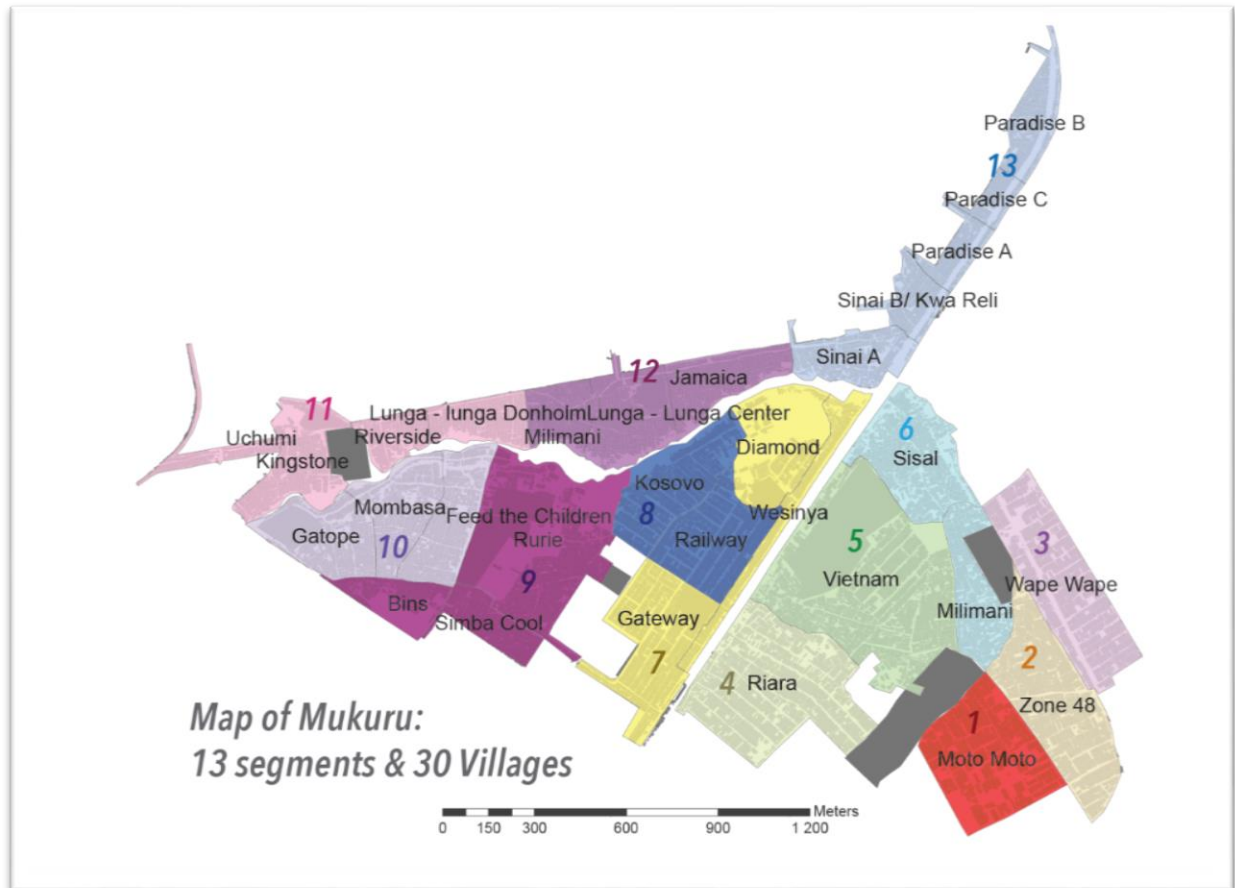


Figure 2: Map of Mukuru: 13 Segments and 30 Villages

g. The rationale for the RVA.

The RVA implemented was a systematic and empirical investigation of the impacts produced or contributed to by intervention and seeks to determine what difference the intervention has made. A dynamic vulnerability lens has been applied within the study. Dynamic vulnerability calls attention to how vulnerability inevitably varies across time, space, and between social groups. As such, the application of a dynamic vulnerability lens to understanding the impact on risk and vulnerability arising from infrastructure development requires not only an understanding of the impact of development before and after the implementation of the infrastructure but also how such development impacts differentially in relation to certain groups within the population (**Error! Reference source not found.**). Such infrastructure may well be largely beneficial but not uniformly across the population. This study accounts for the

vulnerability of the following vulnerable groups before and after upgrading the road infrastructure: women, children, elderly, the relatively less educated, renters, and households recently settled in Mukuru.

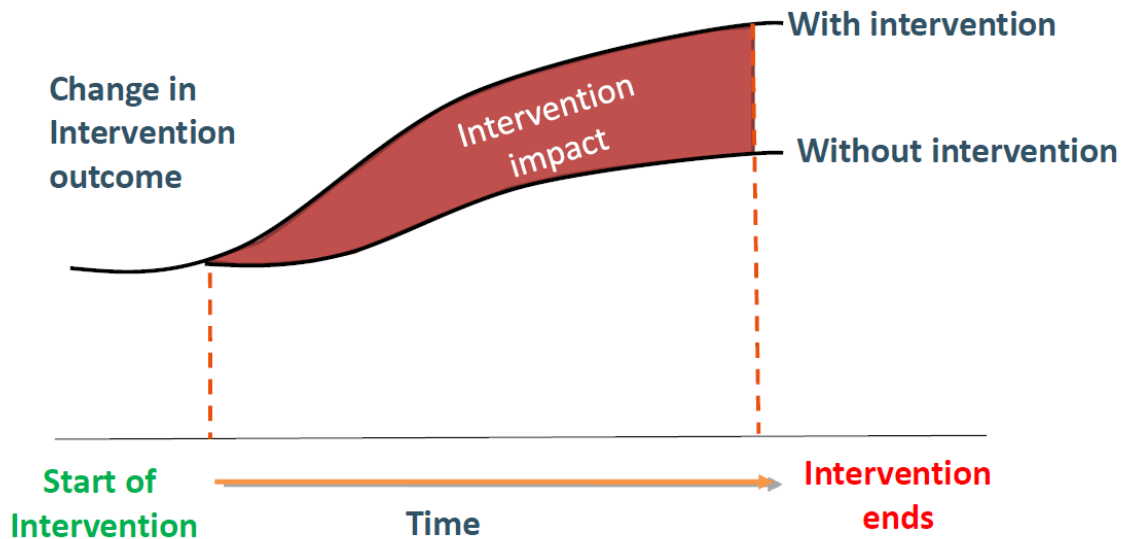


Figure 3: RVA Analysis Framework

With the developments continuing in Mukuru, the NRH RVA process intended to interrogate the impacts of the developments in Mukuru using a livelihoods approach. Besides, the assessment emanates from the risk point of view where the developments are also assessed to ascertain if they contribute to the reduction of risks accumulation or vice versa. Ultimately, the RVA insights intended to show that multiple factors are stacked up to drive risks in the city and urban poor (community and household level) and thus the need to consider risk integration in the planning and development of the SPAs. The key metrics are analysis of livelihood (improved access to market?), social assets (improve access to amenities like schools, transport, emergency vehicle access), social capital (disruption caused by new land-use?), and capacity (willingness to engage in future local and collective action following the experience of the SPA deliberative process and NMS top-down action). Through a consultative engagement with the community, Mukuru Kwa Reuben emerged as our area of interest because it has benefited from the new infrastructure development.

The RVA in Mukuru kwa Reuben was based on policy and hazard analysis to provide context on operationalizing the link between the causality factors and action of different sector responses to it. It was evidenced that the institutional landscape/arrangement for disaster risk in Nairobi is complex, with multiple actors executing different roles and supplying knowledge products. The complex web of actors compounded with lack of clarity on who is responsible for risk is attributed to the emergency response, which often overstretches resource support at the local level. Through NMS, the Kenya national government is leading the implementation of new infrastructure to improve service delivery and reduce disaster risk in Mukuru. This work commenced in the year 2020. The impact of the new infrastructure is anticipated to shape disaster risk in Mukuru slum. The new infrastructure is embedded in improving urban planning to reduce hazards, exposure, and vulnerability. The hub and the residents of Mukuru co-designed risk and vulnerability assessment (RVA) study to unpack how the new infrastructure has influenced prevailing hazards, exposure, and vulnerability. In addition, the study unpacked the governance of risk by looking at the organizational arrangement and its influence on disaster risk in Mukuru.

The RVA work was based on a demand-driven approach where research is designed to inform the needs of the residents of Mukuru and policymakers. This demanded evidence on how households perceive '*disaster risk*' in the context of the new infrastructure development being deployed to Mukuru. The local communities' perception was not accounted for in most plans, such as Mukuru's SPA where the focus has been on general infrastructure, livelihood, and service delivery improvement supported by multiple surveys undertaken over the years. To understand the interaction between '*disaster risk*' and infrastructure development at the community level, a blended approach was adopted to ensure the data tool was co-developed with the involvement of the local community, researchers, and key stakeholders.

Methodology

h. Data collection

To fill up the existing data gaps identified through the preliminary situational analysis, primary data collection was inevitable. The primary data collection was majorly from the household surveys, which were conducted following a rigorous sampling done with the social consideration of gender and the geographical distribution in Mukuru Kwa Rueben. The household survey aimed to support the assessment of the impact of the new road infrastructure on the delivery of essential services and disaster risk (hazards, exposure and dynamic vulnerability). The number of households and their distribution along the new road network were considered. The data collection tool developed was programmed on an Open Data Kit platform, which the Hub chose for its user-friendly nature and reliability. The sampling done was majorly random along the newly constructed road network in Mukuru Kwa Rueben slum. The data collection team observed the COVID-19 guideline.

Using Yamane (1967:886) [59] formula against the estimated number of houses in Mukuru Kwa Reuben with a confidence limit of 95%, thus allowing an error margin of 0.05 only, a sample size of 400. Additional 20 households were also selected to pre-test the data collection tool and pilot the data collection process. The equation below shows the formula used:

$$n = N \div (Ne^2).$$

$$N=47628 \text{ houses}$$

$$e=0.05$$

$$n=\text{sample size}$$

$$n=47628 / (47628 \times 0.05 \times 0.05)$$

$$n=400$$

To effectively collect the primary data, about 16 research assistants were trained in person on the data collection process, including ethics and tool usability. They were well-equipped on the RVA method and the data collection process, which involved physical data collection and response recording. To practically test and apply the skills gained, a pilot exercise was

conducted with a sample of the community from Mukuru. In this regard, the Enumerators conducted a pilot survey involving interviews to test the tool's effectiveness and improve on the questionnaire. The practical experience was used to improve the data collection tool, the methodology, and the logistics of the process. The actual data collection involved physical surveys among the Enumerators. The data collection daily activities were monitored, and records were uploaded to the server alongside with the daily submission of the summaries, including performance, challenges, and experiences to inform improvements. A total of 427 successful surveys were randomly recorded, with only 7 declines due to different reasons (Figure 4).

The collection of primary data was made to be very strategic and detailed in its mixed approach to capture the qualitative data aspects, including the knowledge, perceptions, views, and attitude of the locals in relation to incidences of hazards that they experience. The information was designed to make sure that most of the data on Risk and Vulnerability among the urban more is well captured and articulated.

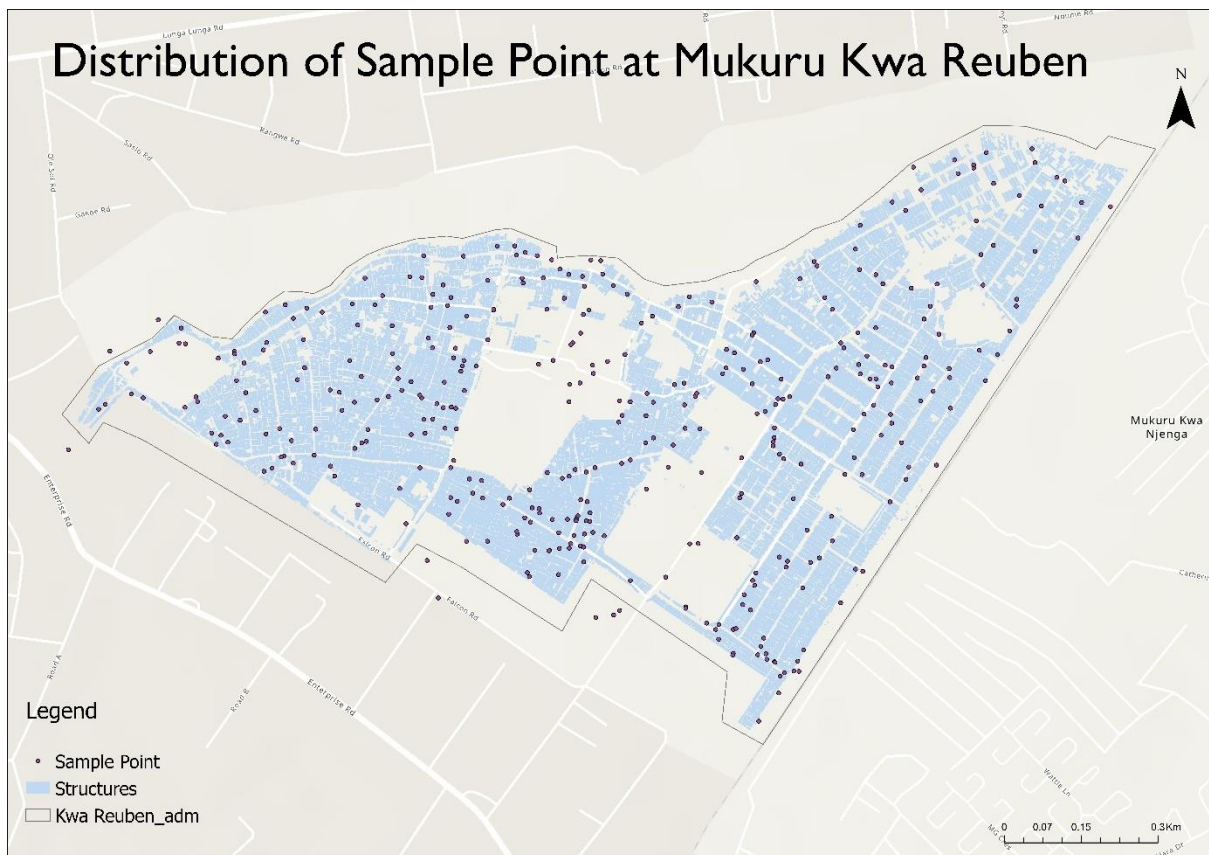


Figure 4: Sample distribution at Mukuru Kwa Reuben

i. Sample Characteristics

The demographic characteristics analysed were gender, age, and education level of the respondents (n=400), as shown in Table 4 below.

Table 4: Demographic characteristics of the respondent

Gender	Percentage
Female	67.25
Male	32.75
Age	
18-24 years	20.75
25-34 years	38
35-44 years	24.75
45-54 years	11.5
55-64 years	4
>65 years	1
Education Level	
None	1.75
Primary incomplete	9.25
Primary complete	22
Secondary incomplete	15.25
Secondary complete	37.25
Tertiary in-complete	4.5
Tertiary Complete	10

i. Gender of the respondent summarise in one table

Out of the sampled 400 households who agreed to participate in the Survey, 67.25% were female and 32.75% were male (Table 4).

ii. Age of the respondents

The respondents' plurality (38%) lies in the 25-34 years age group, as illustrated in Table 4.

iii. Education level of the respondents

The results in Table 4 show that 37.25% of the respondents have completed their secondary education, with 22% and 10% have completed primary and tertiary education, respectively. However, some households (1.75%) have not attended a formal school. Among the respondents, 9.25%, 15.25%, and 4.5% did not complete primary, secondary, and tertiary education (Table 4).

The team searched for RVA tools used elsewhere and how they can be customized to develop an initial draft that was subjected to review by the local communities and the hub research team. The team also consulted IFRC-Geneva. The team from Nairobi also revisited the RVA

they undertook in Nakuru county, which provided another case in terms of being in such a similar setup in governance and politics and hazards occurring in Kenya. Nakuru's RVA was funded by the Covenant of Mayors in Sub-Saharan Africa (CoMSSA) for Sustainable Energy Access and Climate Action Plan (SEACAP) in Sub-Saharan Africa². We consulted Annex 13³: Tools for Climate Risk Assessment of the World Bank's Urban Risk Assessments Understanding. We consulted the ACF-INTERNATIONAL NETWORK' Participatory Risk, Capacity & Vulnerability Analysis Practitioner Manual For Field Workers⁴. We harmonized the draft RVA tool and shared it with the Hub team who did necessary reviews to shape the tool before the local community consultations (participatory mapping and prioritization of parameters to be studied and logistical planning) in Mukuru slum.

j. Focus Group Discussions

Focus group discussions were undertaken both before and after primary data collection. Six FGDs were undertaken selected Mukuru Community members, community groups and CBOs based in Mukuru, four virtual community-based dialogues in 2021 and community members was held on 9th September 2022. Participants were identified by the community leaders Prior to the surveys, the FGD discussions focused on co-designing the data collection tool- the questionnaire and scoping some of the risks experienced by these communities. The last two FGDs were executed to validate the RVA survey results and to give feedback to community member including leaders who could use the finding to create awareness and support local capacity where needed, youth and leaders to support data collection, a clear message to be shared with the community by the leaders and participants, a co-produced data collection tool, map of area of focus (Mukuru kwa Reuben) in Mukuru Slum.

² <https://comssa.org/nakuru-county-advances-climate-planning-by-identifying-hazards-and-conducting-vulnerability-assessments/>

³ <https://openknowledge.worldbank.org/handle/10986/12356>

⁴ <https://www.actionagainsthunger.org/publication/2013/01/participatory-risk-capacity-vulnerability-analysis-practitioner-manual-field>.

RESULTS

A. The infrastructural interventions through the SPA

Mukuru is a Special Planning Area (SPA), where new approaches to some of Nairobi's more intractable land-related problems are being developed and tested. SPAs are seen as having the potential for vastly improving the city's disaster risk management, provided disaster risks are taken seriously in the planning processes. Finding the means of reducing disaster risks in Nairobi's 150 informal settlements must go hand in hand with efforts to open up new areas of affordable housing where comparable land-related contestations do not arise, and disaster risk management can be undertaken more proactively.

Mukuru has been selected as an entry point for developing approaches that may be replicated across the various parts of Nairobi, linked to the hub's overall Nairobi-wide perspective. Mukuru and other Nairobi slums remain priority focus areas for achieving tomorrow's Nairobi based on the ambition of the county, national governments and the international community to adopt a holistic approach to upgrading slums into quality, affordable risk prepared and resilient habitations.

a. Participation of Residents of Mukuru in Governance of Urban Planning for Risk Reduction

According to the respondents, the community in Mukuru Kwa Reuben has engaged in urban planning, infrastructure implementation, resource planning, and social networks. The respondents' response shows that there is less community participation and involvement in the planning and implementation of the Mukuru improvement program. Significantly, a few respondents have been involved or engaged in various events and activities on local urban planning, infrastructure development, and resource discussion in Mukuru Kwa Reuben. Some respondents confirmed that they are members of various social networks, such as clubs and associations, which they use as platforms to engage in social-economic, environmental and political activities in Mukuru Kwa Reuben. Figure 10 shows that at least 9% of the respondents confirmed that they have been consulted or involved in plans and work to improve Mukuru, while 8% have been consulted or involved with the road project implementation, which is one of the provisions in the Mukuru SPA. However, 8% confirmed that they have been made aware or involved in the discussion on county government resources or programs to improve urban service delivery that might reduce risk of flooding or fire. At least 6% of the respondents

confirmed they are involved in community or neighbourhood clubs that bring together members to undertake or discuss community activities (Figure 5).

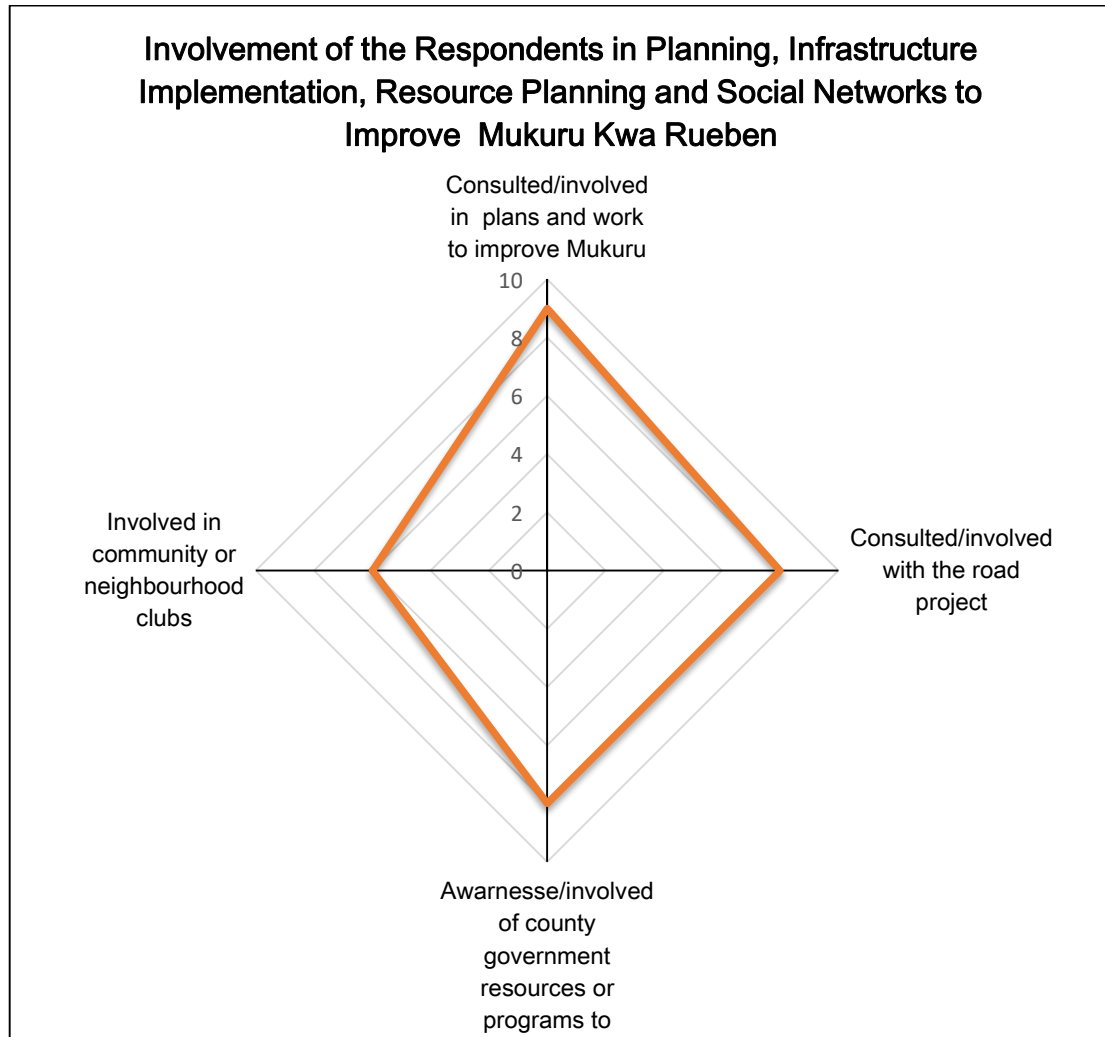


Figure 5: Participation of respondents in Urban Planning, Infrastructure Implementation, Resource Planning and Social Networks in Mukuru Kwa Rueben.

Residents consulted or involved with the road project in Mukuru Kwa Rueben

Among the respondents, only 8% confirmed that they were consulted or involved in the implementation of the new road project led by NMS in Mukuru Kwa Rueben. Some of the respondents were involved as casual laborers (Figure 5). This included cleaning the road during construction, digging drainage, and other support activities. Some respondents were consulted during the Mukuru SPA process which included building consensus on where new roads should pass and mapping road reserves. Majority of the respondents complied with the advice of the county government and the road construction company during their door-to-door meeting and awareness creation advising residents to move out of the road reserve. The key stakeholders

who facilitated the above activities include, Muungano Wa Wanavijiji who is among the Mukuru SPA consortium, area Chief, Nairobi City county government, NMS, landlords among other actors.

Residents consulted or involved in plans and work to improve Mukuru Kwa Reuben Slum

As shown in the Table 5 below, at least 9% of the respondents shared some of the slum improvement and general social-economic activities they have been involved in over the last years. Some respondents identified key organizations who facilitated or delivered the activities they were involved in. Generally, respondents were consulted, and some were involved in the various sum upgrading activities and social-economic activities. Some of the slum upgrading activities include maintaining the sewer system, road construction, cleaning exercise, and water and sewer improvement projects. The respondents were also involved in the following socio-economic activities, training on use of modern and clean modes of energy i.e. the solar project and jiko koa projects, management of Social Gender Based Violence (SGBV), fight against COVID19 and waterborne diseases such as cholera using general sanitation and application of detergents (e.g. soap), saving through SACCOs, improvement of livelihoods, women and girls mentorship among others. The respondents also confirm that their political leaders and government have consulted them on general development issues.

Table 5: Community services

Activities	Organisations
Modern and clean modes of energy i.e. the solar project and jiko koa projects	Community Based Organizations (CBOs)
Helped in maintaining sewer system	Mukuru Youths
How to deal with Social Gender Based Violence (SGBV) cases	Wangu Kanja Foundation; Kenya redcross, , Muungano Wa Wanavijiji
Employed at a road construction site	Nairobi Metropolitan Service (NMS); county government
Involved in drainage digging and cleaning	Natioal Programm called Kazi kwa Vijana & Kazi mtaani
Fight against COVID19 and cholera distribution of soaps	Ministry of Health
Sewage lines	Nairobi Sewerage and Water Supply
Road project	NMS
Saving to improve livelihood	Sacco
Sewer project	Athi water project

Water project	Nairobi Sewerage and Water Supply
Building covid resilience	Shining Hopes for Communities (SHOFCO) in Mukuru
Mukuru SPA process	Muungano Wa Wanavijiji
Women and girls mentorship programmes;	Kenya Red Cross
Xonsulted on generasl development issues	Office of the Membr of Parlimanet (MP) ; NGOs

Residents awareness or involvement in county government resources or programs to improve urban service delivery that might reduce risk from flooding or fire in Mukuru Kwa Reuben

Among the respondents, only 8% shared their involvement in the following activities designed to reduce flood or fire risk, or they are aware of such activities that risk-proof the community from the impact of flood or fire. Among the 8% of the respondents, some confirmed that they are aware and some were involved in the slum upgrading programme and specific activities such a construction of a hospital, water, road, sewer and drainage system to improve the capacity of the exising drainage lines to drain excess water and reduce flooding; distribution of aid foods for flood or fire victims; construction of a police station to enhance physical security. Some respondents were employed as casual laborers under the Kazi Mtaani to support the national government and County government in delivering the Mukuru SPA. Some respondents are aware of the presence of community-based organizations (CBOs) such as Mukuru Skills, Dreamgirls and Hope Worldwide, who play critical role in amplifying the voices of the residents of Mukuru through policy advocacy and lobbying government and stakeholders to FastTrack upgrading of Mukuru slum.

Involvement of Residents In Community or Neighbourhood Clubs in Mukuru Kwa Reuben

Among the respondents, 6% shared some of the clubs, associations and initiatives they have subscribed to as members or involved in their activities. Some of the social networks, clubs, associations and initiatives include the following (

Table 6):

Table 6: Clubs at Mukuru Kwa Reuben

Clubs	
<p>Bold Ideas For Girls with Big Dreams</p> <p>Community school club</p> <p>Esaiga</p> <p>FONYA-volley Ball Club</p> <p>Football club for the youth</p> <p>AEA</p> <p>Hope Foundation (Dreams club)</p> <p>CBO</p> <p>Chama (Merry-go-round group) Called Maendeleo where they do table banking: saving of financial resources and advancing of loan to member</p> <p>Kazi mtaani supported national government</p>	<p>Nyumba kumi Initiative- Security initiative</p> <p>Pillars of women</p> <p>Ruben Vision</p> <p>Shining hopes for communities (SHOFKO)</p> <p>Sports Clubs: Tae Kwondo;Football; Acting/Drama; Waste and Cleaning</p> <p>Social clubs: Youth; The Ladies Group</p> <p>Wasafi Classic Garbage collectors involved in garbage collection and community cleaning</p> <p>YEF Reuben Center</p>

b. Impacts of the road on the willingness of neighbours to collaborate in local efforts

Accessibility of the settlement by residents and other users

Respondents argued that the enhanced accessibility of Mukuru settlement has made it possible for service providers and emergency responders (e.g. firefighters, ambulances etc) and residents to move with limited barriers. This is attributed to the enhanced movement of residents to engage in the ongoing slum upgrading activities and businesses in Mukuru. Respondents affirmed that the movement of people, goods and cars is also less costly and less risky to cross from one section of the slum to the other sections. The ease of movement gradually accelerates the engagement of residents in personal and community activities.

Creation of Job opportunities, source of income and livelihoods

The new road construction has created job opportunities, sources of income and livelihoods for the youth and residents, which respondents attribute to the renewed effort by the residents to

engage in the improvement efforts in the Mukuru slum. The youth and residents are now willing to engage in other slum upgrading programme activities such as improvement of *drainage*, clean-up exercises, waste management, water supply, and health programme. The youth are engaged in income-generating activities such as waste management, which they charge a fee. The national government is also using the *Kazi Mtaani* initiative to provide temporary employment opportunities for the youth and residents, especially women, to engage in the slum upgrading program and receive regular wages. The ongoing development projects motivate residents to engage more in collaborative efforts to upgrade infrastructure to improve access to services and reduce risk in Mukuru Kwa Reuben. The key stakeholders, such as business owners, find it necessary to involve the youth in drainage maintenance. The business opportunities are now growing and residents find opportunities to engage in entrepreneurship triggered by the improvement of infrastructure.

Strengthening Social Networks

According to the respondents, the youth and residents who have joined various social networks are more engaged in their activities and mobilization of more members, which they attribute to the opportunities created by the slum upgrading program, which so far is bearing fruits through access to basic services and easy movement of people, goods and cars. The respondents shared that it is now convenient for residents to gather, plan and engage in community activities. In addition, respondents believe that it has enhanced joint meetings and activities among the most vulnerable groups in Mukuru. Generally, respondents believe that the new road network and other improvement has enhanced social cohesion in Mukuru Kwa Reuben.

Enhancing Communication and Information Sharing

The respondents shared that of late, they are witnessing enhanced communicating and sharing of information regarding the slum upgrading programme, various development projects and sharing of public information. The respondents believed that there is general enhanced communication and sharing of information among the residents triggered by the implementation of the new road network and other infrastructure improvement activities. The residents and youths are enquiring more about the slum upgrading program and the associated opportunities they can engage with. In addition, respondents believed that the expansion of the road network has enable residents to move with ease and reach out to others in the slum.

c. Access to social amenities

All the respondents had a chance to share their perceptions of the old and new road networks either bad, fair, good or there was no change. The respondent's perception/treatment was captured in percentage between 1 to 100. The findings in this section captures the perception/treatment of the respondents before and after the construction of the new roads on access to the following facilities/ amenities: 1) electricity, 2) potable water, 3) latrines, 4) primary school, 5) secondary school, 6) food shops, 7) workplace, 8) health clinics and 9) hospital. The summary results are presented in Table 7 and discussed below.

Table 7: Access to amenities before and after road construction

Access to Amenities	Bad		Fair		Good		No change	
	Before	After	Before	After	Before	After	Before	After
Access to electricity	71	10	20	28	8	49	2	13
Access to potable water	69	9	22	20	8	61	2	10
Access to latrines	60	7	29	12	9	46	3	17
Access to primary school	75	6	22	18	2	65	2	11
Access to secondary school	72	6	21	22	4	59	4	13
Access to food shops	63	6	28	18	6	63	3	13
Access to work	73	9	21	19	3	61	2	11
Access to health clinics	73	5	21	24	3	62	2	9
Access to hospital	73	5	20	24	5	61	2	10

Condition and access to electricity

Generally, the perception of the respondents shows that before the construction of the new road network, access to electricity was ‘bad’ (71%), but after the construction of the new road network, access to electricity is ‘good’ (49%) as shown in Table 7 above. The respondents indicate that access to electricity has been enhanced significantly after constructing the new road network. Despite this, the respondents perception, generally, that the cost of electricity has reduced since the some of the household pay based on the electricity they have consumed as noted in the quote “*Before, I was using sambaza which I was paying a constant monthly bill despite the consumption for me but now I have to buy tokens since I have a meter box.*”

Initially, most community members were dependent on “*sambaza*,” (referring to the illegal connection shared among the community), which involved landowners extending the power cables directly from nearby electricity poles to their plots/houses that their tenants subsequently paid. The high cost of living leaves residents with no option but to revert to the illegal power connection, which is hazardous and poses a danger to them because it is not done as per the

electricity connection guidelines and by the right personnel and institution (Kenya Power and Lightening Company-KPLC). The respondent shared that power rationing before the new road network/infrastructure was rampant due to the illegal power connection. Some households who cannot afford electricity connections still practised the illegal power connection. Some of the respondents argued that the power rationing they experience daily is attributed to the high energy demand compounded by the low electricity connection in Mukuru Kwa Reuben and the nearby environment.

The improved road network has enabled KPLC to install more electric poles and transformers and connect a significant number of households who can control usage using individual electric power meters, enabling them to use a 'token' power system. Besides, respondents shared that KPLC can easily access some areas since road development is in progress.

“Access to electricity is more reliable now since use of individual tokens does not overload the source of power unlike before where the source of power had illegal connection called "sambaza”

However, with the new road network construction, respondents argued that it has led to rampant disconnection due to the relocation of old power lines to pave the way for the new road construction. This is only experienced during maintenance and is not as regular after some road sections have been completed. The respondents attributed some disconnections, and regular blackouts lead to major losses incurred by the businesses that depend on electricity.

“The demolition of houses and facilities on the road reserve to pave the way for the new road network has reduced congestion and overcrowding along the powerlines. However, overcrowding along the power lines still exists in some sections of Mukuru Kwa Reuben.”

Condition and access to potable water

The respondents who perceived that access to potable water before the road construction and after road construction was ‘bad’ were rated as 69% and 9%, and ‘fair’ 22% and 20%, Good ‘8% and 61%, ‘no change’ 2% and 10% respectively. Generally, the respondents' perception shows that before construction the new road network, access to potable water was ‘bad’ (69%), but after the construction of the new road network, access to potable water is ‘good’ (61%). The respondents indicate that access to potable water has been enhanced significantly after construction the new road network (Table 7).

Respondents argued that the improvement of the water infrastructure (drilling of boreholes and waste piping) supported by the new road has improved their accessibility and reduced the cost of water services. There are several boreholes and water vendors at Mukuru Kwa Reuben. Most of the households purchase water from water vendors. The residents of Mukuru Kwa Rueben were depending on the illegal water connections and the unregistered/informal water vendors who often sell water to them at high prices per unit. In addition, the respondents attributed the high cost of water to poor access of the road network, which was impassable during heavy rains, hence rendering them unable to access clean and portable water. The poor road network was earth road hence become muddy and unmotorable during heavy rains. Respondents also attributed the high cost of water and limited or total lack of water for some days to artificial water shortages created by informal water vendors so that they can inflate the price of water per unit.

The improvement of the road network has improved access to water by the residents of Mukuru Kwa Rueben. NMS and NCCG have subsidized water access and simplified, especially by availing free access to water in some areas with boreholes at close range to the residents of Mukuru Kwa Rueben. Besides, through NMS, the government has drilled water boreholes and installed water kiosks. However, some respondents residing far away from the new road network perceived that the residents living away from the road find it hard to access the water services.

Nonetheless, respondents argued that some sections of Mukuru Kwa Reuben areas still face limited or lack of accessibility to portable water. They attribute limited or lack of accessibility to potable water by some residents due to the disruption of water supply system during the road construction. Some water pipes were cut off to pave the way for the new road network. Respondents argued that to date, some water pipes have not been repaired in some sections of Mukuru Kwa Reuben rendering residents to go without water for several days. They also argued that the new subsidized water supply is still insufficient to meet their water demand. Therefore, they recommended restoring the old water supply system and linking it to the new water supply system to bridge the existing water demand gap in some areas of Mukuru Kwa Rueben. Some respondents linked the water supply system to their safety as residents can easily draw to quench the fire in case of fire outbreak within the community. Mukuru Kwa Reuben does experience several fire incidences in a year. Residents shared that the government plans to install fire hydrant points along the new road network to ease access to water for quenching fires in case of a fire outbreak in the slum.

The intervention to improve water access in Mukuru Kwa Rueben was confirmed by the residents that it is designed to not only facilitate access to portable water for domestic use and hazard (fire) management but also to eliminate the the burden on residents who depend on water vendors supplying water at high costs per unit and often not clean water. Before the intervention, water vendors used to charge 15 shillings or even more per 20 liters of water. However, with the improved road network, drilling of water boreholes, and installation of water pipes within the community, the cost of water has drastically reduced to 5 shillings per 20 liters. In addition majority of the residents can easily access water supply points.

“We are accessing free water now; before it was quite expensive to buy on daily purpose now, we can channel the money meant for water purchase to other purposes.”

“The road has opened up easy access to free water at the chief's camp, and also easy access of hospitals that were built after the road.”

Condition of and access to latrines

The respondents who perceived that access to latrines before the road construction and after road construction was ‘bad’ were 60% and 7%, ‘fair’ 29% and 12%, ‘good’ 9% and 46%, ‘no change’ 3% and 17% respectively. Generally, the respondents' perception shows that before the construction of the new road network, access to latrines was ‘bad’ (60%), but after the construction of the new road network, access to latrines is ‘good’ (46%). The respondents indicate that access to latrines has been enhanced significantly after the construction of the new road network (Table 7).

Before the construction, respondents shared their concern that improper human and other waste management caused pollution which is attributed to the polluted water in Ngong River and the foul smell prevailing in the slum. The toilets that existed before the expansion of the infrastructure in 2020 were insufficient because many residents shared a single toilet, and again, they had to pay, hence compromising hygiene. After the road, the Fresh Life foundation has been pivotal in supporting the community in the informal settlement with sanitation facilities by providing them with portable toilets (Plate 1 below). This initiative started after the construction of the new road network. However, the respondents argued that the sensitization on the usage of the improved toilets distributed by the Fresh Life foundation among the community was ineffective. They attribute it to the low awareness that didn't reach the many residents besides those reached by the Fresh Life foundation and its sanitation

services. Many residents in Mukuru kwa Reuben have embraced the portable toilet. Respondents acknowledged that the sanitation initiative has contributed to the rehabilitation of the polluted ecosystem, and a significant level of cleanliness s being witnessed in Mukuru Kwa Reuben.

The respondents linked the new institutions like NMS and the acceleration of the infrastructure improvement to improved access to water to support sanitation services.

‘Portable latrines are available and accessible now unlike before the toilets in the residential area were in bad condition due to lack of water.’



Plate 1: Atlas of the Future

Condition and access to Secondary School

The respondents who perceived that access to primary school before road construction and after road construction was ‘bad’ were 75% and 6%, ‘fair’ 22% and 18% , ‘good’ 2% and 65%, ‘no change’ 2% and 11% respectively. Besides access to secondary school before road construction and after road construction was ‘bad’ were 72% and 6%, ‘fair’ 21% and 22%, ‘good’ 4% and 59% ‘no change’ 4% and 13% respectively (Table 7). Generally, the respondents' perception shows that before the construction of the new road network, access to primary and secondary schools has been enhanced. In Mukuru Kwa Reuben slum, respondents observed that access to primary and secondary schools has been enhanced by the construction of the new road network. However, the respondents noted that motorists' recklessness (e.g over speeding, illegal car parking) has been a key concern, which respondents believed it will create new risks related to traffic. The respondents argued that even though the construction of the road network is ongoing, the excavated soil, which is not properly disposed has caused clogging of drainage system hence restricting flow of water during heavy rains. Residents

attributed the clogged drainage system to waste overflow, which soaks the old roads rendering them unmotorable and making it difficult for school going children to access some schools. Some schools are located several meters away from the improved roads making it difficult for pupils to access during rainfall. The school going children resort to wearing gumboots to school which is only afforded by a few. Therefore, the rest of the pupils are exposed to health and other associated risks.

Respondents shared that the newly constructed road network has triggered the establishment of some (mostly private) schools to bridge the existing gap in accessing education facilities by the residents with school going children. The private schools set up in Mukuru Kwa Reuben tend to be unaffordable to some residents. Most of primary schools and day-care centres charge from 50 shillings to 250 shillings per child per day. Despite the challenges, it is evidenced that the Nairobi City County Government promised the community that they will reclaim the pieces of grabbed land that belong to public schools with the intention to be linked with the new road network. However, the other challenges which include overloading, traffic accidents and reckless driving of pupils to schools remain unresolved by the improvement of the road network.

Condition of and access to food shops

The respondents who perceived that access to food shops before and after road construction was 'bad' were 63% and 6% , 'fair' 28% and 18%, 'good' 6% and 63 'no change' 3% and 13% respectively. Generally, the respondents' perception shows that before the construction of the new road network, access to food shops was 'bad' (63%), but after the construction of the new road network, access to food shops is 'good' (63%) (Table 7). The respondents indicate that access to food shops has been enhanced significantly after the construction of the new road network.

Respondents confirmed that businesses have improved after the construction of the new road network in Mukuru Kwa Reuben slum. The new road network has triggered/ facilitated the establishment of new business ventures and several market places in Mukuru Kwa Reuben slum. Food vendors located near the new road network are easily accessible, as alluded to by the respondents: *“Those who live along the roads got more opportunity to start-up businesses while those who live far from the road got no opportunity to start a business.”*

Besides, the improved access to the food shops, respondents confirmed an increased supply of different variety of foodstuffs to the food shops in the area. They attribute the drop in prices of

foodstuff and reduction of travel to access food shops to the improved road network. The respondents shared that the confidence level of the residents to access reliable foodstuff has increased due to the regular supply of foodstuff to Mukuru Kwa Reuben.

Condition of and access to work

Access to work has been simplified and eased transport to the workplace. The percentage of respondents indicating that access to work was good increased significantly after the construction of the road. Before the road construction, only 3% of respondents described access to food vendors as good, whereas the percentage following the construction of the road was 61% (Table 7). Besides, the new road has provided new business opportunities, especially for those residing close to the road. Many people resolved into merchandise with ease and access and filled other previously unfilled market gaps. This has been a source of employment for both drivers and businessmen and -women who now depend on the road to earn as well as to be self-employed and to employ others. There have been many disadvantages to the residents who had earlier set up business along with the road reserves as their place of business had been demolished to pave way for the road, disrupting their businesses and affecting their employees.

Condition of and access to health clinics and hospital

The respondents who perceived that access to health clinics before road construction and after road construction was 'bad' were 73% and 5% , 'fair' 21% and 24%, 'good' 3% and 62 'no change' 2% and 9% respectively. Access to hospital before road construction and after road construction was 'bad' were 73% and 5%, 'fair' 20% and 24 'good' 5% and 61, 'no change' 2% and 10% respectively (Table 7). Generally, the respondents' perception shows that before the construction of the new road network, access to health clinics and the hospital has been enhanced with the new intervention.

Respondents perceived that the poor road network in the past had been a constraint to them to access health services in health clinics and hospitals within and outside Mukuru Slum. This was compounded by the fact that there were insufficient health facilities to support the population of Mukuru Kwa Reuben hence they had to travel outside to seek health services. The entire Mukuru slum then had only two formal health facilities centres, namely Medical Missionary of Mary Church and Alice Nursing home. The other facilities in the area were mainly informal chemists and mini-clinics. The construction of new infrastructure included the construction of Mukuru Kwa Reuben Level 3 Hospital, a public (run by the government) located inside Mukuru Kwa Reuben but services other sections of Mukuru Slum. New road

network has been linked to Mukuru Kwa Reuben Level 3 Hospital to ease access to the facility by residents of Mukuru slum. This hospital has been equipped with modern and better medical equipment. The hospital and sections of Mukuru Kwa Reuben covered by the new road network are easily accessible by the ambulances hence resident seeking medical services are likely to be attended to efficiently.

‘The roads are also opening up the area to hospitals which aim to provide services; however, the issue of affordability and better services by these hospitals is a challenge.’

Nonetheless, respondents argued that access to health care services varies considerably depending on a household’s location in Mukuru Kwa Reuben. For instance, some households located far away from the improved road network still find it difficult to access the improved health facility and health care services because some feeder roads are still unmaintained (earth road) hence they are rendered totally impassable during heavy rainfall. Despite the construction of the new hospital, respondent argued that new hospital is always understocked hence failing to meet their health needs.

d. The state of livelihoods after the road construction

The respondents shared their perceptions on the influence of the new road network on the state of their livelihoods. The following parameters were used to find out the impact of the new road network on the livelihoods in Mukuru Kwa Rueben: 1) cost of living; 2) rent; 3) price of food and 4) price of water. The respondents were asked if there was change (yes) or no change (No). The ‘change’ means that either the cost of living, rent, price of food, or price of water either increased or reduced. The respondents acknowledged (62%) that there had been a change in the cost of living because of the new road construction; 42%, 44%, and 31% acknowledged a change in rent, price of food, and water, respectively as detailed in Figure 6.

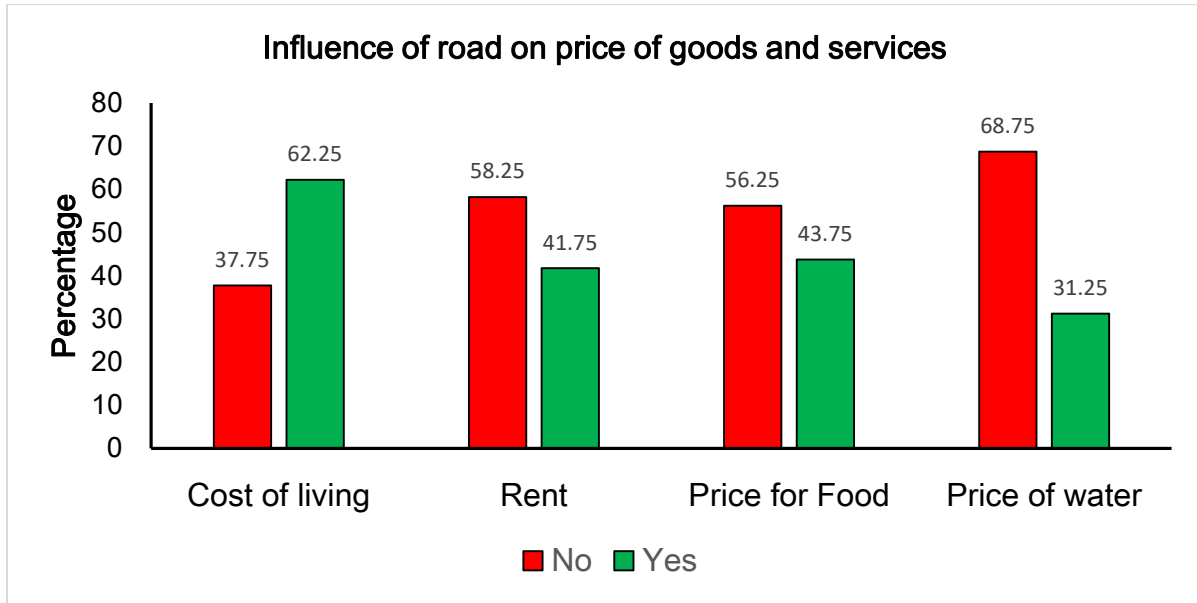


Figure 6: Reported influence of road on the price of goods and services

The respondents acknowledged that the newly constructed road network has brought changes in cost of living, cost of rent, price of food, and price of water associated with the changes in the community's lifestyle. The demand for housing is high, which has led the owner of the structures to increase rents. Structures close to the road network fetched higher prices since some were converted into business premises.

The respondents (62.25%) (Figure 6) perceived that the rent has changed due to the demolition of houses, businesses, and other social facilities to create space for the construction of the new road network. Respondents shared that the affected business owners and tenants of residential houses were displaced to go elsewhere, the structure owners lost the structures and the building materials, residents lost more spaces they used to relax and engage in other social activities, and the social fabric they had built over the years was disrupted because close friends and relatives were displaced.

‘Before the road construction, rent was at KES2000, and now it is at KES3000, which is beyond the reach of majority of the displaced tenants.’

Respondents perceived that the demolition of residential houses and businesses reduced the already insufficient residential houses and shops. Again, the demolished houses and shops were affordable, but the displaced residents and business community argued that the cost of rent has increased significantly. Some of the displaced tenants and business people moved to other areas because they could not afford the increased rent in the areas affected by the road construction.

Besides, the increased rent is also associated with the increased cost of materials for construction in the affected areas as some of the landlord cover up for their loss due to demolition by the landlords.

‘Due to the demolition of houses that happened during construction of the road. The structure owners lost houses and they decided to increase rent to cover the losses they incurred.’

Some respondents believed that the decreased cost of transport and improved access to the market within and outside Mukuru Kwa Rueben is due to the improved roads, which has significantly led to the reduction in the costs of goods. Other respondents shared that before the construction of the new road network, most food vendors, especially those selling perishables like vegetables and fruits, were not paying for rent because they were selling in simple structures or open-air along the old road network. However, demolition, reduced availability of business premises, and the acquisition of new business premises coupled with the government tax have led to an increase in the price of food in some areas in Mukuru Kwa Reuben. The resident perceived an increase in food prices due to the increased cost of operation.

“The stalls selling food items were demolished; hence there are fewer stalls for food leading to price hikes as compared to earlier before demolition.”

Respondents believed that the water demand increased after the infrastructure improvement, which contributed to the drilling of more boreholes and water piping. The water vendors have increased supply and distribution per day because they access the new boreholes and water kiosks as well as improved accessibility to many sections of Mukuru Kwa Reueben. While in the past there was insufficient water and source, and the price per unit of water was high. However, the informal water vendors have increased the price of water per unit due to the increasing demand in sections of Mukuru Kwa Reuben, which are yet to be opened up by the new road network. In the sections of Mukuru Kwa Rueben with new road network and new boreholes, the illegal water connections were disconnected and the residents now enjoy the drop in prices of water per unit.:

“The city-county government and NMS have drilled boreholes and water supply system which supply water for free to the residents of Mukuru Kwa Reuben. However, sometimes the free water is not available due to that the interference by the illegal water

vendors taking advantage of the increasing demand. The illegal water vendors often increase the price per unit of water.”

“Price per unit of water has risen from Khs 5 to Khs 10 in some sections of Mukuru Kwa Reuben. The increasing cost of water per unit was triggered by the limited supply of water due to the disruption of the existing water supply system by the construction of roads. A lot of water pipes were cut during road construction. The remaining piping supplying freshwater could only supply insufficient amount of water, therefore, rendering the illegal water vendors to hike water price to KES10 per unit of water. .”

e. Impacts of the road on population density in Mukuru Kwa Reuben

Respondents perceived that the road network has proven to be “better off” and “worse off” in terms of the social interaction of the residents in Mukuru Kwa Reuben. The respondents perceived that the new road network has provided new opportunities, which has attracted residents even though some had to leave because of the demolition of houses. A considerable proportion of the respondents, 38%, reported that migration of people in and out of Mukuru kwa Reuben happened. The results also show that 37% and 25% of respondents were reported to move in and out of the Mukuru Kwa Reuben respectively (Figure 7). The residents perceived the eviction, increased demand for houses, and increased rent forced most people to look for an alternative home:

“Some residents moved out of Mukuru Kwa Reuben because they were scared of being homeless due to the road construction which threatens them through the proposed demolition of houses to pave the way for the new road network.”

Respondents shared that some of the residents felt insecure, and they moved out of Mukuru Kwa Reuben :

“After demolition of some houses along the reserve created for the construction of the new road network, many people moved to other areas like the neighbouring estates which include Pipeline Estate where they felt they won't be bothered by road construction.”

, “There was high level of insecurity in the area leading more people to migrate to other safe areas.”

Some respondents believed that some new residents came to Mukuru Kwa Reuben because of the new infrastructure, which opened up the area and created more social related opportunities.

The new residents associated their move to Mukuru Kwa Reuben to opening up the of the area, improvement of social amenities and marketplaces, thus providing opportunities for income and a better living:

“Those who moved in are many because there is a good road network to support efficient transport of goods to the market”

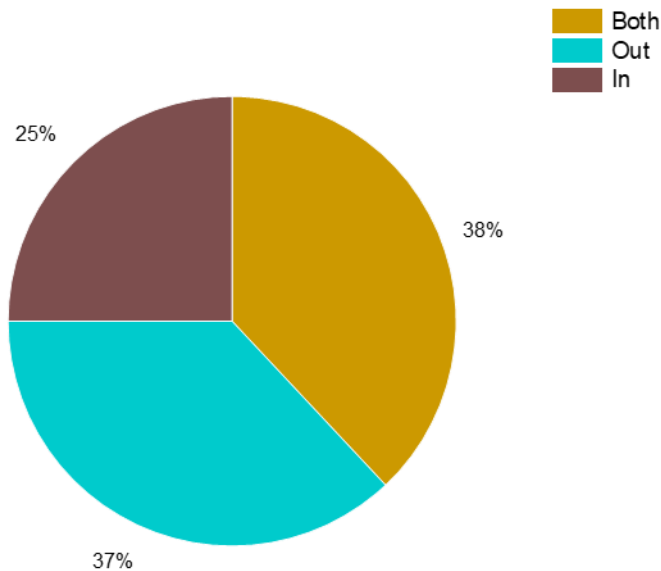


Figure 7: Impacts of roads on population influx

a. Community awareness of risks

a. Hazard exposure

The respondents were asked to state if they have been affected by flood, fire, or COVID-19 in the past twelve months prior to the administration of the survey. From the results, 48%, 47%, and 4% of the respondents reported they were affected by flood, fire or contracted COVID-19, respectively (Figure 8). This highlight depicts that fire and flood are common hazards affecting almost half of the population in Mukuru kwa Reuben, causing a considerable impact on the community. The impacts of fire and floods can be derived from tables 6 and 8, ranging from minor to major impacts.

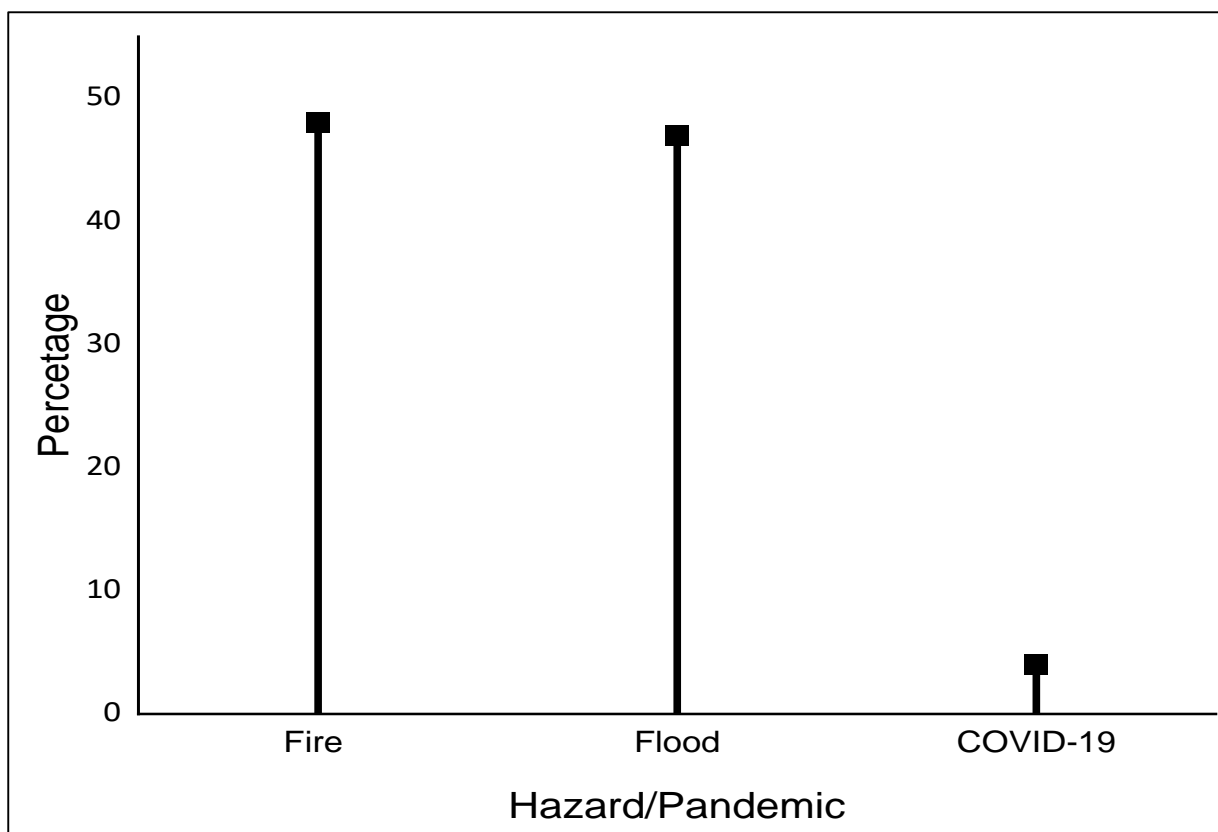


Figure 8: Household respondents reporting being affected by fire, flooding and Covid-19 in the past twelve months prior to administration of the survey.

Impacts of floods on households

From the study, the most significant impact of floods on households captured is the damage to properties, resulting in the loss of valuable household assets. Among the respondents, 66% reported major damage to their properties, while 29% reported minor damage to their properties.

The other negative impact reported by the respondents include health, which manifests in terms of water-borne diseases. Among the respondents, 41% of them reported that the impact of flood on health is major, whereas 29% reported that flood had small impact on health. According to the respondents the other major effects brought about by the flood included discomfort (69%), loss of earnings (29%), and missing school attendance (37%) and displacement (33%) (

Table 8).

Table 8: Impacts of floods

Reported impacts of the hazard	Flood (%)
Discomfort	69
Small Impact on Health	29
Major Impact on Health	41
Small Damage to Property	29
Major Damage to Property	66
Loss of Earnings	29
Time Away from School	37
Had to Leave	33

- Loss of earnings

The respondents (29%) (

Table 8) reported that flooding caused loss of earnings. Respondents argued that informal businesses and other sources of earnings are prone to flooding. Some of the informal businesses that generate earnings include hawking of food items and general wares and informal occupations like barbers, cobblers, tailors, and second-hand clothing vendors. According to the respondents, these informal businesses and occupations do generate substantive earnings for them, but they get disrupted by floods during rainy seasons hence their earnings are reduced significantly in some cases, while some lose total earnings.

- Time Away from School

The other impacts of the floods shared by the respondents are the indirect impacts on children within households, which manifest through incidences of children failing to go to school and they are pre-occupied with household chores and helping family in running errands. According to the respondents, flooding renders roads and bridges impassable hence school children cannot walk or cross to school.

- Displacement

Interestingly, 33% (

Table 8) of respondents linked some cases of displacement during rainy seasons to floods. They shared that flooding has forced some residents to move away from their residents because they cannot access essential services or run their businesses or go to workplaces, as reflected in table 12 above.

○ Discomfort

Some respondents shared that flooding have direct negative impacted on some household members, which manifest in form of mental and psychological discomfort. The respondents argued that flooding has caused negative impacts which causes mental stress because of the affected families witness or experience deaths and injuries in their families, destruction of property, and loss of livelihoods, among other negative impacts. The respondents shared that the struggle to recover is hard, and they go through state of fear for the worst, which exacerbated the prevailing condition.

Impacts of Fire Hazard

From the study, respondents shared the significant impact of fire on households in Mukuru Kwa Rueben (table14). Among the respondents, 78% reported that fire caused major damage to their properties, while 16% reported that there was minor damage to their properties. Some of the associated impacts reported by the survey respondents include; major damage to property (78%), discomfort (58%), loss of earnings (47%), small impact on health (23%), major impact on health (33%), small damage to property (16%), time away from school (37%), had to leave (40%) as shown in Table 9 below. The interaction of this hazard with the already pre-existing vulnerabilities among the urban poor worsens the impact fire poses in the slums. However, different groups are more disproportionately exposed and vulnerable than others, as observed in the Mukuru Survey that partly examined those most affected by the fire hazards.

Table 9: Impact of Fire

Impacts of fire	Percentage
Discomfort	58
Small Impact on Health	23
Major Impact on Health	33
Small Damage to Property	16
Major Damage to Property	78
Loss of Earnings	47

Time Away from School	37
Had to Leave	40

Respondents highlighted some of the causes of fire in Mukuru Kwa Reuben, which includes open electricity wires which are illegally tapped or connected to houses. Respondents shared with the survey team that in Mukuru Kwa Reuben, residents predominantly use "Sambaza," commonly used because some residents cannot afford or don't want to pay for formal electricity connection or are not connected by the relevant power agency. The respondents recounted related cases of illegal power connection which have resulted in or caused fire outbreaks. They believed that some of a lot of fire incidences are linked to illegal power connections, which is widespread hence the scale of fire outbreak is also widespread because the houses are too close and it is not easy to trace switches to switch off power lines.

Respondents believed that some of fire outbreaks attributed to illegal electricity connections is exacerbated by the explosion of gas cylinders used by some of the residents in Mukuru Kwa Reuben. They believed that such fire outbreaks spread rapidly across the settlement resulting in significant damage to property, human injuries, and other direct and indirect impacts.

i. Community members affected by fire

The survey identified community groups that are most vulnerable to the impacts of the fire in Mukuru Kwa Reuben. Respondents identified six groups they believe are the most vulnerable to fire outbreaks in Mukuru Kwas Reuben. The six vulnerable groups include (1) women, (2) children, (3) youth, (4) men, (5) business owners, and (6) persons living with disabilities (PWDs).

Women and children

Respondents believed that women and children are among the most vulnerable to the impacts of fire since they often find themselves in the house, running the day-to-day chores. The children, especially those being breastfed, are even more likely to be affected by fire outbreaks due to their feeble nature. Respondents shared cases where some households have had children, especially under the age of 5 years, with severe burns and some resulting in death.

Youth

The respondent's believed youths are vulnerable to fire because of their role in the community. It emerged that the youths are community champions who are the first respondent in the event

of fire to help to suppress the fire and rescue the household items. Some of the champions are subjected to burns and some of them lose their lives.

Persons living with disabilities

Respondents also noted the persons living with disabilities (PWDs) as among the vulnerable groups to fires. The respondents attributed their vulnerability to physical challenges such as their inability to run or walk safely away from fire. Besides, people with PWDs are often left at home, and thus sometimes, they do not have someone to attend to them and provide a hand in the event of fire. Those who are visually impaired and deaf are at risk.

Business owners

According to the respondents, business owners are among the vulnerable groups to fire outbreaks in Mukuru Kwa Reuben, with the impact being predominantly economic, characterized by massive losses. The business owners in Mukuru are largely informal businesses run in simple structures made of flammable materials such as polyethylene or cartoons and wooden materials. Business owners were also disproportionately affected by the fire outbreaks, with the impact being predominantly economic, characterized by massive losses. Overall, from the analysis of the study, it is noted that the elderly and disabled are also considerably affected by fire, primarily due to their inability to move swiftly from an instance of a fire outbreak.

ii. *Community members affected by flood*

The survey identified community groups that are most vulnerable to the impacts of the perennial flood in Mukuru Kwa Reuben. Respondents identified six groups whom they believe are the most vulnerable to flooding in Mukuru Kwas Reuben. The six vulnerable groups include (1) women, (2) children, (3) youth, (4) men, (5) business owners, and (6) persons living with disabilities (PWDs).

Women

Since informal settlements entail a community pooling together in a similar area, respondents believed that the impact of the flooding affects households and the entire neighbourhood. The respondents believe this amplifies the hazard into a community problem rather than a household issue. In addition, respondents noted that most households, children and women are the most vulnerable to the impacts of the floods. The respondents shared that the traditional role of women as house managers in slums has seen them remain behind to take care of most

household affairs as their husbands look for sources of income. This puts them in the first line of defence and as first responders when hazards such as floods occur.

“My neighbours and I were affected, but I wouldn't call it flooding per say I would term it as poorly drained water flowing through homes and causing minor properties damage.”

Children

Some of the other impacts of the flood were attributed to children being at risk of being swept away and loss of life by drowning. Respondents shared that during the rainy season to the is overflow of water which contributes to water accumulation in the house. The respondents attributed the cases of suffocation of young children who cannot cope with the situation of flooding. Respondents also attributed some cases loss of young life (children), to some incidences of fire, which often leads to deaths but also total destruction of houses.

Respondents believe that children are more vulnerable to the disruptive nature of the flood hazard, which includes the spread of waterborne diseases due to exposure to contaminated water. Other risks include injuries to their children, which at times result to deaths among the affected children. For instance, where the flood water came into contact with exposed electric wires, which lead to the electrocution of child who stepped on it.

Respondents shared linkage between flood and health issues in Mukuru Kwa Rueben. The presence of mosquitoes is because they believe stagnant water provides them a breeding ground. They believe that the presence of mosquitoes is associated with the spread of malaria, which is a life-threatening disease to the already poverty-stricken neighbourhoods. Respondent als observed an instance where some children became unwell after drinking unsafe water in one of the local schools. Children are perceived by the respondents to be at risk of being carried away by the floodwater and disrupted from education due to the direct and indirect impact of flooding as discussed previously.

“Children because they are easily swept away by floodwater if their parents do not accompany them.”

Youth

The youth is another group that respondents believed they are vulnerable to floods, which manifest in disruption of their daily activities. The respondents shared that as the youth try to

establish themselves in society and obtain livelihoods over time, this is reversed by the floods because of the disruptive nature, hindering their capacity to grow and posing a risk to the already established investments. Besides, it emerged that most the community champions are youths. During the evacuation in the event of flooding, they sometimes get injured, and some lose their lives.

Business owners

According to the respondents, business owners are among the vulnerable groups in Mukuru Kwa Reuben. The business owners in Mukuru are largely informal businesses being run in simple structures or in an open space hence highly vulnerable to hazards such as floods. Some examples of the informal businesses identified by the respondents include kiosk owners, vegetable, fruit and food vendors, barbers, and cobblers, among others. The respondents argued that the business owners especially feel the economic impacts of the floods in Mukuru because they lose a lot in terms of income and livelihoods because their items are swept away and their places of work are flooded, damaging their property.

“Some of the tenants who were my neighbours were displaced from their homes because their houses were filled with water, and their properties are being destroyed and carried away with the flow.”

Persons living with disabilities

Respondents also noted the persons living with disabilities (PWDs) as among the vulnerable groups to hazards such as floods. This attributed to their physical challenges such their inability to run or walk safely away from a hazard or during a disaster. This mainly relates to those who cannot move and effectively react to save themselves.

b. Community response to hazards

a. Community support in the event of fire incident

This section focuses on the respondents' responses regarding interventions received by the community during fire outbreaks in Mukuru Kwa Reuben. According to 68% of the respondents in table 15, the significant intervention received by the community during fire outbreaks is the support from neighbours, friends, or family. Only 15% of the respondents believed that community groups help in the event of a fire outbreak, while 10% of the respondents believed that government agencies also help in the event of a fire outbreak in Mukuru Kwa Rueben.

The support received by affected households includes quenching of fire, financial support, accommodation, and evacuation. The community group supported by contributing financial resources to settle the hospitals bill of her mother when she got burns from household fire outbreak. The community group runs a merry-go-round for money mobilization and loaning members known as *Chamas* (in Kiswahili language) in Kenya

” Chama helped in settling the hospital bill for the respondent's mum. She couldn't settle it and community groups and Chamas stepped in”.

Some respondents (32%) believed that the new road network has an influence on fire outbreaks, while 29% believed that the new road network has an influence on fire affecting hazards of their neighbourhood. Significant number of respondents shared perception of the community with regards to recovery from disasters or if they have made any changes to mitigate fires or response to fire outbreaks in Mukuru. Out of the survey, 18% of the respondents perceived that the households affected by recent fires have recovered from the associated impact, while 23% of respondents perceived that community members have necessary changes at their homes to mitigate fire or respond to fire incidence (Table 10).

Table 10: Community support in the event of flood and fire incident

Interventions in the event of a fire	Percentage
Neighbours, friends, or family help in the event of a fire	68
Community groups help in the event of a fire	15
Government agencies help in the event of a fire	10
Influence of the road on the fire	32
Influence of the road has affected on hazards for your neighbourhood	29
Perception if the community has fully recovered from the event	18

Preparations or made any changes to your home to be ready for another flood since we have a new development of the road	23
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i. Community perception on how to reduce the impacts of Fire

Respondents believed that if Mukuru Kwa Reuben residents adopt the ‘*token*’ model of electricity connection and access from the Kenya Power and Lighting Company (KPLC) over the ‘*sambaza*’ model then fire incidences will reduce drastically. Respondents linked most fire outbreaks that have occurred in Mukuru Kwa Reuben to ‘*sambaza*’ model, which is an illegal electricity connection and doesn’t follow any electricity supply regulatory measures to guarantee its safety. The respondents believed that the appropriate way to mitigate illegal power connections is through awareness creation on the pros of legal and cons of illegal connections and the associated fire outbreaks. In addition, respondents confirmed that the usage of gas and kerosene stoves are part of the other causes of fire outbreaks in Mukuru Kwa Reuben.

They also emphasized the need for KPLC to play the most significant role in regulating the types of electricity used and conducting regular checks to guarantee the legality of electric connections. Some respondents recommended building better road infrastructure to increase the response time of the fire brigade to any fire hazard in some parts of Mukuru because even with the opening up of the new road network, they argued that some sections are still inaccessible to cars, including the firefighting engines. In addition, respondents emphasized the need to strengthen the capacity of the fire brigade team in the city to effectively respond to fire hazards.

Respondents noted that the county and national governments have been weak in responding to disasters occurring in Mukuru Kwa Reuben. Most respondents claimed that they have never seen any fire hydrants in their locality and emphasized the need to install fire hydrants closer to the people as well as guide them on using them in case of a fire outbreak. They recommended governments to enhance interventions such as building capacity of the residents to respond to fire breakouts and other hazards.

Some respondents perceived that the weak government’ response to disasters in Mukuru is linked to hidden political motives, which for instance, they believed some political leaders are using the fire outbreaks to push their agenda.

ii. Community perceptions on capacity to recover after the fire

Respondents perceived that in the event of fire outbreaks, the support they received from the government was limited. They claimed that the government rarely intervened to provide support, such as rebuilding houses destroyed by fire. Respondents believed that the slow response by the government has forced the community to get re-organize and restructure their response to fire outbreaks. The community rebuilds their structures after fire outbreaks. The victims of fire outbreaks rely on the benevolence and empathy of friends, relatives, neighbours, and the community to cope with the impacts of the fire. Respondents shared that this support has been in the form of relief donations such as food, utensils, and beddings, among other basic items needed by the victims. Through this, most respondents noted that some level of relief and emergency support was provided quickly to the victims of fire outbreaks.

As one respondent noted, *“Knowing that people are there for you and willing to support you gives you the highest hopes of feeling better. If one were to go through the experience without any support, then they would be so demoralized”*.

In addition, respondents noted that the shift from the *sambaza* model of accessing electricity to the token model has been unprecedented and it is proven to be the solution for the fire outbreaks. The token model is a formal process of accessing power supply hence it is less associated with fire outbreaks. The new road network has opened up the settlement, and there is easy access to houses during response to fire outbreaks by the firefighting team and fire brigades. The time for response to fire outbreaks has reduced drastically. The other infrastructure improvement in the health and water services has complimented the response and recovery efforts in Mukuru.

Some respondents recommended that the victims of fire outbreaks need long-term support towards recovery. Some of the strategies recommended by the respondents for long term and sustained recovery support include the provision of psychological support. Respondents noted that there is a growing norm of hoarding relief support to affected households by local authorities which hampers the recovery of households who solely depended on such intervention.

Respondents shared limited advocacy, awareness creation, and capacity building on best response mechanisms at the household level, therefore hindering proactive and recovery measures. The unpredictable nature of the fire outbreaks is also noted to be hindering recovery efforts.

“You never know that you will be a victim of a fire outbreak. It just happens. And even after being affected, you still live in fear. You want to recover, but you imagine that it will happen again. So, it becomes hard to recover”.

The respondents alluded that the other significant challenge to response and recovery from fire outbreaks is attributed to the ill-equipped firefighting team at the city and local levels. Respondents argued that the lack of modern firefighting equipment at the household and community level is responsible for extensive damages caused by fire outbreaks which could have been handled and extinguished before it spread further *“If the government can give me a fire extinguisher, I will be very happy. At least I will be able to handle the fire”.*

iii. Preparations/ changes made at home to be ready for another fire

Respondents shared some of the preparations for fire control adopted by some community members at home, including adopting and installing a token model of electricity rather than the *sambaza* model. Other households have disconnected themselves from the national power grid and installed a solar power system. Respondents noted that adopting and using renewable energy sources such as solar power systems is safer and has not caused any fire incidence. The other fire breakout control measures adopted by some of the households in Mukuru include the following:

- Some households are reinforcing their physical structures with roofs and stones. This reduces the flammable materials in a structure hence in case of a fire breakout, the rate of burning is slowed down hence giving the responders the adequate time to intervene.
- Using better wiring systems compared to the thinner wires that easily cause structure ignitions and fire outbreaks.
- Other households have acquired fire extinguishers to help them to control fire outbreak at the household level immediately
- Other households have moved closer to newly built roads for easy access to support from the responders and fire-fighting engines.
- Some households switch off power when there are blackouts to minimize the chance of fire outbreak.
- NMS, county government, and partners have drilled boreholes at strategic locations to ensure water for household use is available and make it easy for responders to access water to quench any fire outbreak.

- Some youth and self-help groups have organised themselves as responders to fire outbreaks in the settlement.

iv. Community perception on Institutional roles in reducing fire hazards now

Respondents perceived that different institutions play different roles in reducing hazards in Mukuru Kwa Reuben. They believe that government institutions play a crucial role in working with the community to reduce the impact caused by the disaster. More than half of the respondents (64%) acknowledged that the community plays a crucial role in reducing the disaster (Table 16). Besides, 57% of respondents perceive that the government is the key player in reducing disaster impacts. Some respondents (47%) think that individuals have the responsibility to reduce hazards, while 8% of the respondents think that the non-state actors have a role to play too in reducing hazards in Mukuru Kwa Reuben. Only 2% of the respondents think that other stakeholders contribute to reducing hazards in Mukuru (Table 11).

Table 11: Institution mandated to reduce fire hazards

Institutions mandated to reduce fire hazards	Percentage
Government	57
Community	64
Individual	47
Non-state actors	8
Other	2

v. Support to the household to curb the pandemic

Respondents shared some of the support provided to the households and the community in Mukuru Kwa Reuben to curb the impact of COVID19. The following are some of the supports provided to the households and the community by the community groups, government agencies, and the impact of the new road network led by NMS:

1. They support the distribution of masks and sanitisers which are provided by the the Kenya Red Cross Society (KRCS)
2. The government agencies helped the community with the response and management of the impact of COVID-19 using the following strategies:
 - a. Government agencies provided food aid to some persons under self-isolation

- b. The government provided a monthly stipend of KES2000 per household in some vulnerable households.
3. The new road network in Mukuru Kwa Reuben influenced the community's response to COVID-19: The new road network has improved access to Mukuru Kwa Reuben, but it had little impact on the social distancing recommended by the Ministry of Health as one of the strategies to curb the spread of COVID19. The original design of the new road was integrated with pedestrian lanes, but the current road didn't integrate it. Respondents argued that the new road network had no effect on reducing overcrowding and, therefore, there were chances that COVID19 continued to spread among the crowd along the new roads. In addition, the new road network became the preferred choice hence attracting more people to use, and crowding was not minimised.

However, according to the respondents, the community acknowledged that the expansion of the road network created a space and easy penetration by the well-wishers to reach the households and individuals impacted by COVID19. In addition, the new road network made it easy for the community health volunteers and health specialists to sensitize and create awareness of COVID-19 response. Respondents believed that the easy access to the Mukuru Kwa Reuben health centre gave the community confidence in receiving medical care in case of contracting COVID-19.

vi. Interventions before and after the floods (who supports the community)

This section focuses on the respondents' responses with regard to interventions received by the community before and after the flooding in Mukuru Kwa Reuben.

Community groups and government support in the event of the recurrent floods as the most common source of support at 12% and 8%, respectively. However, 47% of the households confirmed receiving support from neighbours, friends, and families in the event of floods. As a result, everyone else gets caught up trying to deal with their challenges (Table 12). Most of the support was in the form of donations of relief materials such as food, beddings, and utensils. Additionally, others received financial support from these actors. Some households highlighted the presence of humanitarian agencies and county or national government in the aftermath of the events.

The respondents perceived that households receive support from friends, family, and neighbours to recover in the event of a flood. Respondents believed that the support from

friends, family and neighbours is motivating the affected households accelerate recovery from the impact of disaster.

Table 12: Community support in the event of flood and fire incident

Interventions in the event of a flood	Flood (%)
Neighbours, friends, or family help in the event of flooding	47
Community groups help in the event of flooding	12
Government agencies help in the event of flooding	8
Influence of the road on the hazard/pandemic	44
Influence of the road has affected on hazards for your neighbourhood	44

vii. Community perception on minimizing the impacts of flood

The respondents shared their perceptions on minimizing the impacts of floods in *Mukuru Kwa Reuben*. The respondents shared the following priority areas as key areas of minimizing the impacts of flood:

- Construction of drainage and sewer systems to channel the water to the right places;

- Revamped and more established support from the government;

- Capacity building and training on the best forms of coping with floods;

- Continuous cleaning of drainage and sewer systems to avoid clogging;

- Discouraging construction along the river banks;

- Community-led excursions to maintain the drainage systems.

c. Implications of infrastructure intervention on risks

a. Community perspective on the impacts of the roads

The respondents perceived the impact of the new road network in *Mukuru Kwa Reuben* differently. Some respondents (60%) perceived that the new road network has had a positive impact on the livelihoods of residents of *Mukuru Kwa Reuben* (Figure 9). These respondents attributed the gains being seen in *Mukuru Kwa Reuben* to the new road network. Some respondents (21%) perceived that there was negative impact of the new road network on residents' livelihoods, while 18% perceived that there was negative and positive impact on livelihoods.

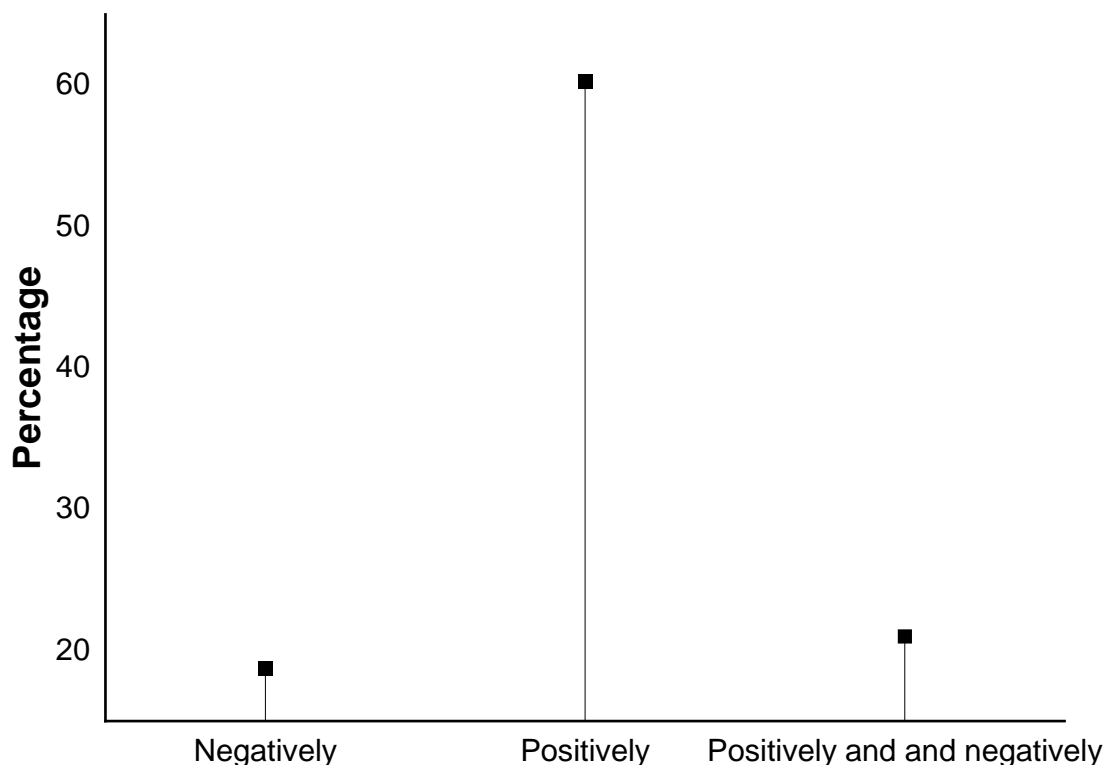


Figure 9: Attitudes of respondents concerning general impact of the road on Mukuru Kwa Reuben

Positive impacts

- Improved living standards and increased job opportunities

Respondents who perceived that there has been positive impact of the new road network expressed that the residents of Mukuru Kwa Reuben are now enjoying improved living standards and increased job opportunities and better wages. The respondents shared that the job opportunities created were due to road construction. The other jobs created were channelled through the government-led youth job creation program known as the “*Kazi kwa Vijana*” initiative, which supports youth to engage in general public cleaning and road maintenance activities at a fee. The businesspeople also highlighted that the road project had boosted their businesses since customers can now easily access their shops and services. Other respondents outlined that the transport costs have been reduced owing to the accessibility of different areas and motor ability of the road that facilitate different modes of transport to use and access Mukuru Kwa Reuben. Respondents also shared that Mukuru Kwa Reuben has attracted investors attributed to new road network and other new infrastructure development.

“Generally, the standard of living in the neighbourhood has improved; There some many job opportunities and better wages in the daily jobs hence better income”

“More jobs have been created increasing the amount of income of the residence hence their able to afford basic commodities needed for survival”

- Security

The study revealed that there were minimal security issues after the construction of the new roads. Street lighting was integrated into the new road network, which has enhanced the lighting of streets and made it safe for the residents to move around at night. The respondents attributed reduction of theft and burglary cases to the street and estate lighting.

Respondents also attributed improved security to job creation for youth under the “*Kazi kwa vijana*” initiative. The new road network has also facilitated access to the authorities and area administration, such as police, which respondents believed it has contributed significantly to security

“The new improved road, well structure drainage system, security has now been enhanced since police patrol well in the area and also in times of disaster, other vehicle and emergency vehicle can access the houses.”

“It has at least ease transportation in the area, enhanced security, creation of employment opportunities for some community members" youth and women.”

- Access to social amenities

The road network has also facilitated residents’ access to social amenities such as schools, hospitals, and churches, whose accessibility was initially impeded by poor road networks. The respondents also indicated that the road project had improved the hygiene and sanitation of the area since there are better drainage systems and improved water connections. Similarly, with the new roads network respondents shared that residents can now respond better to common disasters caused by fire outbreaks and floods other hazards. The drainage systems along the new road network have mitigated the impact of floods in the area by draining rising water efficiently.

- Linkage with the rest of the city

Another noticeable benefit of the new road network is the enhanced connection to the surrounding environs of Nairobi city. The residents can now access various modes of transport,

including personal cars and public transport which were initially restricted by the poor road network.

Negative impacts

- Displaced and lost their properties

The survey showed that many people were displaced and lost their properties to pave the way for new road construction. Respondents attested that they were not given sufficient time to transfer their personal belongings and property to safety after receiving a notice of eviction. Respondents shared that the demolition was undertaken without informing most residents. Some structures were reduced in size, which forced some residents to adjust to the prevailing condition, limiting them in many ways due to shrinking spaces.:

“Part of my house had to be cut down to give room for the road construction.”

- Road Accidents

Some respondents perceived the improved road network that it has resulted to road accidents which took away lives. They attribute also to the untrained drivers and riders who often over speed on tarmacked road which if they cause accidents then there is high chances of fatalities.

“My neighbour's child was hit by an over speeding motorcycle which led to the divorce between her and her husband.” (source)

- Job losses among the affected residents

The evacuation to pave way for the road construction led to some residents losing jobs and livelihoods they had developed over many years. Some residents moved to the nearby estates, but they couldn't secure new jobs. The associated consequences of the job losses include stress experienced by the affected families and individuals. This was also compounded by the impact of COVID-19, which led to the closure of many businesses and workplaces.

“My initial business station was demolished, so I had to start again from scratch.”

“It's because it has affected our businesses, and many customers opt to go to big shopping centers to buy their goods.”

- Waste disposal

Disposal of excavated soil from the road construction along drainage lines and river channels lead to clogging of drainage system and narrowing and raising of the riverbed. Respondents perceived that some drainage networks were blocked by the soil dumped along the drainage

system. Respondents shared that the contractors working on the roads are not disposing the excavated soil appropriately but they dump at the road sides, along the drainage line, and empty fields and on the river banks. The blockage or clogging of drainage system cause accumulation of waste water and rain water during rainy season hence leading to overflow of drainage lines and river channels resulting to flooding in some sections of the settlement. Respondents shared negative impacts which include destruction of household property and businesses and disruption of transport, among other impacts. The secondary impacts include loss of jobs due to the demolition of business premises

i. Impacts of the road network on flood

In responding to flood, respondents shared different perspectives on the interaction of the roads with flooding. Most households acknowledged that the construction of the new road network has reduced the risk of flooding because the new road network is integrated with better drainage systems. However, some community members argued that the new road network has influenced flooding in Mukuru Kwa Reuben by enhancing flooding and its associated impact, which they attribute to the mismanagement of the drainage systems along the new roads. Respondents alluded the some community members find it easy to dispose of waste in the drainage system hence causing clogging, resulting in inefficiency and subsequent water accumulation.

ii. Community perception on inspiration to recover after a flood

The respondents shared their perspectives on the perception of the community on inspiration to recover after a flood as shown in table 8 below. The respondents (54%) shared that the community had not recovered from flooding events at the time the survey was administered (Table 13). The respondents attributed the failure of the community to recover from the recent flooding to the massive disruption caused in their social and economic activities. However, despite the failure to fully recover, respondents noted that community' solidarity on certain occasions acts as a beacon of hope for better recovery in the future. The respondents confirmed that communities have organized themselves into groups to do regular clean up and manage the drainage systems voluntarily. This solidarity was reinforced by the “*Kazi Mtaani*” program, which is national government led program designed to facilitate job creation and create livelihood opportunities for the youth. The “*Kazi Mtaani*” program brings together youth and other members of the communities to jointly manage drainage systems and undertake general clean-up work at a fee paid by the government. However, the respondents argued that, due to

the short-lived nature of the “*Kazi Mtaani*” program, the passion of the members in the program to volunteer without any incentivizing mechanism wades off.

Table 13: Community perception on inspiration to recover after a flood

Perception	Percentage
Perception of the community has fully recovered from the event	46
Preparations or made any changes to your home to be ready for another flood since we have a new development of the road	25

“Availability of free social amenities and services such as free water, education, and health care services”

“I was motivated by roads, and I had to move to an area where there was proper drainage and sewer line.”

“Solidarity amongst Mukuru neighbours, friends and family in times of floods provides adequate consolation to recover.”

iii. Household measures in preparation to curb floods

Respondents shared other innovative approaches employed by the community in recovery from disaster. There are innovative community-led approaches such as establishing a financial base to help the affected households to recover from the impacts of perennial floods and other hazards. The following measures adopted by the households to cope with the floods in Mukuru Kwa Reuben:

- i. Cleaning of the open sewers that run-in front of their households to prevent the sewage from flowing into their homes;
- ii. Elevation of foundations of their houses.
- iii. Using sandbags to block water flows into households; raising furniture in the house (beds, tables, wardrobes, and chairs);
- iv. Migrations to locationally-advantaged areas;
- v. Weekly clean-ups to empty the drainage systems; construction of sewage systems and temporary drains along with households (channels water to other locations);
- vi. Construction of concrete protective walls;
- vii. Mide layering the drainage systems with hard structures;
- viii. Moving valuable house properties to high levels or safe places in the neighbourhood;
- ix. Proper disposal of solid wastes to avoid clogging of the drainage systems; and create stagnation points.

However, respondents noted that with the limited support received by the households from the government, some are incapacitated and cannot initiate changes to make their homes safer.

“We as residents always volunteer in cleaning drainages often to avoid blockage. We ensure in the estates we put litter in one area/container to avoid littering the environment which mostly ends up in the drainage.”

iv. Perception of the community in handling disaster after the road construction

Community confidence in handling disasters varies depending on the available infrastructure and their ability to access the grassroots level of social amenities. The study revealed that 70% (Table 14) of the respondents perceived they can handle the disaster, accounting for more than half. Strengthening the social network, improved access to social amenities, and the ability to get emergency support are critical factors that can be attributed to changes in the community's perception. Besides, local leadership working with national actors, NGOs, humanitarian organizations, and other well-wishers have played a key role in creating awareness among the community on the disaster. Given that most of the incidents can be controlled, it is depicted that some of the respondents perceive there is an improvement at a personal level regarding preparedness on how to handle such incidence depending on the nature of the disaster.

Table 14: Community perception in handling disaster

Self-reported perception of the ability of respondents to respond to disaster	Percentage
Don't know	13
Less able	4
More able	70
No change	13

The disaster response largely depends on those who have experience in handling the disaster to estimate and accept risks at the community and individual levels. This varied in Mukuru as some of the respondents felt there was no change, some were unsure about the change, and some felt they could not. It was depicted that the following are some of the factors that are associated with some of the respondents perceive they are less able to handle disasters:

- a. Access to social amenities; poor road network in some areas
- b. Lack of capacity to handle disaster
- c. Inadequate equipment
- d. Financial constraints

d. Policy implications

a. Awareness and Governance

Capacity and Awareness of Residents of Mukuru Kwa Reuben on Disaster Preparedness

According to the respondents, the community in Mukuru Kwa Reuben has engaged in different training and awareness programs, including awareness creation of disasters and basic training on disaster preparedness by various organizations. The results of the respondents interviewed show that there is less participation and involvement of the community in disaster preparedness programs that are geared to support them (Figure 10). Several disaster preparedness programs delivered by various organizations were pursued through the respondents who gave their confirmation if they have participated in any of them.

The respondents confirmed their participation or if they received communication materials on disaster preparedness delivered by various organizations in Mukuru Kwa Reuben (Figure 10; Annex 1). Among the respondents, 7% participated in disaster awareness meetings; 11% participated in First aid Training; 6% participated in Disaster or evacuation drills; while 10% volunteered in community disaster preparedness or prevention activities. At least 4% were given pamphlets or flyers about disasters or a person visited them to discuss disasters occurring in Mukuru, while 4% provided a pamphlet or flyer about disasters or a person visited them to discuss disasters (Figure 10).

The disaster preparedness activities attended by the respondents were delivered by state and non-state actors in Mukuru Kwa Reuben (Annex 1). Some of the non-state actors include CBOs and NGOs who were involved in the Mukuru SPA process. The state actors include the national government agencies such as NMS. Nairobi City County government is visible in the delivery of disaster or evacuation drills supported by auxiliary agencies such as the Kenya Red Cross Society (KRCS) and St. Johns Ambulance Services. The First aid training is strongly delivered by the KRCS and supported by volunteers and various CBOs in Mukuru. The delivery of the above disaster preparedness activities shows there were collaborative efforts towards empowering the residents of Mukuru Kwa Reuben to respond to disasters.

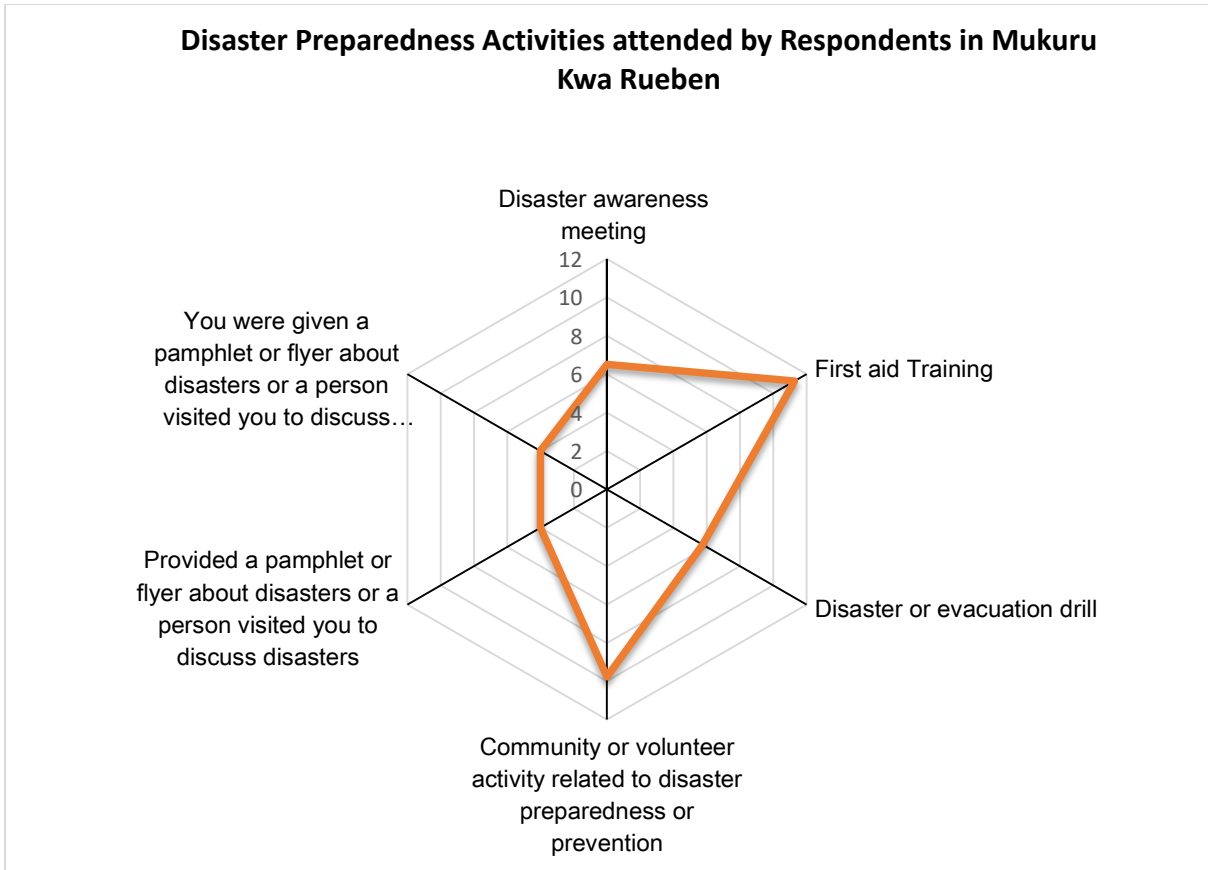


Figure 10: Disaster preparedness activities which respondents participated and delivered by various organisation in past in Mukuru Kwa Rueben

Discussion

Demographics Characteristics of the Respondent in Mukuru Kwa Reuben

From the overall analysis of the study, it was depicted that a more significant percentage of the sample population has acquired formal education. The education level is an important parameter as it influences awareness of disaster risk reduction. Furthermore, literacy contributes to a better choice of household activities and the ability to gather and articulate information relating to DRR. This is because, environmental communication is a two-way social interaction process enabling people to understand key environmental issues such as climate change and interdependencies and how to respond to problems associated with the phenomena competently. Information on day-to-day issues creates new mindsets and perceptions that change peoples' lifestyles and judgments and efficiently use valuable environmental resources [60].

As per the results, more than half of the respondents were female. Based on the results, it is an indication that most women play a vital role in DRR. Gender is an indication that in the event of a hazard incident in the daytime, women and children are vulnerable to being impacted by the magnitude of the disaster. Disaster does not consider gender, but the impact does. The poor and marginalized are mostly affected with high impact. Women, children, and girls tend to have less skill in dealing with the consequences of disaster and are likely to suffer most since they are highly exposed. Most studies have shown that the fatality rate caused by disasters is higher for women than men. In this study also, the majority of the respondent are energetic and thus they are vital in supporting the community by providing help in the of a disaster. Having young and underage people in the event of a disaster can be devastating [61], [62].

On the contrary, older people tend to have vast experience handling a disaster, which has helped them understand the surrounding local environment. Older people are at risk because of aging, poor health, poor eyesight, poor hearing, and mobility. According to Gaisie *et al.* 2022 [63], female-headed households tend to have less capacity to deal with the disaster. The author noted that despite women's ability to cope and prepare with disaster, gender inclusion is vital in building resilience and disaster management, a driving force towards policy making and implementation. According to Morrow and Enarson 1996 [64], women exhibited a greater readiness and awareness to prepare and evacuate in the event of a disaster. The varied social characteristics of the community in Mukuru Kwa Reuben influence their ability to recover and prepare, the impact of disaster, resilience, and coping strategies.

Access to essential services in the informal settlement

Infrastructure development (road) helps to ease transportation in Mukuru Kwa Reuben and the nearby environ. Opening an area with new roads leads to significant changes in the community's social life, especially in the informal settlement. Untarmacked roads hinder the mobility of people and goods, thus increasing the initial direct and indirect cost of transport. This can also be attributed to access to other amenities such as the input and output market, education, water access, health services, and workplaces. In the case of Mukuru kwa Reuben, access to amenities and services has improved, which signifies widespread investment. The improved access is attributed to reducing poverty.

As per the study, it is depicted that there is an improvement in terms of the availability of essential services and amenities in the informal settlement. This indicates that the new intervention has triggered economic activity, attracted shops services and increasing residents' identity with their place of residence, bringing an enhanced sense of security and orderly development. The widening of the roads and installing streetlights and mixed-use along roads brought more usage and social interactions amongst residents with positive impacts on public safety.

The massive investment breaks up an informal settlement into a more urban set-up, permitting cohesion among the residents. New social groups emerged, and the existing ones became more assertive in implementing projects. This transformation result has led to spatial heterogeneities reducing inequality and exclusion in the informal settlement in Mukuru. Ultimately, it indicates that Mukuru kwa Reuben is transforming into a more sustainable society. The market output raises the resident's income since they can easily transport goods in and out of the business places. According to Mu and van de Walle [65], improved road networks are associated with improved access and increased job opportunities, especially for unskilled people.

The available evidence could be the reason for the new prospect in terms of business opportunities leading to competition of newcomers and old habitants of Mukuru Kwa Reuben. Mouratidis [66] mentioned that new opportunities in the urban setup attract new inhabitants because access to amenities is a critical determinant of the quality of an area. This includes access to suitable housing, treated drinking water, good drainage, availability of hospital and banking facilities, and access to electricity, latrines, and bathing, among other social amenities. Furthermore, the improvement in the living standard will ultimately lead to change in the formation of informal settlements and population growth in the future.

The upgrading strategy uses roads not only as a physical entity for mobility and accessibility but also as an avenue through which water and sewerage pipes, power lines, and drainage systems are laid but also for the common good and the public domain where social, cultural, and economic activities are articulated and carried out. This has provided the structure of owners and tenants who already know each other and have common interests as they share the same space and associations. According to a study by Msimnag 2017 [66] in Jika Joea and Pietermaritzburg informal settlement in South Africa, the author alluded that the complex setup in area improves the services infrastructure have a positive impact on the environment. For instance, improved waste disposal reduces emerging infectious diseases and reduces pollution. As per the study by Haques (2016) [67], due to infrastructural development in West Bengal, the town exhibits a higher relative availability of basic amenities and services.

The local infrastructures in informal settlements tend to determine how the community can address and handle a disaster. Besides, implementing disaster management activities involving the community is paramount since it puts its their heart and thus their commitment in the entire process. The community in Mukuru kwa Reuben has demonstrated their capability to access social amenities and improve living standards after the intervention. This aligns well with a study by Thinda 2009 [68] in the informal settlement in Lusaka, who alluded that the informal settlement's coping mechanism is determined by the resources that determine how the community understands and perceives disaster.

Community Adaptive Capacity

Interestingly, the community in Mukuru kwa Reuben perceives they are more able to handle disaster at the individual and community level after the road intervention. This indicates that more effort has or can be put in place to create awareness of DRR. This is highly influenced by respondent/ household personality, such as their ability to face danger. This suggests the respondent are knowledgeable about the cause and risk involved, and thus with the infrastructure in place, they are more sensitive and confident in handling a disaster. The infrastructure is vital because it influences the functionality of the disaster management cycle, such as evacuation, rescue, reconstruction, adaptive and coping strategies, awareness, resilience, and connecting community, thus gearing towards reducing disaster impacts.

Research has established that the development projects have both positive and negative impacts on present-day societies. However, well-structured developments with clear plans will ultimately magnify the positive impacts on the communities. While implementing development

programs and projects, the development practitioners must focus on designing the projects to increase community resilience to disasters. According to Chandra et al. 2018 [57], community resilience can be defined as the sustained ability of a given community to withstand and finally recover from adversities such as disasters. In retrospect, when building community resilience to disasters, it is vital to assess the communities' causal factors and vulnerability contexts. After the assessment, it is essential to devise strategies for disaster mitigation and build the capacity of the community to deal with disasters and recover quickly from these adverse events.

Strengthening of community resilience to disasters adopts both active and proactive mitigation and remedial measures. Such measures are supported by infrastructural developments and access to essential amenities. With the exception, this varies depending on different facets and perceptions. For instance, the perceptions depend on experience with hazards, access to social amenities, and information that is likely not proportionate to every community member. According to Mawere 2019 [58], societal nature such as culture and belief, greatly will determine how they influence response to the disaster at a different scale. In other words, the disaster response is defined by the culture of the community. Community adaptation depends on the resource available, which is depicted from the direct and indirect impact of the road in the case of Mukuru Kwa Reuben. Ultimately, Community based risk management at a local level strives towards reducing risk at the local level through participation. As depicted in Mukuru Kwa Reuben, the community's strategies to reduce and prepare for flood and fire hazards are foreseeable as a goal in building a resilient community. This gives an advantage with the support of state and non-state actors in strengthening the community's capabilities to build a resilient city. Integrating informal community participation in DRR is instrumental in city project development, thus developing stringent mitigation strategies. Proper training enables the community to safeguard and minimize disaster [68].

Modern society has seen unprecedented growth in infrastructure and increased access to amenities. Such developments have been critical in promoting the well-being of the societies and enhancing community resilience to disasters. Disaster management entails building the capacity of the community to deal with the eventualities of both manmade and natural disasters. Well-developed road networks as part of infrastructural development increase the resilience of communities to disasters in many ways. For instance, when disasters such as fire occur, it is easy to call upon emergency responses such as firefighters and rescuers to mitigate the impacts of disasters. Good road networks also aid in transporting casualties to hospitals hence reducing the mortality rate when disasters happen.

Moreover, in a disaster situation, the road networks help in the evacuation process and easy resettling of the affected person. In other cases, well-developed networks have been instrumental in facilitating aid and relief logistics and promoting the recovery process. Similarly, the development of amenities boosts communities' ability to cope with the impacts of disasters and recover speedily. For example, the development of suitable housing structures reduces the vulnerability of communities to multiple hazards such as fire and floods that have a significant impact in areas with dilapidated housing structures. Further, access to amenities such as water points is crucial in empowering local people in fighting disasters such as fire and disease pandemics.

The role of Health facilities in building resilience to disasters cannot be downplayed. As part of amenities, health facilities need to be developed, especially in disaster-prone areas, to help treat casualties with the broad objective of minimizing the impacts of hazards and disasters. In essence, promoting community resilience to disasters should adopt a multifaceted approach that mainly focuses on equipping the community with the necessary resources that enhance their resilience. Overall, developing community-based infrastructures such as road networks, better housing structures, and health facilities are crucial in strengthening community resilience to disasters. With ease, access to the hospital and availability of water depicts signs of bouncing back by the community. It is eminent from the results that different stakeholders play a critical role in mainstreaming disaster risk reduction in the informal settlement on different level. However, the community have emerged as key focal point and link to disaster reduction with development.

Policy implication and community participation in planning in the DRR

The urban life defines the characteristics of the social group in a given area and over time. This means the community are the custodian information and the host of the policy implementation in the area. In developing countries, case of Nairobi Kenya, the government have embraced slum upgrading as a tool to transform the informal settlement. This is comprehensive approach which entails understanding of the spatial environment, social development, and governance. This may differ depending on the approaches undertaken by the relevant institution mandated to ensure the holistic approach in engagement process to enhance a sustainable approach in the development process.

The slum upgrading process has been participatory to ensure an inclusive involvement of all the actors in the planning process. The approach of creating an inclusive city could be an

obstacle to implementing sustainability at the city level. For instance, for effective implementation of the policy and plans at the city level, there is need for a holistic approach to making choices since the implementation is based on values of the choices. Infrastructure development not only influences per capita income, but also should lead to improved income distribution, reduced poverty, and decreased unemployment since these indicators of development. Besides, the implementation approach should ensure that the community's welfare is considered for a better and prosperous life [56]. The involvement of the social group in Mukuru Kwa Reuben in planning process depicts there is a disconnect their participation in the planning process. The percentage of community involvement in the planning process is small. This thus means that, this could be the reason for transferring risk from one area to another as such their concern in addressing vulnerability were not addressed.

Recommendation

1. Addressing disaster management issues in the informal formal settlement should be based on applicable plans which is co-produced by the relevant stakeholders and the community.
2. Local urban planning needs to be informed at the initial stages and at the implementation by a comprehensive sector wide and data-driven dynamic risk and vulnerability assessment.
3. Strengthen the involvement of local communities and formal and informal social networks in the local urban planning in order to leverage local and indigenous knowledge and resource support to risk-proof planning.
4. Incorporate risk-sensitive MEL- monitoring, evaluation and learning in the implementation of local urban planning to risk-proof implementation and review of local urban plans
5. There is need to create awareness to the community to change their perception on their day-to-day activity and how they can mitigate and reduce incidences of hazard.
6. The implementation of infrastructure development should consider the indicators of infrastructure such as per capita income, income distribution, reduced poverty, and decreased unemployment at the informal settlement to improve the welfare of the community. This will influence the adaptive capacity of the social group to hazards.
7. The implementation of plan should consider the values of choices being taken to ensure a holistic and sustainable approach to safeguard the safety of the social group.
8. The need to create a well-defined collaboration among different institutions who are key in supporting the community on disaster issues is key to avoid duplication of the effort. This will ensure that such initiatives are well coordinated and the scope is extended to the wider community.

Conclusion

The RVA study in Mukuru Kwa Reuben provided more insight on the infrastructure interplay with on risks at the informal settlement. Through the implementation of the SPA, Kwa Rueben benefited first during the infrastructure development. The implementation of the SPA was inclusive where the some of the community and other key stakeholders were involved in the process. The new intervention had a positive impact, and such as construction of other network e.g sewerage and water. Through this initiative the new road infrastructure has led to improved access to social amenities for the communities. Despite the positive impacts, some of the community members had to relocate to pave way for the road construction and also due to hike in rental fee. Additionally, the development process exposed the community to other risks such as hanging wires and flooding. It is evident that despite the intervention, floods and fire are the common hazards reported by the respondent. Currently, the community feels confident in handling hazards compared to before the road construction because of the improved access to social amenities, ease of navigation, and improved community social cohesion.

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Appendices

Appendix 1: Disaster preparedness activities attended by respondents and delivered by various organisations in Mukuru Kwa Reuben

	Disaster preparedness activities	Organisations
1.	Disaster awareness meeting	<p>At work CBOs and Kenya Red Cross D. Messi, an announcer of Reuben FM trained them on how to deal with disasters in ghetto. DPL Festive Government through chief's office Kenya Red Cross Youth Group KOMEA Kenya Red cross and CBOs Kenya Red cross and local administration Special Planning Area (SPA) consortium St John's Ambulance Training by county government on how to handle fire related risks In 2019</p>
2.	First aid Training	<p>a. A gas company.(Don't know the name); b. Aphia plus c. At work place d. Aucma company e. County government on emergency response f. CBOs g. Church ie Salvation Army Kariokor h. College i. Company-vajas company j. Hand in hands with collaboration with Pillars of Women. k. High school scouting club l. Hope world wide m. IBA n. Industry o. It was organized by the school (high school) p. Kenya Redcross q. Kenya Redcross while in campus r. KOMEA s. Mugano MTCC t. Our organization u. Kenya Red Cross and local CBOs v. Kenya Red Cross in conjunction with the local administration</p>

		<ul style="list-style-type: none"> w. St. John's Ambulance x. Wangu kanja foundation
3.	Disaster or evacuation drill	<ul style="list-style-type: none"> a. County government b. CBOs c. CBOs and local administration d. Community members e. Community members and local administration f. Leopard Onyango, Former Leader of Kijiji Mzee, a community organization g. Local administration h. Local administration and community members i. Mukuru Skills j. St Johns Ambulance k. St. John's l. Utalii college
4.	Community or volunteer activity related to disaster preparedness or prevention	<ul style="list-style-type: none"> Action aid Afia plus, Area chief and community committee National government National government through the kazi mtaani CBOs Church community cleaning the drainage systems Community Group Community members responding to fire outbreaks Community youth group County Government through Environment Department Gatoto primary schools Government agency Individuals helping in the community clean-up exercise Helping in taking care of the sick to avoid further hazard exposure Kenya Red Cross Community organizations Mukuru Youth Initiative Village elder
5.	Provided a pamphlet or flyer about disasters or a person visited you to discuss disasters	<ul style="list-style-type: none"> Area chief Community health volunteer team Industry Kenya Red Cross My employer selected few willing to participate SPA Consortium St John's Ambulance

