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Assessing Community Adaptive Capacity for Climate Resilient Development

A Complex Adaptive Systems Case Study Analysis of Mathare Valley, Nairobi, Kenya

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Summary

This research takes an urban resilience standpoint to explore the interconnections of resilience components within a community network. It identifies leverage point based on empirical evidence, in depth case study and statistical analysis to draw conclusions as to the mechanics of relationships in the context of a post-colonial sub-Saharan African state, where informal settlement are in a state of deprivation and are a significant risk.

Keywords

Climate Resilient Development, Urban Resilience, Community Adaptation, Adaptive Capacity, Inequality, Resilience Activities, Complex Adaptive System, Kenya, Mathare.

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Abbreviations

CAS	Complex Adaptive Systems
CBA	Community Based Adaptation
CFI	Comparative Fit Index
CR	Climate Resilience
CRD	Climate Resilient Development
CRI	Community Resilience Initiatives
HCA	High-Capacity Agent
ICFI	International Centre for Frugal Innovation
ICT	Information and Communications Technology
IHS	Institute for Housing and Urban Development Studies
IPCC	International Panel on Climate Change
NWS	Nairobi Water Services
OLS	Ordinary Least Squares
RMSEA	Root Mean Square Error Approximation
RN	Robust Networks
SI	Supportive Institutions

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An informal dumpsite cascades over into the Mathare River next to precarious homes in Mathare 3B

Photograph 1: Authors Own Image

Chapter 1: Introduction

As the compounding impacts of urbanization and climate change place increasing pressure on interconnected urban systems, communities on the frontline must develop the capacity to adapt. Climate resilient development calls for robust urban systems capable of managing critical and complex interdependencies to maintain system function. Global structural inequality and negligent policies are barriers to securing sustainable urban environments into the future. Communities facing these extraordinary risks are extremely vulnerable – and must develop complex survival mechanisms to cope. These mechanisms can be framed within Complex Adaptive System (CAS) and Transition literature so that leverage points can be identified within the system that might have the most positive impact on Climate Resilient Development.

1.1 Background

Global Scale - Climate & Urbanization Patterns

Global population growth is placing increasing pressure on ecological, economic, and social systems, some of which are reaching their limits of their capacity to absorb human activity. The IPCC state-of-the-art report on climate science outlines the impacts expected in the coming decades, and what is needed to avert significant escalations in climatic changes and their catastrophic impacts (IPCC, 2022; IPPC, 2021). Urbanization and Climate Change impacts are 'two sides of one coin' (Shi et al., 2021) as the adaptation challenges are inextricably tied to development challenges. Internationally, people and assets are increasingly concentrated in cities with these clusters of significant investment, essential infrastructure and innovation now covering 2% of the surface of the earth yet being home to 55% of the world's population (UNFPA, 2018). Cities are drivers of extraordinary innovation and progress, but contribute significantly to climate change (Crutzen, 2016) and are extremely vulnerable to natural and human risks (Dodman, Archer, & Mayr, 2018) Cities consume 75% of global resources extraction (Madlener & Sunak, 2011 in Ribeiro & Goncalves, 2019) and are characterised by consumer societies predicated on economic notions of perpetual growth (Raworth, 2017; Rose, 2022), with vast interconnected supply chain infrastructures (Amaral, Benites-Lazaro, Antonio de Almeida Sinisgalli, P., Prates da Fonseca Alves, H., & Giatti, 2021; Swilling & Annecke, 2012). As the loci of both cause and solutions, urban areas will require profound institutional, behavioural, technological and physical changes to mitigate and adapt to climate change impacts (Barrière et al., 2019; Wolfram, Vd Jeijden, Juhola, & Patterson, 2019). These dynamics have led many authors to argue that climate change will be won or lost in cities (Adhern, 2011; Barrière et al., 2019). Consequently, climate policy action must focus on building adaptation capacities at the city scale to increase urban resilience (Croese, Green, & Morgan, 2020; Swilling & Annecke, 2012; Tyler & Moench, 2012).

Focus on Global South & City Scale Impacts - Inequity

These benefits and challenges are not distributed equitably across the globe. Significant variation in levels of deprivation exist between societies, communities, individuals, and the ecosystems on which we all depend (Adhern, 2011; Chu, Anguelovski, & Carmin, 2016; Dobson, 2003; Dodman et al., 2018; Fainstein, S., 2014; Raworth, 2017). The compounding stressors of climate change and urbanization will exacerbate these deprivations (Dodman et al., 2018) increase global inequity and will be experienced most tangibly in nations in the Global South - where populations are expected to grow the most over the next few decades,

and where climate change impacts are predicted to have the most devastating effects (Adhern, 2011; IPCC, 2022; IPPC, 2021). Despite these areas contributing the least to global greenhouse gas emissions (and having the smallest share in the direct benefits of fossil fuels) the marginalised and vulnerable communities in these regions - who already suffer multiple forms of historical institutional and systemic injustices - are expected to be further disproportionately affected by the effects of climate change and rapid urbanization (IPCC, 2022). Throughout Sub-Saharan Africa contexts of informality pose particularly complex developmental challenges, as the nature and organizational structure of these environments sit outside of the prevailing formalized governance models of contemporary cities (Leck & Roberts, 2015).

1.2 Case Study Area

Historical Context

Imperial colonialism in Africa was predicated on the prioritization of capital gain over all else and used domination, subjugation, and extraction as primary methods of accumulation across the continent (Mignolo, 2007). With this aim, a vast system of human, social, and physical infrastructures to connect network of settlements, railways, and ports were established throughout colonial Africa.

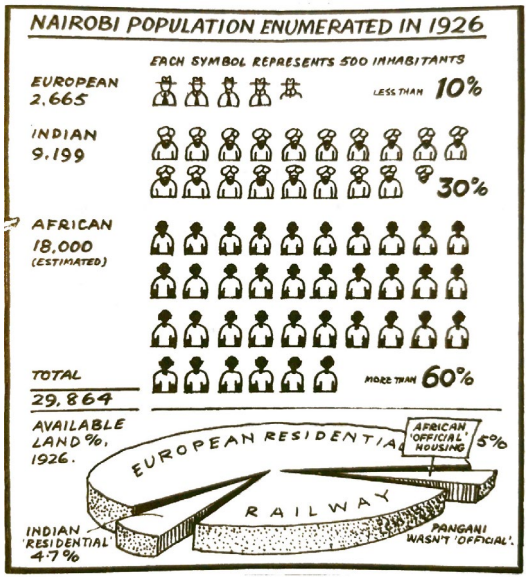

Figure 1: Infographic showing land allocation in Nairobi (Hirst & Lamba, 1994)

One example of this is the city of Nairobi, Kenya which was established in 1896 as a node to facilitate the movement of raw materials and goods from the interior to the port city Mombasa (Lamba, 1994). Today, 120 years later, the pattern of repressive and exploitative governance of the region by elites established during the colonial period (see figure 1) continues as the population increases and additional strain is placed on resources (Lamba, 1994). A 'policy of neglect' (Lamba, 1994) and neo-liberal attitudes coupled with pervasive networks of patronage have been wielded to entrench infrastructures established by the original owners of the capitalist system and which are now the norm (Hatuka, Rosen-Zvi, Birnack, Toch, & Zur, 2018; Hendriks, 2010; Myers, 2015). If South Africa has anything to teach us of colonial impacts, it is that lessons can be drawn from the caricature of spatial segregation that was entrenched throughout the period of Apartheid, and just how pernicious and self-replicating inequity in the urban environment can be (Christopher, 2001; Soja, 2009). In Nairobi, similar patterns of settlements which can be characterized as 'labour dormitories' are located within walking distance of the affluent, 'leafy suburbs' of Nairobi's elite.

What is striking about this relationship, and how it manifests today – is that these leafy areas are now home to embassies and international institutions which employ and play host to international elites whose lifestyle is disconnected from the reality of the majority of Kenyan citizens (Jimmy, Martinez, & Verplanke, 2020; Myers, 2015). Despite the good intentions of the individuals who work in spheres related to development and politics, they

are subsumed into the dynamics of class politics that are resilient to change (Hall, 1983; Jimmy et al., 2020). These well-connected individuals, with ties to international funds - and political power - continue to live a privileged existence which rests on the same colonial infrastructure established all those years ago. They continue to employ local Kenyans at minimum wage, who are forced to live in a city that receives minimal investment crumbling infrastructure, unsafe and unreliable drinking water, and systems of extortion that exist at every scale of governance (Hendriks, 2010; Jimmy et al., 2020). It is a tale of two cities, which is not unique to Nairobi, or Kenya.

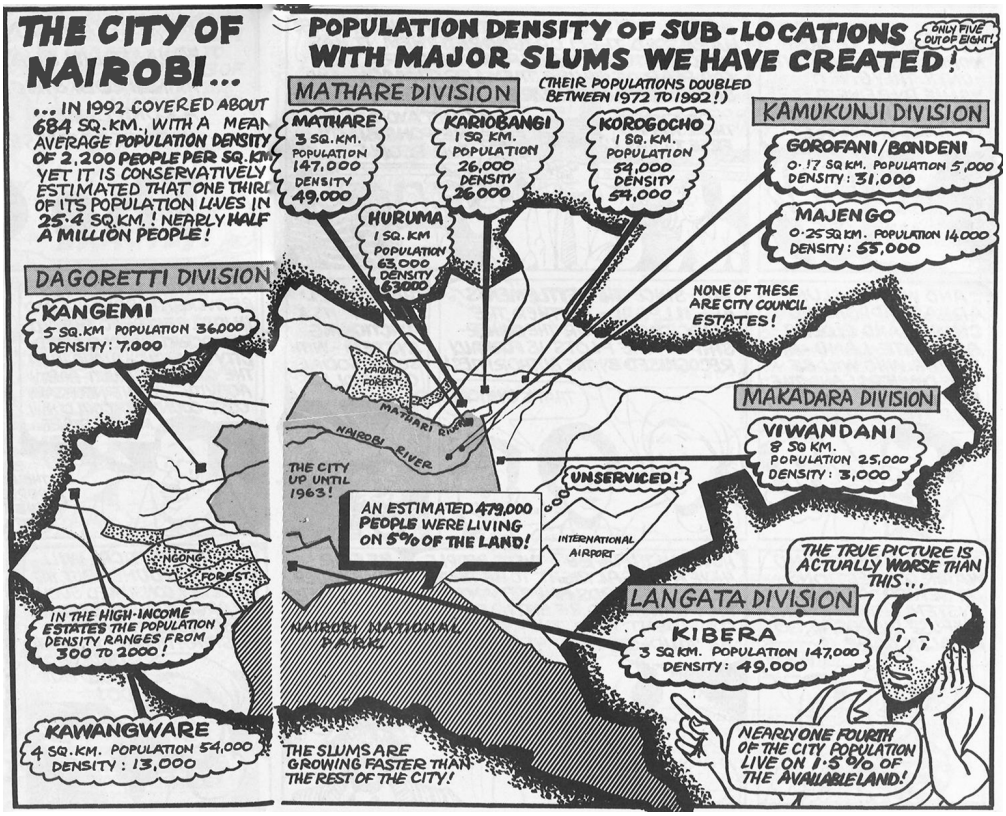

Figure 2 : Illustration showing location of Nairobi slums in 1992 (Hirst & Lamba, 1994)

Contemporary Context

Urban development in Nairobi is fragmented (Jimmy et al., 2020) and highly unregulated. Environmental management failure is compounded by multiple issues: excessive borehole water extraction; increasing imperviable surface cover - leading to increased runoff into stormwater systems; stormwater contamination with solid waste as well as sewage; frequently blocked sub-surface drainage systems; significant tree removal and loss of green space (Mwaniki, Gakuya, Mwaura, & Muthama, 2019). Climate change impacts experienced in Nairobi include increased water insecurity and variable rainfall patterns which contribute to growing threat of food shortages exacerbated by acute inflation linked to global supply chains (Kogo, Kumar, & Koech, 2021). Nairobi does not produce its own food and brings in water from dams which feed from catchment areas that are increasingly experiencing the effects of drought (Njoroge, Wahab, Tracey, & Oting, 2018). These challenges pose significant threats to the city. Nairobi faces serious challenges in

transforming its urban systems into robust networks capable of withstanding increasing stresses and the unpredictable shocks that climate science predicts. These compounding effects of climate change and urbanization will disproportionately affect the poor and marginalized.

Current development patterns and climate change impacts are exacerbating the risk and vulnerability of marginalized communities (Dodman et al., 2018; Lamba, 1994; Myers, 2015). The systems upon which cities have been built are coming under increasing pressure with far reaching consequences on ecological systems and human lives. Patterns of urbanization in the global south suffer from legacies of discriminatory planning, cumbersome bureaucratic systems and significant effects of climate change which increase urban vulnerability and risk. Marginalized communities manage various forms of risk and vulnerability daily through a complex system of coping mechanisms and adaptive planning in precarious circumstances. An increase in stresses or higher frequency or intensity of shock events may push these communities over their tipping point. There is an urgent need to build on the understanding of these contexts and situate this knowledge within the discourse of climate vulnerability to prepare for uncertain futures.

Mathare is a large slum in Nairobi in the Northeastern area of Nairobi, 10km from the city centre (Hendriks, 2010; Hirst & Lamba, 1994). It has a population of approximately 207,000 people living in a valley of only 7.5km^2. During the 1890's, Mathare began to develop informally through 'subsistence urbanization' outside of the newly establishing settler boundary, and was later designated for Indian use where it was quarried (Hirst & Lamba, 1994). A history of neglect and maldevelopment has resulted in complex dynamics surrounding land ownership, discretionary power relationships, and a degraded urban environment.

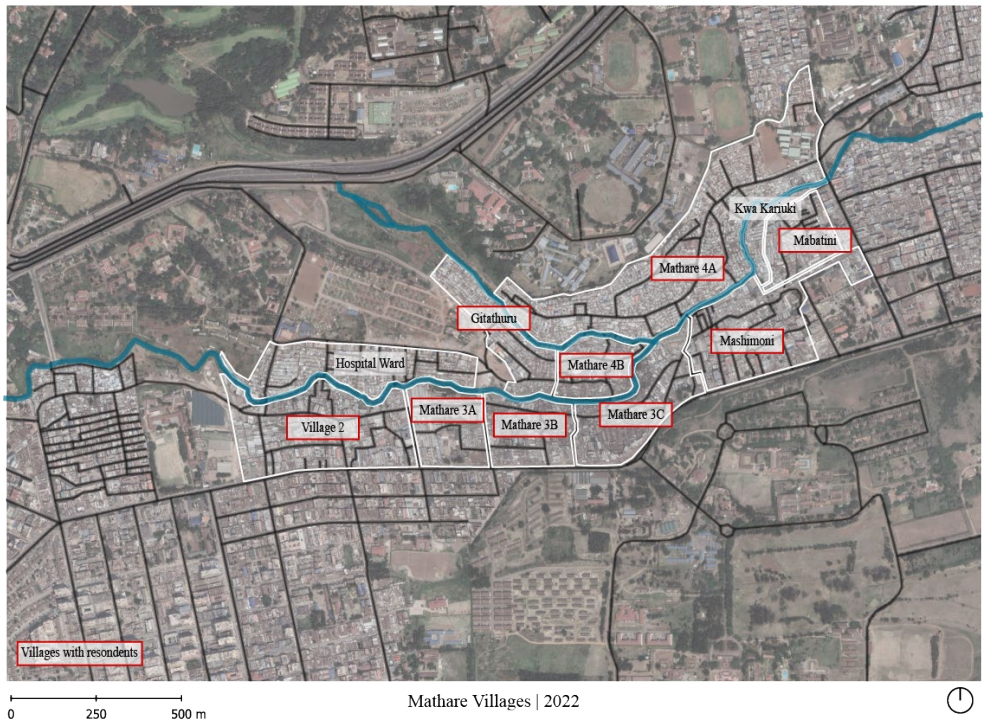

Figure 3: Authors own image

Today Mathare is characterized by dense informal housing and business (UN-Habitat, 2020) in unsanitary conditions, with an inadequate and unsafe water supply, deficient drainage, sewage and waste collection systems (Lamba, 1994), frequent fires (Hendriks, 2010) and floods (Karisa, 2010; Owuor & Mwiturubani, 2021). The Mathare river bisects the area flowing from the west, carrying the contents of contaminated stormwater drainage from the city as well as raw sewage and solid waste from within Mathare. Figure 3 depicts the boundary of Mathare and its 13 villages, as the rivers which run through the area showing show they converge in the centre.

1.3 Problem Statement

'Climate change is contributing to humanitarian crises where climate hazards interact with vulnerability' (IPCC, 2022). Several well-known risk factors face residents of Mathare daily and are outlined below (Douglas et al., 2008; Hendriks, 2010; Hirst & Lamba, 1994; Jimmy et al., 2020; Lamba, 1994; Myers, 2015; Wainaina, 2018):

Patterns of land ownership, and limited access to services perpetuate the status quo which has been co-opted by cartels (powerful resource owning families who benefit from the system as it is). This has led to continued criminalization and stigmatization of Mathare residents which further marginalizes the community. The history of land ownership in Mathare is deeply entwined with the colonial and post-colonial history of the city and shaped current ownership patterns (A.3.1.1) (Hirst & Lamba, 1994). Today a complex land ownership matrix is comprised of three forms of land ownership: government, private, and collective ownership all characterized by conflict and maladministration. Decades of informal land grabbing, illicit land trading, and politically motivated and illegal land allocations result in questions of legitimacy being central to the conflicts and lengthy legal battles paralyzing attempts at development.

The legacy of corruption and patronage results in slum landlords controlling multiple aspects of life in Mathare. Water Provision, which constitutionally should be provisioned as a public good, is subject to cartel-controlled purchase as a private good and today non-revenue water provision accounts for around 45-50% of water supply in Nairobi (Wainaina, 2018).

Systemic vulnerabilities have been exacerbated by climate change and unplanned urbanization. Several factors affect flooding in Mathare (Douglas et al., 2008). Firstly, urbanization results in increased surface-cover and the channelization of stormwater runoff which is directed into the river system, and which then runs through Mathare. Secondly, urban migration and population increase is driving land-hunger, resulting in increased densities which push the poorest along the river where they are most at risk of flooding as well as suffering the effects of living downhill of a settlement which does not have a wastewater system, adequate sanitation, and minimal solid waste collection. These environmental conditions coupled with the variable rainfall patterns mean that those living in the riparian zone suffer the most, have the least capacity to cope, and face the biggest risks.

The impacts of climate change further exacerbate these issues. Variable rainfall patterns mean that the ground is increasingly dry for longer periods of time leading with health consequences as wastewater pits dry up and pollution become airborne. Riparian areas are increasingly encroached upon during dry periods, and unanticipated flash floods rush down through the valley taking everything in its path.

These structural issues must be addressed for both the increased risks associated with predicted climate changes, as well as for unanticipated and unpredictable events. This is a major challenge in all contexts, but particularly so in contexts of minimal resources and high vulnerability.

1.4 Research Objective

Learning from the front line

Multiple stakeholders in the urban realm are required to work together to find solutions and respond to these challenges and risks in a way that allows for transitions to more resilient forms of development. The response of communities on the frontline of these intertwined climate and development challenges offers an opportunity to learn about systemic urban resilience and to understand what is required to increase adaptive capacity across the multilevel systems to transition out of extreme poverty and vulnerability and to survive the climate battle as it plays out in cities. People living in informal settlements without access to basic infrastructure and services or steady source of livelihoods are often most exposed to environmental hazards. The ability of communities to persist and develop the necessary survival strategies in the face of such challenges, and with minimal resources, whilst being an injustice that needs to be addressed may provide significant insights into how other urban systems may cope in such extreme circumstances of urban challenges.

Individuals, households, organizations, and the institutions that support them interact through a set of complex, dynamic, contested, and interdependent relationships. This research is situated within the literature of complex adaptive systems and climate transitions. It investigates the range of existing capacities across the Mathare Valley community, and the level of adaptive action taken to solve challenges in this urban complex adaptive system that is responding to a range of challenges simultaneously. This offers an opportunity to understand what is needed to support the governance of adaptation in complex environments.

1.5 Research Questions

The main research question and the five sub-questions of this thesis are:

What is the influence of the current adaptive capacities and resilience activities on community resilience three component levels of governance in Mathare for transition towards climate resilient development?

The five related sub-questions are:

1. What is the level of adaptive capacity in each component level?
2. What is the level of resilience in each component level?
3. What are the interrelationships within and between each component level?
4. Which, if any, have strong relationships with community resilience?
5. What are the key mechanisms which influence community resilience?

These questions isolate each element required to answer the main research question above. Sub-question one and two requires independent and dependent variables to be formulated, measured, and scored. This then allows for relationships to be identified, as per sub-question

three, and for in-depth analysis using appropriate methodologies to explore the relationships, as per sub-question four. The aim of this research is to then integrate these findings through the framing of a Complex Adaptive System and identify the key mechanisms of community resilience that might enable transitions towards climate resilient development.

1.6 Significance of Study

There is growing awareness amongst urban planning practitioners of the complexities that coalesce around the impacts of climate change and urbanization dynamics and the increasing pressure being placed on urban communities at different scales around the world in the context of inequality. Empirical studies that synthesize theoretical developments and explore their relevance in real world contexts have the potential to provide significant insights for the development of tangible responses. Understanding social change in this context requires research with specific aims and contextually embedded knowledge that can inform policy and action at multiple levels and assist in the development of strategies that enable individuals or groups to self-organize, increase knowledge, and produce quality planning. Therefore, the ability to learn from the past, examine the present and predict future impacts from a theoretical and empirical point of view is needed.

This research aims to contribute to these objectives.

1.7 Scope and Limitations

The scope of this study is limited to one settlement with a unique history and a contemporary socio-political and economic character. All measures possible have been taken to ensure validity and reliability for generalization, however a much larger study would be needed to identify fine-grained patterns of interdependency needed for a more nuanced understanding.

This study is limited to the theoretical associations outlined below and would benefit from engagement with the vast literature that exists across the fields of urban development studies, urban geography, behavioural sciences, economics, and psychology to name a few. These theoretical considerations are beyond the scope of this study.

1.8 Structure of the Study

This research is composed of five chapters: the Introduction, Literature Review, Research Design and Methods, Case Study, Data Analysis and Discussion and, finally the Conclusion. The first chapter introduces the theoretical and contextual background motivation for this study and presents the research objectives and questions. The Literature Review outlines the trajectory of existing urban development literature regarding Climate Resilience, Adaptive Capacity, Community Governance and Transitions as Complex Adaptive Systems. The chapter on Research Design and Methods outlines the strategies of the data preparation and collection. The fourth chapter details the analysis of the quantitative and qualitative results and discusses them. The final chapter summarizes the findings of the study by answering the research questions and offers implications for climate resilient development policies and further research.

An encroached and severely polluted Mathare River runs between homes separating Mathare 3C & 4B

Photograph 2: Authors own image

Chapter 2: Literature Review

2.1 Climate Resilient Development in Urban Theory

Paradigm shift - Sustainability to Resilience

Over the course of the 20th century the scientific paradigm shifted fundamentally from a deterministic conception of nature, science, and ecology to an increasing recognition of the role of variability, uncertainty, and unexpected change across the interdependent systems on which urban centres depend. This has had a significant impact on urban development and planning (Adhern, 2011; Barrière et al., 2019; Berry, 1973; McGranahan & Satterthwaite, 2014; Rauws, 2017; Restemeyer, Vd Brink, & Woltjer, 2018). Sustainability science is problem solving oriented (Adhern, 2011; Kuhn, 1970), and has been concerned with finding a balance between social, ecological, and economic developmental needs as defined in the seminal 1987 Brundtland Conference (Brundtland, 1987). Global institutions have been established to promote these aims through the development of international frameworks and strategies such as the 2030 Agenda for Sustainable Development (UN, 2015) and the New Urban Agenda (UN, 2017) which seek to make cities more livable for all inhabitants and reduce inequalities around the globe. While it may be true that collectively, standards across the world are improving (Rosling, Rosling, & Rönnlund, 2019) and that there is much progress to celebrate – the reality is that the urban poor and marginalized groups bear the brunt of our developmental blunders (Dodman et al., 2018; Douglas et al., 2008). Sustainability discourse and practice has been critiqued from many angles, most notably from within the broader environmental and movements which have argued that the sustainability paradigm has not gone far enough to address the underlying epistemological flaws on which the global development agenda is based (Bernstein, 2000; Dobson, 2003; Pieterse, Edgar & Parnell, 2010). Some have argued that dominant Sustainable Development policy frameworks 'are the compromise of liberal environmentalism' (Bernstein, 2000) which maintain the status quo of untenable global supply chains and international development patterns. These promote unsustainable levels of consumption (Rose, 2022), and maintain unequal distributions of power and resources (Raworth, 2017). Significant complexity exists between these often interwoven and overlapping systems (Batty, 2008; Baynes, 2009; Bettencourt, 2013; Mele, Pels, & Polese, 2010; Waddock, 2013) resulting in 'wicked problems' which have no clear solution.

Consequently, there is increasing recognition that a systemic view is needed if we are to make tangible changes that will impact significantly on our developmental and climate crises (Von Bertalanffy, 1972). Disciplines ranging from ecology (Mele et al., 2010), resource management (Bellamy, Walker, McDonald, & Syme, 2001; Checkland, 1995), urban planning (Ernston et al., 2010; Lützkendorf & Balouktsi, 2017; McGranahan & Satterthwaite, 2014; Rauws, 2017; Roo, 2016) and economics (Biles, 2009; Gómez, Chawla, & Fransen, 2020; Laska, 1990; Raworth, 2017; Rose, 2022; Singh, Madhavan, Arvind, & Bazaz, 2021) have increasingly recognized experimentation, learning and adaptability as core pillars of their theoretical character and adopted complementary concepts related to systemic disequilibrium, flux, emergence, and resilience. These have gained theoretical momentum. This has had a significant impact on urban development theory as new insights have signalled a shift from conceptions of results oriented 'stable conservation' approaches to a transformative evolutionary perspective that tends to be process oriented (Tzioutziou & Xenidis, 2021).

This departure from traditional sustainability science fundamentally reframes how equilibrium and change is understood in planning theory. Urban resilience is now a central concept in contemporary planning literature. It is conceptualized as a critical emergent feature of complex socio-ecological and socio-technical systems, across temporal and spatial scales, when they are exposed to stresses or shocks, and which resist, absorb or transform in response to external interferences to maintain their core structure and critical functioning (Adhern, 2011; Cao, Lovell, Colenbrander, Wilkinson, & Pettinotti, 2021; Khatibi et al., 2021; Meerow, Newell, & Stults, 2016; Shi et al., 2021; Tyler & Moench, 2012; Tzioutziou & Xenidis, 2021). The term underscores that change, disturbance and uncertainty are fundamental characteristics of the systems on which we depend, and require flexibility, learning and adaptability (Adhern, 2011; Cao et al., 2021; IPCC, 2022; Meerow et al., 2016; Musacchio & Wu, 2002; Pickett, Cadenasso, & Grove, 2004; Ribeiro & Goncalves, 2019; Tyler & Moench, 2012; Tzioutziou & Xenidis, 2021). Conventionally, urban systems functioned and were designed on notions of permanence and control, a stable climate, and slower-paced socio-economic change. The inflexibility and lack of responsiveness resulting from this has contributed to vulnerable and mismanaged urban environments (Tzioutziou & Xenidis, 2021).

A great deal of urban resilience literature focuses on tracing and unpacking vulnerability (Dodman et al., 2018; Douglas et al., 2008; Ford et al., 2018; Kyprianou, Carlucci, & Serghides, 2022; Pieterse, E., 2022; Seebaß, 2017; UN-Habitat, 2020). Vulnerability is most often conceptualised as the inverse of resilience, and is understood in relation to particular hazards, which are the potential occurrence of events that may cause loss of life, negative health impacts, or damage to property (IPCC, 2022) and which is measured by the total risk of the levels of exposure and sensitivity of those impacted against their adaptive capacity (Tyler & Moench, 2012), as illustrated below:

[Vulnerability = (sensitivity to impacts) + (exposure to hazards) = risk + adaptive capacity = Resilience]

Exposure relates to the presence or proximity of people to risk, whereas sensitivity is the susceptibility to being adversely affected (IPCC, 2022). Vulnerability, therefore, can be understood as when a system does not have the capacity to ‘engage’ latent resilience mechanisms to withstand and rebound from the risks of incoming shocks (short-term), and stressors (long-term). Adaptation is the process of adjustment to moderate harm or the taking advantage of opportunities and, “plays a key role in reducing exposure and vulnerability to climate change” (IPCC, 2022: 7). These processes can be anticipatory, reactive, incremental and/or transformational and are subject to hard and soft limits (IPCC, 2022). Resilience therefore, is the capacity of a system to cope with hazardous disturbances by reorganising in a way that maintains essential functions, “while also maintaining the capacity for adaptation, learning and transformation” (IPCC, 2022: 7).

The notion of the Resilient City is premised on the conception of the city as a ‘risk society’, capable of withstanding or rebounding from risks (Coaffee, 2013). These risks may emanate from multiple sources including natural disasters, human disasters, the economy, the environment, safety, transportation and social processes (Shi et al., 2021). Contemporary approaches to measuring resilience rely on a process of prediction modelling to assess vulnerabilities and adjust policies, practices, and plans (Tyler & Moench, 2012). However, these risks are expected to become increasingly variable, with potential unprecedented and localised effects that will be difficult to model (Tyler & Moench, 2012) and therefore to adequately prepare for, and furthermore often overlook long term processes that promote health and wellbeing (Thibodeaux, 2021). This approach has been criticised for the inability

to cope with unexpected shocks, to identify indirect effects and institutional weaknesses, or to fully recognize the significance of learning and governance in adaptive management (Tyler & Moench, 2012). It has been suggested that these indirect, complex, and unpredictable stresses may be ignored if climate adaptation plans continue to focus on addressing vulnerabilities and that a more strategic focus would be to build *adaptive capacities* across urban systems – including the physical and social infrastructures (both of which should have the ability to adapt strategically by reorganizing and recovering in the face of unexpected disturbances) in order to increase overall urban resilience and transition to a state more capable of maintaining systems function in the face of these compounding challenges (Adhern, 2011; Owen, 2020; Shi et al., 2021; Tyler & Moench, 2012).

Resilience, Vulnerability & Inequality

In response to these challenges many characterisations of 'The City' have been developed to capture and steer development actions towards different conceptual paradigms. Examples include notions of the: 'Just'; 'Emergent'; 'Smart'; and 'Resilient' City (Wolfram et al., 2019). It is important to recognize that while each has its own nuances and focus areas, (and often conflicting actor strategies), each notion is goal oriented – a characteristic which has proven invaluable in enabling critical action (David Bach & Henning Meyer, 2022).

However, in cities across the world there remains a shared conceptual framework of neo-liberal governance and development paradigms which immiserate the urban sphere, and is reason to approach each of these models with caution if we are to avoid 'winners and losers' at different scales (Adger, 2000; Leitner, Sheppard, Webber, & Colven, 2018; Wolfram et al., 2019) and make meaningful progress in addressing the existing inequalities and alleviating future burdens for the most marginalized and vulnerable populations (Hatuka et al., 2018). Global urbanization and investment patterns reflect pervasive forms of exclusion and marginalization commonly based on conceptions of *inter alia* class, race, gender, caste, culture, and nationality which further contribute to the vulnerabilities of individuals, communities, and regions (Bankoff & Hilhorst, 2022; Carmody & Owusu, 2016; Watson, 2009). In cities around the world marginalized communities are subjected to discriminatory and exclusionary systems of urban planning which peripheralize and expose them to hazardous and undesirable environments with significant negative effects (Dodman et al., 2018; Douglas et al., 2008; Fainstein, S., 2014; Freire, Lall, & Leipziger, 2015; IPCC, 2022; Oldfield, 2014; Pieterse, E., 2022; Siddiqi, 2022; Watson, 2009). Vulnerable groups are often excluded from decision making processes and budget allocations. In this way vulnerability can be seen as an effect of further marginalization and neglect, perpetuated by the dynamics of powerful investment practices (Siddiqi, 2022). In such contexts of deprivation, survival tactics prevail and remarkable resilience in the face of significant change - albeit sometimes negatively – can perpetuate systems of exploitation where the vulnerable are preyed upon. Therefore, taking an urban resilience systems approach in this context of significant complexity and multiple coalescing risk factors is a particularly useful characterisation of urban functioning as it encourages a systematic understanding of disparity in urban experiences and recognizes that urgent action is needed at varying levels to increase a system's ability to transform.

Climate Change Impacts on Urban Systems

We are running out of time to make the necessary adjustments to keep global warming below the critical threshold of 1.5° to limit potential impacts (IPCC, 2022). Critical challenges exist in the context of rapid urbanization and climate uncertainty which compound systemic vulnerabilities and may paralyse action in climate adaptation and mitigation planning. Climate change related stresses on urban systems are likely to be indirect, incremental, or both, producing stresses that may originate in remote areas interlinked by vast infrastructural systems - indicating that while some stresses may be predictable - many will remain unforeseen (Tyler & Moench, 2012). As cities continue to grow and become increasingly complex their vulnerability is likely to increase proportionally (Ribeiro & Goncalves, 2019). Climate change impacts and continued rapid unplanned urbanization trends are highly likely to increase, replicate, and entrench these existing vulnerabilities if explicit mechanisms to address these inequities are not systematically integrated into urban resilience strategies (Fainstein, Susan S., 2014; Swilling & Annecke, 2012). Climate Resilient Development can advance the Sustainable Development Goals with an increased emphasis on building adaptation and mitigation measures - and their enabling mechanisms - into systems designed for the required transitions (IPCC, 2022). These pathways recognise questions of equity and focus on the interface of human activity with ecosystems at all scales (IPCC, 2022). Resiliency in urban development requires a re-conceptualization of development goals and patterns, away from a fixation on stable hierarchies established over the course of preceding centuries towards a more flexible and interconnected system predicated on mutual enhancement and learning of all sections of society.

Complexity in Urban systems

Approaches that account for a high degree of complexity and uncertainty are needed to tangibly increase urban resilience and address systemic vulnerabilities by strengthening the latent capacity of urban systems to endure and develop as needed to overcome compounding risks. Because “Cities are inherently complex as they aggregate a multiplicity of systems that function on the basis of internal system logics as well as rationalities that arise from their interdependency with other systems” (Pieterse, E., 2022: 115), urban systems comprise of a overlapping systems which interact across multiple scales, sectors, localities and communities. Resilience literature now views urban systems as open systems displaying typical complex adaptive system features including emergence through self-organization, open but distinct boundaries, having complex components, non-liner dynamics, adaptability through dynamic interactions, and exhibiting sensitivity to initial conditions (Han, Ruan, Wang, & Zhou, 2021; Shi et al., 2021). The capacity for resilience in urban systems is built through physical and social infrastructures, both of which should have the ability to adapt strategically to unexpected changes or disturbances by reorganizing and recovering themselves in the face of disturbances (Adhern, 2011). Resilience within these systems can be achieved in multiple ways, through the combination of strategies at different levels in a system according to circumstance, making it appropriate to focus on strengthening specific facets of a system to build increasing levels of robustness (Tzioutziou & Xenidis, 2021). As recognition of these system dynamics have grown, and climate change impacts become increasingly tangibl,e climate resilient development has become a key strategy for achieving sustainable development (Shi et al., 2021) and is being incorporated into local government policies internationally.

2.2 Adaptive Capacities in Multi-Level Governance

Adaptive Capacity

This research has been informed by conceptual frameworks drawn from resilience literature to situate adaptive capacity as a crucial part of the adaptation strategies necessary to absorb and transform in response to challenges posed by risks. As biophysical and social drivers present risks and opportunities within the urban sphere, it is increasingly urgent to understand whether systems are able to adapt and foster actions that improve the abilities of a given system to manage change (Whitney et al., 2017). The notion of capacity is used to convey a specific understanding of context in socio-ecological resilience and is strongly related to the notion of adaptation (Tzioutziou & Xenidis, 2021).

Adaptive capacity is defined as the latent ability of systems to adjust, take advantage of, or to respond proactively or positively to the consequences of stressors or opportunities (Whitney et al., 2017). Adhern advocates that a culture of innovation, monitoring and assessment that reconceives the processes of urbanization as sustainable and resilient is critical to counterbalance the risks produced by exposure and sensitivity to hazards (Adhern, 2011). This requires learning which is a critical element to adaptation and change (Whitney et al., 2017). Adaptive capacity assessments have generally focused within a given time frame, centred around either ecological ecosystem responses or on social aspects of governance, agency, socio-political and economic contexts, or social capital, all of which are measured through quantitative measures that summarize capacity or qualitative perceptions about the capacity to act (Whitney et al., 2017). A key characteristic of *adaptive capacity* in urban resilience can be understood as the total latent capacity, or ability, to leverage assets, resources, and environments, towards a particular goal. This is argued here to be the component of resilience that informs which adjustments are possible in a particular context based on the capacities and resources that exist across a particular system. This research explores how to achieve climate resilient development in the informal settlement of Mathare across the community system.

In the social sphere adaptive capacity has been defined as the ability of individuals or groups to self-organize, increase knowledge, and produce quality planning, positing necessary characteristics of adaptive capacity to include ***diversity and flexibility***, ***access to assets***, ***learning and knowledge***, and ***governance and institutions*** (Whitney et al., 2017; Wulansari, Abdoellah, Gunawan, & Parikesit, 2022). Community capacity is, "the interaction of human capital, organizational resources, and social capital existing within a given community that can be leveraged to solve collective problems and improve or maintain the well-being of a given community" which may operate through informal social processes and/or organized effort (Chaskin, 2001: 295). According to Chaskin (2001), there are four main *characteristics* of community adaptive capacity including *sense of community* (connectedness); *level of commitment* (perception of existence and willingness to participate); *ability to solve problems* (agency); and *access to resources* (economic, human, physical and political), each with minimum necessary thresholds needed to accomplish certain ends (Chaskin, 2001).

These efforts may be engaged through some combination of the ***individual***, ***organizational***, and ***network*** levels of social agency to enable individuals to contribute through their general availability as well as specific contributions (Chaskin, 2001; Tyler & Moench, 2012). Individuals who come together to speak or act collectively as a 'node' within a broader relational infrastructure can provide individuals and organizations with greater access to

resources, including a social context in which to learn (Adhern, 2011) and inform decision making (Chaskin, 2001). Social agency reflects an agents position and structure within society and it is associated with opportunities for, and constraints to, action. A crucial component of social agency is the existing *levels of agency*, which are the enabling structure for adaptive characteristics to be expressed through the interaction between an ***individual**'s* skills, knowledge, and resources; an ***organization's*** production of goods and services; and the ***networks*** of social structure and social capital (Chaskin, 2001). Social Capital is based on trust, reputation, and reciprocal action, and has both private and public elements (Adger, 2003), and produces collective actions, social networks, and collaborative actions that contribute to overall adaptive capacity - however it is important to note that it does not necessarily translate into gains for individual capacity (Wulansari et al., 2022). Social capital and collective adaptation mechanisms are crucial for vulnerable communities and depend on trust in leadership and planning capacity (Wulansari et al., 2022). The nature of these relationships between groups can be bonding (internal), bridging (between), or linking (across level power) (Claridge, 2018) and at its core, social capital is the amount of trust, reciprocity, and exchange across networks towards collective action (Adger, 2003). Income diversity and flexibility, access to assets, and learning and knowledge have also been identified as particularly significant contributors to the ability of a component to act (Wulansari et al., 2022). More broadly, these networks can be interpreted as the *mechanisms*, or *systems*, through which ***components*** are connected and would therefore include physical and social infrastructures identified in this broader resilience literature. Institutions should support, or enable, these relationships by creating the underlying context necessary for reliable systems through which individuals develop and build their capacities (Tyler & Moench, 2012).

A key aspect of connection, learning, and social networks today includes critical digital infrastructure and ICT (Tyler & Moench, 2012), and contribute significantly to reconfiguring urban systems as dynamic, continuous and inevitable processes (Egerer et al., 2021). Systems thinking (Luhmann, 1995; Von Bertalanffy, 1972) and complexity science (Baynes, 2009; Roo, 2016) provide a foundational concept and a shared operational framework for resilience literature to incorporate smart technologies as a 'design requirement' of resilience theory (Tzioutziou & Xenidis, 2021). Complexity, sustainability, learning, and technology are notions most frequently associated with resilience according to Tzioutzio & Xenidis (2021) who argue that the integration of resilient and smart city concepts at the operationalization level would enhance the overall performance of urban system resilience in the face of complexity. They argue that the frameworks are complementary due to the prominence of uncertainty and multilevel, multi-scalar interdependencies and the fundamental conceptualizations that surround emergence, and therefore that leveraging technological tools would enhance *efficiency*, *flexibility*, interoperability and the *capacity for learning*, and thus adaptability, across urban systems (Tzioutziou & Xenidis, 2021). Learning, a core aspect of resilience, would be enhanced through the deployment of technologies that enable increased efficiencies in *self organization* and innovation across a range of mechanisms, for example *monitoring and evaluation*, *participatory governance*, and early warning systems (Tzioutziou & Xenidis, 2021). Technology increases the complexity and vulnerability of a system but is regarded as such a significant enabling mechanism in multiple areas (coupled with the fact that it is already employed in multiple areas) that it is nevertheless critical to include this in consideration of resilience mechanisms. Smart technology, 'promotes interaction between a network and its operators' (Tzioutziou & Xenidis, 2021), and in the urban realm could facilitate individual, community, institutional, or multilevel innovations.

These strategies are supported by theories of proximity which hold that in order for learning and innovation to take place elements must be able to interact across a combination of five types of proximity. These are identified as: cognitive, organizational, social, institutional, and geographical (Boschma, 2005). In essence, the author argues that the productive transfer of knowledge depends on a foundational level of 'absorptive capacity' which is created in part, by the arrangement and degree of these proximities to stimulate learning while avoiding the negative aspects of proximity, namely 'embeddedness' or 'lock-in' (Boschma, 2005). Therefore, it could be argued that the key aspects of adaptive capacity and resilience outlined above are subject to the relationships of proximity that exist in a particular context.

Community strategies and actions take place within a broader framework of urban resilience, which we have so far understood as an emergent property embedded within a complex set of interactions and interdependencies across the urban sphere. Chaskin (2001), argues that community capacity is critical to build understanding and social change, and that it needs to have specific aims, and means, which are embedded in contextual understanding and combined with strategies at other levels of action (Chaskin, 2001). Societal adaptation is a highly complex and dynamic process where deep transformations of the cultures, structures, and practices across urban systems are required to meet the adaptation challenges that climate change demands (Wolfram et al., 2019) and will largely be determined by the limitations and capacities of various ***agents***, ***networks*** and ***institutions*** to act collectively (Adger, 2003). These strategic actions interact across multiple levels of governance to galvanise change, which provides insight into the fluid and nested nature of adaptation actions within the context of resilience planning. Tyler & Moench, (2012) identify three critical components for resilience planning: ***systems***, ***agents***, and ***institutions*** which together outline a pragmatic conceptual framework that emphasises the interwoven *relationality and interdependency* of systems across urban sphere by qualifying the characteristics that are needed to increase overall resilience. The authors state that, 'Resilience is high where robust and flexible systems can be accessed by high-capacity agents and where that access is enabled by supportive institutions' (Tyler & Moench, 2012: 318).

Components of Community Resilience

[Breakdown Theoretical Organizational Structure of Resilience]

These theoretical frameworks for resilience share significant commonality which would benefit from integration. Thus, each of the components of community resilience below are outlined in detail using aspects of the above theory and are integral to the methodology employed in this study.

Component 1 | High-Capacity Agents

Individual (agent)(solo)(subsystem)(micro)

Definition

Agents are the individual and social organizational actors that are equipped with capacities for learning and innovation thereby contributing significantly to disaster risk reduction and overall resilience (Chaskin, 2001). An agent's ability to act is facilitated by adequate resources and access to supporting systems, including the ability to access resources

provided by other agents (Adger, 2003; Tyler & Moench, 2012; Whitney et al., 2017). Agents exist in a continuous feedback loop in their interactions with the multiple systems and institutions that exist in the urban realm. The capacities of independent functions within each *component* or *level of agency* may be performed or manifest differently at different moments of time in ways that benefit the entire system. Therefore, the entire system benefits when the base capacity of each node is at its strongest and subsequently the aim of all components involve strategies to increase individual agent capacity for Responsiveness, Resourcefulness, Independence and Capacity to Learn (Boschma, 2005; Chaskin, 2001; Ribeiro & Goncalves, 2019; Tyler & Moench, 2012; Whitney et al., 2017; Wolfram et al., 2019).

Component 2 | Robust Networks

Community Providers (network)(collective)(system)(meso)

Definition

Systems refer to the social and physical infrastructures and ecosystems that connect multiple scales to enable patterns of provisioning and exchange (Barrière et al., 2019; McDaniels, Chang, Cole, Mikawoz, & Longstaff, 2008; Roo, 2016; Swilling & Annecke, 2012; Tyler & Moench, 2012; Tzioutziou & Xenidis, 2021; Wulansari et al., 2022). These critical systems cater to supply water and food (and the ecosystems that support these), energy, transport, shelter, and communications and are interlinked which can lead to cascading failures if chains are interrupted (Tyler & Moench, 2012). Tyler & Moench describe five key strategies to counterbalance this risk four of which are relevant to systems, and one of which will be discussed as part of component 3. *'Multifunctionality'* is achieved by combining functions for improved spatial and economic efficiency across the system and *'Diversity'* by overlapping the ability of one component to store different forms of knowledge. Diversity is attained when multiple sources, and kinds, of knowledge are present and contribute to providing a more complex response to change; '*Redundancy and Modularization'* is attained when multiple components do, or can, provide the same function, spreading risk through a decentralized system that can be isolated in areas if need be (due to failure or maintenance for example).; *Multi-scale networks and connectivity* is a critical parameter to support functioning across scales, in both the physical and social infrastructures, and is the primary generator of sustainable urban form (Adhern, 2011)

These characteristics contribute to resilient systems which support agents and institutions by providing robust connections (Tyler & Moench, 2012).

Component 3 | Supportive Institutions

Gov & NGOs (institutional)(hyper-system)(macro)

Definition

Institutions, both informal and formal, legitimize experiences of inclusivity or marginalization within society as custodians of an individual's 'entitlements' to resources and services which may be facilitated, enabled, supported, or constrained (Pahl-Wostle, 2009). Institutions link agents and systems through formal instruments including policies, plans and governance mechanisms as well as the informal conventions that structure human

behaviour and norms of exchange, such as pricing structures, markets for communication, transport, and remittances (Adger, 2003; Rodima-Taylor, Olwig, & Chhetri, 2012). In this way, institutions condition how agents and systems respond to pressures and risks - such as those associated with climate change and urbanization. Inclusive governance, public information, and institutions that foster learning and change are critical for building *agent capacity*, as institutional norms and legislation can act as barriers to innovative practices (Tyler & Moench, 2012). *Adaptive Planning and Design* (Tyler & Moench, 2012), recognizes that uncertainty and imperfect knowledge implies that solutions may fail, and therefore that innovation and experimentation is critical in order to learn. These concepts form the basis of 'adaptive planning', which promotes innovation through 'responsible experimentation, developing a culture of monitoring, and learning from modest failures' (Adhern, 2011: 342). These strategies form the basis on which institutions can provide support for agents to access systems needed to increase resilience.

Community resilience therefore is the interwoven *relationality and interdependency* of systems across the urban sphere qualifying the characteristics of three critical components that are needed to increase overall resilience. The aim is to increase the adaptive capacity of the community so that the changes that are needed to mitigate risk and adapt to changing circumstances can be made – ultimately transitioning from a state of vulnerability and deprivation to a more robust network capable of pursuing the sustainable development goals and increasing the overall quality of life in the urban environment.

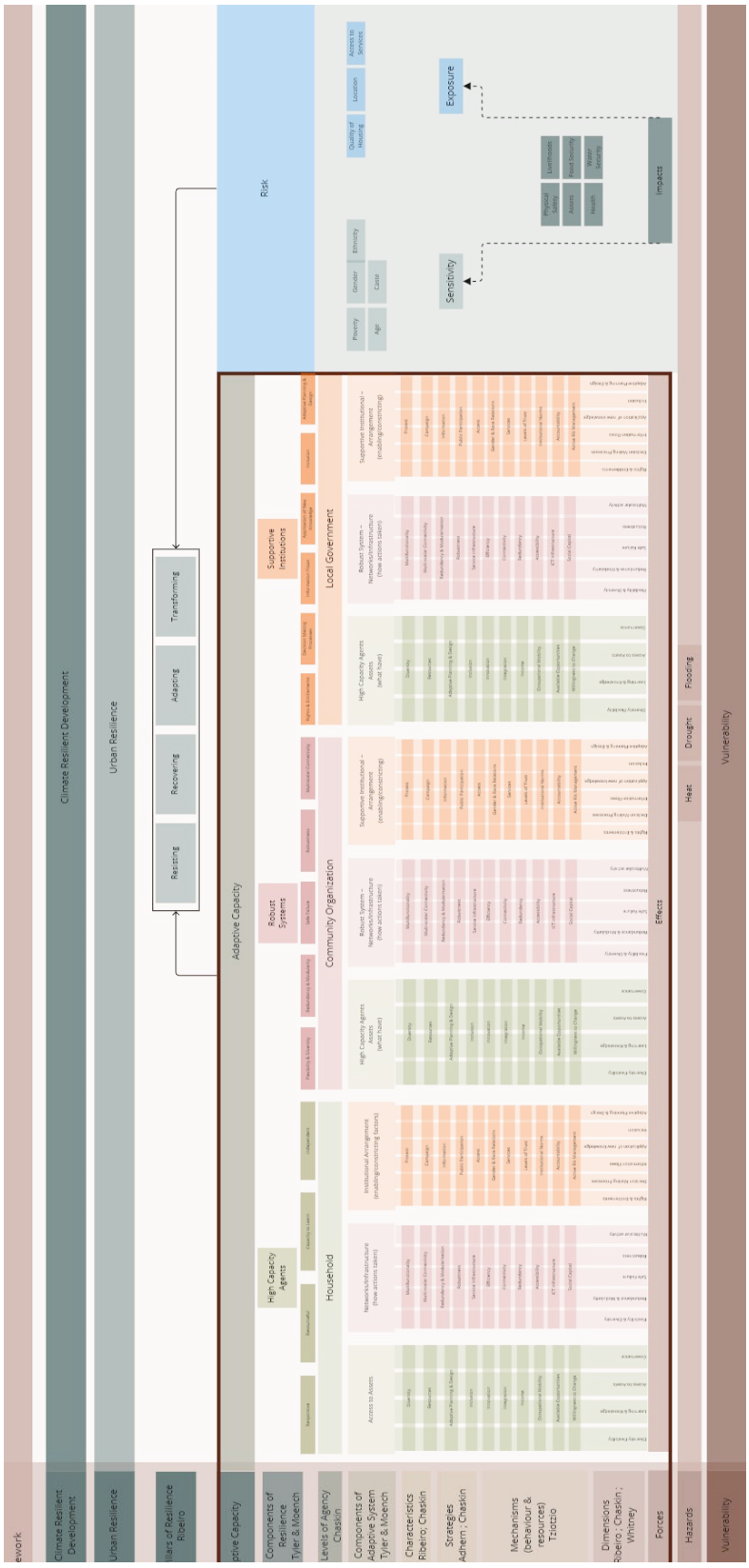

Figure 4: This diagram illustrates the urban resilience and adaptation literature in which this research is situated.

It is adapted from Adhern, 2011; Ribeiro & Goncalves, 2019; Tyler & Moench, 2012; Tzioutziou & Xenidis, 2021; Wulansari et al., 2022. The area outlined in red (Adaptive Capacity) is the focus area of this study, however, the theoretical setting is critical to frame what the capacity for adaptation is being measured against.

2.3. Transitions to Resilient Multi-level Governance System as Complex Adaptive Systems

Multilevel Network Governance & Complex Adaptive Systems

Transitioning towards climate resilient development will require integrated system change across multiple sectors at multiple levels. The scale of this task implies that urban systems will need to learn how to self-regulate in order to build the capacities required to respond to local conditions and support sustainable and resilient urbanization (Ribeiro & Goncalves, 2019) moving beyond short-term coping mechanisms to interrelated long-term adaptation strategies (Yang & Andriesse, 2021).

The rich urban resilience research has created a basis for in depth qualitative and quantitative methods to develop and assess these strategies. However, due to the fine-grained coupling of systems and subsystems, it is difficult for these existing evaluation methods to capture the complexity of urban systems (Shi et al., 2021). Therefore, contemporary assessment methods of urban resilience draw on complexity theory to evaluate resilience from a complex adaptive systems perspective to further our understanding of the functioning of urban systems, and to develop ever more effective assessment methods (Han et al., 2021; Shi et al., 2021).

Complex Adaptive Systems (CAS) theory and resilience literature share their roots in Complex Systems Theory which conceptualises capacity as relational and contingent on the context and systems in which the element of analysis is embedded (Befani, 2013). CAS are composed of networked nonlinear interacting elements which can comprise sub-systems capable of adapting behaviours to their environments, while depending on mutual co-operation (Shi et al., 2021). Han et al. (2021) define six properties of CAS which are argued to be relevant to an analysis of urban systems: Emergence through "self-organization"; open but distinct boundaries; complex components; non-linear dynamics; adaptability through dynamic interactions; and sensitivity to initial conditions. Each component of community resilience described in the section above have their own unique characteristics and functions which are all highly interdependent in supporting mutual development, and therefore can be understood as a complex adaptive system.

Dominant established development models have resulted in strong path dependencies, suggesting that strategies developed to respond to adaptation and mitigation may reinforce these systems, rather than transforming them (Leitner et al., 2018; Wolfram et al., 2019). The challenge facing institutions in a resilience framework is their ability to learn. Governance systems increasingly incorporate contemporary understandings of resilience and adaptive planning in interactions inclusive of a wide range of critical urban stakeholders and multi-level network governance processes of learning, policymaking, and implementation needed (Egerer et al., 2021; Wolfram et al., 2019). Strategies for adaptation requires a proactive approach that acknowledges and incorporates these interrelations (Egerer et al., 2021).

'Management' of complex adaptive systems is therefore comprised of dynamic interactions of individual behaviours which are conditioned by institutions and enabled by networks. At the community scale the processes within this CAS system of decision making and action planning can be described by Community Resilience Initiatives and Adaptive Co-Management Theory. Both these models recognize that a critical enabling mechanism for action is the underlying capacity for interaction between the agents, networks, and

institutional components within a particular context. Community Resilience Initiatives (CRI) are a temporary expression of a resilient community that is able to galvanise critical resources by following different pathways determined by key contextual vulnerabilities, forms of social capital, and the broader governance landscape which together impact the emergence of CRI's (Fransen, Peralta, Vanelli, Edelenbos, & Olvera, 2022). Fransen et al. highlight that CRI's are typically situated in vulnerable and hard to reach urban communities and are a 'hybrid form of participation, engaged in both service and civic activities (Fransen et al., 2022: 435). Adaptive co-management theory (Fabricius & Currie, 2015) outlines four core elements which are critical to the process of ongoing and inclusive management: an enabling environment; learning through experimentation; collaboration between diverse stakeholders; and iteration. It is particularly useful in contexts of significant complexity where no single agency or governing system alone will work (Fabricius & Currie, 2015). The ability to participate and manifest change therefore takes place within an ecosystem of constraining and enabling factors. To capture the potential for transition, or to measure adaptive capacity in one moment, requires framing how strategies/pathways are created from the interrelated actions of individuals performing functions at different levels.

Resilience literature outlines three types of response for system functions when exposed to disturbances including: (a) when critical functions persist and bounce-back; (b) when functions transition between states to absorb change; or (c) transformation into a new state of dynamic adaptation (McDaniels et al., 2008). The level of adaptive capacity within the system determines the system response, and is mediated by decision or developments regarding adaptation and mitigation efforts illustrated below:

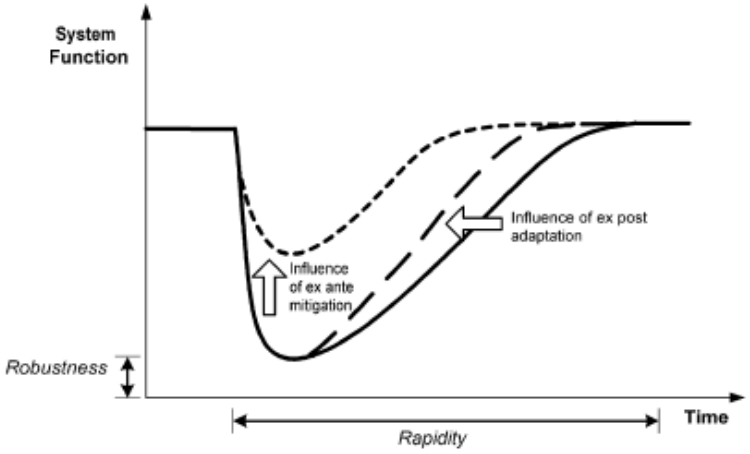

Figure 5: Effects of decision making on resilience (McDaniels et al., 2008)

This diagram illustrates the effects of a complex set of mediated interactions that take place within a system to produce particular and measurable effects through time. The impact of the disturbance is mediated by the robustness of system functions and is measured by the length of time to recover, as well as to the level of functioning to which the system returns. If adaptive capacity is high, then the time taken to return to a state of equilibrium is reduced.

2.4 Theoretical Framework

Contemporary Climate Resilience literature integrates aspects of the latest climate science as well as development theory to guide urbanization transitions towards sustainable

development (Allam, Jones, & Thondoo, 2020; Arsel, 2022; Bankoff & Hilhorst, 2022; Berrang-Ford et al., 2021; Broadhurst & Gray, 2022; Cao et al., 2021; Shi et al., 2021; Singh et al., 2021; Thibodeaux, 2021). Cities have a crucial role to play in meeting this challenge by fostering increasingly resilient networked communities capable of withstanding potentially numerous and dynamic shocks and stresses.

In this theoretical framework Community Resilience is comprised of three critical components identified by Tyler & Moench, (2012): *systems*, *agents*, and *institutions where* agents are understood as individuals; systems as networks; and institutions as organizations each with particular characteristics, strategies and defining mechanisms. These elements align with the frameworks developed by authors who have operationalized aspects of resilience and adaptive capacity using similar constructs and are integrated here to capture multiple dimensions of adaptive capacity and resilience. They include: Chaskins' (2001) relational operationalization model; Ribiero & Gonzalves' (2019) conceptual framework for urban resilience; Adherns' (2011) strategies for building urban resilience capacity; Tzioutzios'(Tzioutziou & Xenidis, 2021) integrated framework of smart city and resilience concepts; the assessment framework of Whitney et.al. (2017) for adaptive capacity; and Adgers' fundamental concepts of social agency, collective action, and adaptation to climate change.

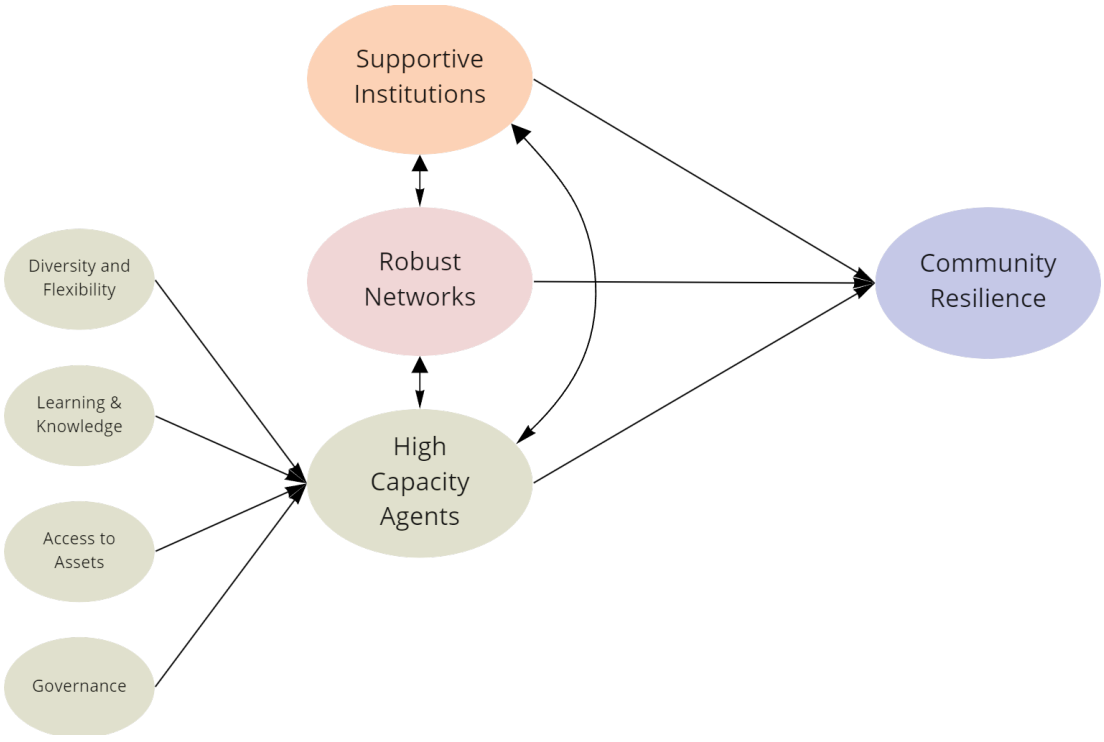

Figure 6: Theoretical Framework

The theoretical framework on which this research is premised combines theoretical frameworks to assess community resilience as an indirect dependent variable which is comprised of the interaction between three critical components – high-capacity agents, robust networks, and supportive institutions. The level of agent capacity in the community system is critical and dependent on four variables, as well as the degree of interaction between each of the three resilience components, to facilitate increases in adaptive capacities. In other words, there is a feedback loop between the community resilience system components and variable indicators, as they are stimulated by the effectiveness of the components relationships (community resilience), while simultaneously affecting the effectiveness of that relationship. Therefore, the adaptive capacity of the Agent Component is directly measurable through four associated variables drawn from literature: *Diversity & Flexibility*, *Learning and Knowledge*, *Access to Assets*, and *Governance*, which are further broken down into quantifiable sub-variables which are also drawn from the literature. The remaining two components are more complex constructs to measure and will require in-depth exploration to determine the level of functioning as well as the internal relationships which impact functioning.

Drainage channel outflow consisting of stormwater, sewage, and grey water running underneath and between homes next to the river in Mathare 3C

Photograph 3: Authors Own Image

Photograph 3: Urban Drainage System

Chapter 3: Research Design and Methods

3.1. Research Objective and Strategy

The research objective is to answer all the research questions stated in Section 1.4 through empirical and deductive mixed methods research in the case study area. This will comprise primary data collection and analysis methods designed to explore, describe, and test the theoretical framework outlined in Section 1.3. through an in-depth case study of the community in Mathare Valley. The mixed-method research strategy to achieve these objectives encompasses:

1. A comprehensive survey conducted at household level using a closed ended questionnaire to capture the individual (agent) adaptive capacity and interaction with other components to evaluate the role of the *High-Capacity Agents* in the CAS. Statistical analysis will explore the relationships across variable and sub variable levels.
2. In-depth interviews with members of relevant organizations (qualitative) at community and institutional level to capture the collective attitudes and roles of the *Robust Networks* and *Supportive Institutions* components in the CAS.
3. Content analysis of interviews and statistical outcomes to develop an integrated analysis of the relationships between each component as part of a CAS.

The research program (A.1.1) was supported through a partnership with *Ghetto Foundation* and the *International Centre for Frugal Innovation* (ICFI) in Africa – two research organizations in Nairobi. The first is an organization of community researchers who are Mathare residents. ICFI is an academic research consultancy which supports development research internationally across multiple domains.

3.2. Operationalization and Tabulation

Using the frameworks and literature outlined above a comprehensive set of indicators has been identified to capture each variable, and sub-variable used to assess each component (Adhern, 2011; Chaskin, 2001; Ribeiro & Goncalves, 2019; Tyler & Moench, 2012; Tzioutziou & Xenidis, 2021; Whitney et al., 2017; Wulansari et al., 2022). Control variables included *gender, age, area (village), distance from river, and religion* as external factors which may influence research results and are therefore important to capture. Independent variables include *Diversity & Flexibility, Learning & Knowledge, Access to Assets,* and *Governance,* each with associated characteristics as sub-variables. Dependent variables include components *High-Capacity Agents*, *Robust Networks*, and *Supportive Institutions* and associated characteristics as sub-variables.

Although *"Multifunctionality"* is outlined in the literature as a variable of a network's robustness, it has been excluded as part of this analysis. The reason for this is that in the social context its shares a very similar meaning to *"Redundancy and Modularity*" and would therefore run the risk of double counting. Community networks are dissimilar to the more technical components in that if a community network is redundant, it is because its modularity and multipurpose nature is fulfilling multiple functions within a system.

The independent variables focus on what is the current state of capacity measured through variables which define a situation. Dependent variables measure the engagement with activities that increase resilience through building agent capacity, engaging robust networks, or sharing in supportive institutions. Therefore, the indicators for variables have been adapted for quantitative and qualitative methods due to the nature of the methodological needs as are outlined in detail under their respective sections A.3.3.1 and A.3.3.2. The table below shows the generic operationalization table that both methods share up to the variable and sub variable level:

Table 1 : Operationalization Table

Control	Independent	Source	Dependent	Source
Gender	**Diversity & Flexibility**		**High-Capacity Agents**	
Age	Livelihood and Income Diversity	Whitney (2017) & Chaskin (2001)	Responsiveness	Tyler (2012)
Area	Economic Opportunities	Whitney (2017)	Resourcefulness	Tyler (2012)
Location from River	Level of Dependence on Natural Resources	Whitney (2017)	Capacity to Learn	Tyler (2012)
Religion	Occupational Mobility	Whitney (2017)	Independence	Adhern (2010) & Ribiero (2019)
	Place Attachment	Whitney (2017)		
	Migration Patterns	Whitney (2017)		
	Willingness to Change	Whitney (2017)		
	Learning and Knowledge		**Robust Networks**	
	Resource Monitoring & Feedback Mechanisms	Whitney (2017) & Chaskin (2001)	Flexibility & Diversity	Tyler (2012)
	Knowledge of Disturbance	Whitney (2017)	Redundance & Modularity	Tyler (2012)
	Perceptions of Risk & ability to anticipate change	Whitney (2017)	Safe Failure	Tyler (2012)
	Diversity of Knowledge and information sources	Whitney (2017)	Robustness	Ribiero (2019)
	Recognition of Causality and Human Agency	Whitney (2017) & Chaskin (2001)		
	Intergenerational learning capacity	Whitney (2017)		
	Access to Assets		**Supportive Institutions**	
	Household Material Assets	Whitney (2017)	Rights & Entitlements	Tyler (2012)
	Levels of Education & Training	Whitney (2017)	Decision Making Processes	Tyler (2012)
	Financial Status & Access to sources of credit	Whitney (2017)	Information Flows	Tyler (2012)
	Access to Markets	Whitney (2017)	Application of New Knowledge	Tyler (2012)
	Social Capital & Institutional Support	Whitney (2017)	Inclusion	Ribiero (2019)
	Natural Capital	Whitney (2017)	Adaptive Planning & Design	Adhern (2010)
	Governance			
	Levels of Trust, Networks	Whitney (2017) & Chaskin (2001)		
	Gender & Race Relations	Whitney (2017)		
	Levels of Participation & quality decision making	Whitney (2017)		
	Planning Capacity	Whitney (2017)		
	Presence of local Environmental Institutions & Social Norms	Whitney (2017)		
	Quality of Governance and Leadership in environmental policies and agencies	Whitney (2017)		
	Accountability of managers and governance bodies	Whitney (2017)		
	Active Risk Management and Adaptive Governance Processes	Whitney (2017)		

3.3. Household Survey | Quantitative Research

This section will outline the research design for the household survey, including a brief description and explanation of methods utilized in determining sample size and selection, and collection methods as well as providing the detailed operationalization used to determine survey contents. Annex 1 contains the research instruments used for this section.

Component 1 is explored primarily through Household surveys, which are a quantitative measure. Therefore, the objective of the survey is to measure the adaptive capacity, and resilience activities being engaged in at the household level. The specified indicators have been drawn from the literature and in accordance with the operationalization above.

3.3.1. Sample Size and Selection

The required sample size was calculated using the following formula (Hsieh, Bloch, & Larsen, 1998):

$$\text{Finite population: } n' = \frac{n}{1+\frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

Where:
z is the z score = 1.95
ε is the margin of error = 0.05
N is the population size = 700 000
$\hat{p}$ is the population proportion = 0.1

A population proportion of 10% was used due to the specificity of respondents, limited to households living either along the river or along significant drainage paths within the settlement, as they would be most affected by flooding. Therefore, sample size was calculated to be 139.

3.3.2. Collection Methods

Responses were be collected from household surveys collected door-to-door every 10 or so houses along the stretch of the river throughout Mathare and at random points where drainage runoff routes were prominent. The survey comprised of 140 close ended questions with Likert-scale answers from 1-4 to acquire more heavily weighted answers.

The collection method was digital, using a software application administered on cell phones by four community researchers. Due to the illicit nature of many income generating activities operating in the settlement - particularly along the river, it was decided that to avoid bias, and potential conflict, the survey team would be comprised of trained community research members only.

The questionnaire was piloted prior to circulation with a small group of Mathare residents, and community researchers, to test the relevancy of questions, their language, coherence, sensitivity, and overall accessibility. In this process a few adjustments were made to the language and structure of the questionnaire, as well as to the scope of questions included - which will be elaborated on in Section 3.7.1.1. Detailed operationalization tables can be found for independent (A.3.3.1) and dependent (A.3.3.2) variables.

3.3.3 Quantitative Analysis Methods

This component is measured quantitatively and therefore provides a baseline measure of household adaptive capacity and participation in resilience activities as per sub-question 1. Both regression and multivariate modelling have been employed in this study to account for different levels of detail. The benefit of SEM is that it allows for concurrent analysis of all indicators and variables, as opposed to consecutive calculations as in regression modelling. However, sample size considerations require simplification of the SEM model, resulting in lost detail at the sub-variable level. Multiple regression modelling is therefore used to capture this detail as well as a confirmatory component for the SEM. The results of the descriptive and inferential statistics using regression and structural equation modelling will be presented to trace relationships of influence and interdependence between components.

3.3.3.1 Regression Analysis

Regression analysis describes the relationship between two variables by determining the strength and direction of the effect of the independent variable on the dependent variable using the following equation (Smith, 2015b):

$$Y_i = \beta_0 + \beta_1 X_i + u_i$$

where:

Y_i = dependent variable
X_i = independent variable
β_0 = regression coefficient
β_1 = slope coefficient
u = error term
$_i$ = the number of predicating variables(x)

This relationship is expressed as the regression of Y_i on X_i, where β_0 and β_1 are estimated using the Ordinary Least Squares (OLS) estimator. Consequently, testing for the assumptions of normal distribution of a random sample with no large outliers are required.

Multiple regression builds on this approach to allow for multiple regressors to be simultaneously calculated to measure the expected change in Y from a one-unit shift in X, keeping all other factors constant. Tests for omitted variable bias and multicollinearity are required. Multiple regression is calculated using the following equation (Smith, 2015a):

$$y = \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + c.$$

where n = number of independent variables

3.3.3.2 Structural Equation Modelling

SEM is a multivariate analysis method that can be used in cross-sectional research to examine the relationships between latent variables (Streiner, 2006). The benefit of this method is that it captures multifaceted concepts which are hard to measure with less random error- as the method weighs contributing indicators more accurately than multiple regressions in their contribution to the true score of a latent variable (NCRM, 2022). The approach represents the regression equations between measured variables as a system of relationships between multiple observed variables.

Measurement Model:

Confirmatory Factor Analysis

Factor Analysis is a mathematical model which explains the correlation between many variables in terms of a smaller number of underlying factors (Mardia, Kent, & Bibby, 1979; Streiner, 2006). It tests the factor model and assumes that the factors are not directly observable and that variables are subject to these factors as well as other random or systematic errors (Mardia et al., 1979). It is well suited to subjects, such as community adaptive capacity and complex adaptive systems where it is not possible to measure variables directly and ambiguity can surround their definition (Mardia et al., 1979) . In SEM, this logic is translated into the measurement model, using true score theory to evaluate the reliability of the model's measure of the construct (Gana & Broc, 2019).

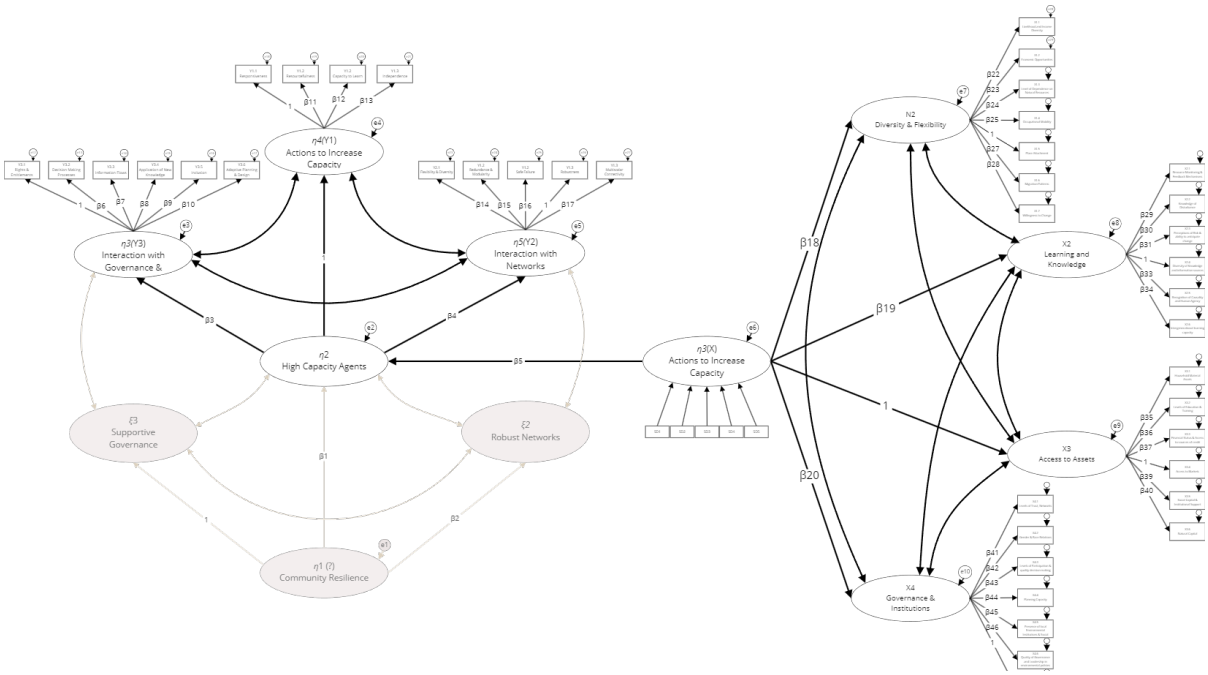

Figure 7: General structural equation model with latent variables

True Score Theory evaluates reliability, or the precision with which the model can measure a construct. Reliability (precision) is reflected by the amplitude of the random errors around the real score; therefore, the reliability of a score increases as the measurement error approaches 0. Validity (accuracy of the measure) results from the absence of systematic errors in the conformity of the data with respect to the construct being measured, and therefore can seriously affect the population mean score and bias the perception. (Gana & Broc, 2019)

3.4 Community & Institutional Interviews | Qualitative Research

This section outlines the research design for qualitative interviews undertaken in Mathare Valley. Community organizations and institutional experts represent a body of respondents which together give insight into the level of functioning of components 1 and 2. Therefore, both perspectives will be analysed in parallel to determine the degree of functioning of each component, as well as the interrelationships between each component and the internal mechanisms between independent and dependent variables. The research design has been applied equally for both groups and will therefore be discussed in this section in tandem.

3.4.1. Sample Size and Selection

Interviews were conducted with representatives of community organizations and institutional experts from different domains working in Mathare. The sample method used was a mixture of purposive methods including maximum variation (Glaser & Strauss, 1967) to capture different perceptions across the community and convenience sampling (Merriam & Tisdell, 2016) for community organizations contacted through the Ghetto Foundation Network. The sample size was determined by a combination of availability restrictions (see section 3.7.3) and information saturation and redundancy. Saturation was determined during the data collection phase limiting the total number of respondents when no new insights were forthcoming (Merriam & Tisdell, 2016).

3.4.2. Collection Methods

Interviews with community organization representatives were held in the Ghetto Foundations Office located in Mathare 3C which is centrally located in Mathare Valley. Institutional expert interviews were predominantly held off site, either virtually or at the offices of the specific organization.

All interviews were semi-structured and recorded to allow the researcher to fully participate as an observer (Merriam & Tisdell, 2016) for flexibility and in-depth conversation to capture nuances as well as specific information relating the variables being measured in the operationalization table (Merriam & Tisdell, 2016). The operationalization table was used to guide the conversations and ensure all variables were discussed. The guide makes provision for a mix of more and less structured questions to stimulate the specific perspective relevant to the interviewee (Merriam & Tisdell, 2016), by engaging in conversation centring on the behaviours, opinions and values, feelings, and background of the subject (Patton, 2015). Although Patton (2015) recommends not using 'Why' questions, as they can lead to 'dead-end' and speculative answers, they were included in in this research to draw out the speculative perceptions which would then be triangulated through analysis (Patton, 2015).

3.4.3. Qualitative Analysis Methods

These components are measured through content analysis of the in-depth interview transcriptions. The results of both components are drawn from interview transcriptions, content coding, weighting, and relationship tracing.

Content analysis followed definitions drawn from theory. Codes have been defined according to the themes in the operationalization table, as in the table below. Interview transcripts were coded with these codes according to the analysis guide which can be found in the annex (A.3.3.4) in order to trace the relationships between the topics without

assigning a value to the contribution. The objectives of this process were twofold: firstly, to accumulate ordered data for further analysis in tandem with quantitative findings; and secondly to draw out relationships across the interviews.

Digital software allows for frequencies, co-occurrence, and significant quotes to be collected and employed in analysis.

Table 2: Content Analysis Codes

Code	Code Group 1	Code Group 2	Code Group 3	Code Group 4	Code Group 5	Code Group 6	Code Group 7
DA_ Capacity to Learn					HCA		
DA_ Independence					HCA		
DA_ Resourcefulness					HCA		
DA_ Responsiveness					HCA		
DG_ Adaptive Planning & Design							SI
DG_ Application of new knowledge							SI
DG_ Decision Making Process							SI
DG_ Inclusion							SI
DG_ Information Flows							SI
DG_ Rights & Entitlements							SI
DN_ Flexibility & Diversity						RN	
DN_ Multiscalar Connectivity						RN	
DN_ Redundance & Modularity						RN	
DN_ Robustness						RN	
DN_ Safe Failure						RN	
I1_Dependance on Natural Resources	1. D&F						
I1_Economic Opportunities	1. D&F						
I1_Livelihood & Income	1. D&F						
I1_Migration Patterns	1. D&F						
I1_Occupational Mobility	1. D&F						
I1_Place Attachment	1. D&F						
I1_Willingness to Change	1. D&F						
I2_Diversity of knowledge sources		2. L&K					
I2_Intergenerational Learning		2. L&K					
I2_Knowledge of Disturbance		2. L&K					
I2_Monitoring & Feedback Mechanism		2. L&K					
I2_Perception of Risk & Change		2. L&K					
I2_Recognition of Human Agency		2. L&K					
I3_Access to Markets			3. AA				
I3_Cultural Memory			3. AA				
I3_Education & Training			3. AA				
I3_Financial Status/Economic Status			3. AA				
I3_Material Assets			3. AA				
I3_Natural Capital			3. AA				
I3_Social Capital & Institutional Support			3. AA	4. G&I			
I4_Accountability of Governance Bodies				4. G&I			
I4_Active Risk Management & Adaptive Governance				4. G&I			
I4_Environmental Institutions & Norms				4. G&I			
I4_Gender/Race Relations				4. G&I			
I4_Level of Participation in Decision Making				4. G&I			
I4_Level of Trust				4. G&I			
I4_Planning Capacity				4. G&I			
I4_Quality of Gov/Leadership in Policy				4. G&I			

3.5. Data Analysis Strategy

The system of relationships under study is composed of multiple variables, which are interconnected and combine in complex ways to contribute to, or undermine, the adaptive capacity of the overall system. This makes it important to present the results of each component separately before conducting an integrated analysis of the results. Therefore, the data analysis strategy traces the research trajectory outlined in the research design and is therefore comprised of two phases:

3.5.1 Phase 1

The first phase presents the results of the quantitative and qualitative analysis. Each analysis method is conducted separately to draw descriptions, measurements and results pertaining to the related component as per the conceptual framework.

3.5.2 Phase 2

The second step is an integrated analysis of the results presented in Phase 1. The relationships between each component and their respective adaptive capacities and resilience activities are explored using the mixed methods data to present an integrated analysis of community resilience as a complex adaptive system. Subsequently this section is where all research questions are answered.

3.6. Validity & Reliability

All research design components have been drafted to meet the requirements for internal and external validity and reliability and are outlined below.

3.6.1. Validity

Validity is composed of two components, internal and external validity, which will be addressed separately.

In this study the theoretical framework and subsequent operationalization of concepts to indicators is based on the academic literature with little to no distortion of the structure of variables, thereby ensuring internal validity (Van Thiel, 2014). Operationalization was subject to peer review from colleagues and experts, and the survey questionnaire was piloted with a small group of Mathare residents and peers prior to circulation.

The sampling methods employed in quantitative and qualitative methods included random and purposive methods as appropriate to ensure maximum depth and breadth of information required to support validity of the analysis.

The Survey sample size of n=139 is not restrictive as the number of respondents meets the threshold for generalization in statistical analysis. The survey and interviews are complementary due to the structure of the framework and operationalization, and therefore the study is generalizable and could be replicated in community contexts to measure adaptive capacity and resilience activities (Van Thiel, 2014).

3.6.2. Reliability

The reliability of the research design outlined above will be discussed in two parts, each focusing on accuracy and consistency respectively, to account for the degree of explanatory and recommendatory power of the results.

Accuracy depends on the degree to which the measured variable is captured correctly and precisely without distortion (Van Thiel, 2014). This requires that all variables are clearly defined (Van Thiel, 2014). All survey questions have been directly translated into straight-forward questions with clear language to maintain the integrity of the indicators ability to measure the associated variable. Interview questions are harder to measure due to the nature of the structure, however the detailed definitions used for the content analysis and

ranking of each variable can be found in A.3.3.4. This guide ensures structured content analysis with a consistent metric applied across all interviews, ensuring accuracy.

Consistency is related to the replicability of the study. It is therefore conceivable that if this survey was to be replicated similar results would be obtained for the first component (accounting for the challenges and limitations described in Section 3.7). A total of 14 organizations comprises the sample size for the remaining two components, and subsequently the study falls short in this aspect of reliability as there may be perspectives that have not been included, thereby distorting the results. However, saturation was reached with regards to community organizations and service providers, who discussed component 3 – *Institutional Support* and therefore contribute meaningfully to the measurement of the variable

As validity is dependent on reliability of the data, and there is some question regarding institutional perspectives, it will be critical to note these implications in any further analysis and triangulation of opinions and outcomes across the two analysis methods, as well as across component responses. These two issues will be explicitly addressed in Chapter 4: Data Analysis.

Additional sources of interference are outlined in section 3.7 as challenges and limitations of the study.

3.7. Challenges and Limitations

Several challenges and limitations manifested in the given research context were unavoidable due to circumstance. While they were identified and mitigated as much as possible, it is likely that there remains a degree of influence on the study and are therefore noted in detail below:

3.7.1. Impacts of Election period

The research period fell over the 1-month period prior to the 2022 National Elections in Kenya, which held significance due to the living memory of the infamous post-election violence experienced in 2007 (Myers, 2015).

The study was impacted in the following way:

3.7.1.1. Indicator Restriction

During the peer-testing pre-test of survey it was requested that questions related to *Cultural Memory and Assets* (vx3.7), as well as *Accountability of Managers and Governance Bodies* (vx4.7) be excluded from the questions as there was concern regarding political sensitivities following the events of 2007.

3.7.1.2. Biased Responses

In general, there exists some potential for bias (see section 3.5.2). However particular attention is drawn to possible bias in household survey questions about the right to vote (*Access to Assets – Social Capital & Institutional Support)* and participation in voting (*Interaction with Institutions - Decision Making Processes*). It was found during the interview process that residents experience discriminate levels of government support

based on voting patterns by ward. Therefore, there is a high likelihood of skewed results. This limitation is included in section xx. It would be interesting to see if the results had been different if it was not an election period where this was at the forefront of people's minds

3.7.1.3 Access to Local Government Officials

Access to local government was restricted. Two key causes are identified. Firstly, local government officials were particularly busy with election run-up activities and were unavailable. Secondly, networks were somewhat limited (see section 3.5.3).

3.7.2 Impact of Language Barrier & Identity

Although the primary language spoken in Nairobi is Swahili, many people speak English to varying degrees. As a mono-lingual English speaker I was able to conduct my own interviews with all interview respondents and engage independently in the community. However, in some cases a language barrier impacted on the opportunity to ask more nuanced questions to attain in-depth knowledge.

In addition, due to my identity as an external and individual foreign student travelling from Western Europe some unstated assumptions may have been made as to the potential opportunities, I may have been able to afford individuals or organizations.

Tactics which attempted to combat theses biases included clearly communicating my position as a South African student; through the assistance of community researchers to gather survey responses who may have elicited more legitimate and consistent results; and triangulation of answers through household, community, and institutional interviews on key issues. Despite these measures it is noted that there remains some potential for biased answers and particular liberties to have been taken by respondents with a motivation of securing benefit, and therefore data collected may have been skewed.

3.7.3 Impact of Network

All community organizations, except one, have been facilitated through Ghetto Foundation. Therefore, the selection methods rely on, and are dominated, by the available connections identified through Ghetto Foundation network and may therefore be subject to some bias.

Chapter 4: Data Analysis and Discussion

Chapter 4 will detail the data analysis and findings as per the research questions in two phases. The first phase will present the results of qualitative and quantitative analysis with only the necessary interpretation. Phase 2 will fully interpret the results presented in Phase 1 to provide an integrated analysis and answer the research questions.

4.1. Phase 1 | Data Analysis

Phase 1 is comprised of Section 4.1.1. and 4.1.2. which will detail the results of the in-depth interviews and household survey respectively, describing the data and summarizing the key results.

4.1.1. Results of Interviews with Community Organizations & Institutional Experts

This section presents the results of the qualitative content analysis to be fully analysed in Section 4.2. Section 4.1.1.1 will present the description and results of content analysis. Section 4.1.1.2.1 includes description of the frequencies, key findings, scoring and correlation of observed variables, while Section 4.1.1.2.2. and Section 4.1.1.2.3 outline the relationships between inferred independent and dependent variables respectively.

4.1.1.1. Description of data

The data presented in this section are the results of a total of fourteen interviews - ten with community organizations and four with institutional experts. Fifteen interviews were conducted; however, saturation was reached and subsequently the last interview has been excluded.

The range of respondents is spread across several domains which provides a valuable breadth of perspective and individual depth into the nuances of each, the details of which can be found in the annex (A.3.4.1). The ten community organizations each fulfil different roles. This satisfies the definition identified of *Networks* in the literature. The definition outlined in section 2.2 highlights the role of networks acting as interlinked systems of infrastructures which connect critical elements across system to enhance the critical characteristics of *Flexibility and Diversity*, *Redundancy and Modularity*, *Safe Failure*, *Robustness,* and *Multi-scalar Connectivity*. The organizations represented in this sample fulfil these functions at the community level and their functioning depends on a series of interdependent relationships to provide critical infrastructures in the context of informality. The *Supportive Institutions* component is comprised of four critical institutions which include support of Mathare as part of their mandate. The institutions represented each have an expressed function to link agents to critical systems and reduce marginalization and increase an agent's ability to respond to pressures and risks. Each institution has demonstrated support for the community through the facilitation of learning and change and an attempt to remove barriers to access and innovation, thereby fulfilling the description outlined in the literature.

There is an imbalance in representation between groups which is a limitation of the study and has been discussed in Section 3.6.2. The impact of this limitation on reliability will be addressed throughout the analysis and will make explicit reference to triangulation to confirm the validity of findings where appropriate.

4.1.1.2. Content Analysis Results

This section presents the results of qualitative content analysis of frequencies, key findings, scoring and correlation of observed variables to be fully analysed in Section 4.2.

4.1.1.2.1. Observed Variables: Adaptive Capacity & Resilience Activity of Components

i. Frequencies

A summary of code frequencies (A.3.4.2) provides a good overview and entry point into the data as it shows the spread of codes in relation to each variable. It shows that of the independent variables, *Access to Assets* was mentioned the most, followed by *Learning and Knowledge*, *Governance*, and *Diversity & Flexibility,* which was the lowest with a margin of almost four percent. Of the dependent variables *High-Capacity Agent* was mentioned the most, followed by *Robust Networks* and *Supportive Institutions* the least.

It is important to note that throughout qualitative coding analysis, a high frequency does not indicate a direction of the relationship, merely the degree of relatedness, without assigning a positive or negative value. Therefore, relevant quotes will then be used to describe these relationships further and provide a general measure of the standing of each variable within the community.

ii. Key Frequencies of Sub-Variables by Variable

The two most frequent sub-variables for each variable are identified below with a brief summary of the key associated themes. This gives an overview of the key themes across all discussions and signals relative weighting. Extensive tables can be found in the annex (A.3.13.X)

Diversity and Flexibility
***Willingness to Change* (163) *and Livelihood & Income* (141)**
Statements centred on the desire for community change, and the **level** of willingness of individuals and organizations to create partnerships or to pursue education or training to try new approaches. Forms of work present the most gendered perspective of all variables. Women's work is generally thought to include clothes washing, and house cleaning. Men's work is associated with construction and gardening, security, and maintenance for wealthy households, as well a common perception that men tend to engage in drinking alcohol instead of searching for work. Other references cite the search for work as a cause for rural-urban migration, and corruption activities as a source of income for those who engage in it.

Learning and Knowledge
***Perception of Risk & Change* (374) and *Recognition of Human Agency* (284).**
Multiple references to risk draw attention to the prevalence of different forms of violence, elements of poverty, health challenges, various negative coping mechanisms, and a general lack of trust. Change is perceived primarily in terms of how socio-demographic, environmental, and weather pattern changes impact Mathare.

Access to Assets

Social Capital and Institutional Support* (392) & *Financial/Economic Status* (216*)

The significance of social capital as trust is highlighted as a mechanism to draw resources into the community. It also plays an important role in providing physical security to 'known people'. Multiple examples of a lack of social capital and institutional support are referenced, primarily in relation to land title and evictions, sense of abandonment, recognition of cartels and politicians having significant influence. Financial barriers are referenced as a major challenge in the community in terms of assets, as well as the associated social stigmatization and class barriers.

Governance

***Planning Capacity* (233) and *Levels of Trust* (203)**

The successful planning of community clean ups and river embankment planting and other cooperative initiatives such as 'Merry-go-rounds' (savings groups) are examples of positive community level planning, which in some cases receive institutional support. Levels of trust are most commonly made in reference to the ability for these partnerships to form and are frequently negative citing a range of sources of tension linked to the erosion of trust. However, many reference is made to an absence of planning in critical areas, most notably related to dynamics around land management and urbanization.

High-Capacity Agent

***Responsiveness* (407) and *Independence* (363)**

Multiple reference is made to passionate individuals who act and respond to every opportunity to network or seek livelihood opportunities, despite limited capacity. There is evidence of institutions responding to a lack of services by providing a range of training, some critical social facilities, and emergency services. There is however also reference to lack of responsiveness, or negative responses with individuals who respond to challenges by engaging in criminal activity, political violence, or drug abuse. Another notable contribution to lack of responsiveness is the apparent normalization of (or resignation to) the status quo and feelings of low self-esteem (which is an internalization of an external failure). Reference is made to a lack of resources and the dynamics surrounding the role of social capital as contributors to a sense of dependence in multiple areas of life in Mathare. The precariousness in which people live translates into a sense of lack of independence as many individuals are highly exposed to unpredictable circumstance and shocks - when they become entirely dependent on assistance.

Robust Networks

***Robustness* (437), *Safe Failure (*141) *and Redundancy & Modularity* (141)**

References to robustness are the most frequent by a large margin. It is relevant to most topics and key risks discussed making it a key feature of all service provision mechanisms of both formal and informal networks. References to *Safe-Failure* and *Redundance & Modularity* receive much less attention. The absence of 'safety-nets' if actions fail is cited as a restriction for some, although many instances of experimentation and interventions do exist, and many references are made in relation to a feeling of willingness to try options that may fail. A key example of this is the water kiosks infrastructure. Provisioning networks such as this are contested and often subject to cartel monopoly, which reduces the potential for redundancy and modularity. However, the prevalence of partnerships and abundance of organizations are one area where many options exist.

Supportive Institutions

***Rights & Entitlements* (205) and *Information Flows* (200)**

References to a lack of rights primarily surround land management issues, and human rights violations including forced eviction and extrajudicial killings, as well as lack of provision for rights outlined in the 2010 constitution such as adequate housing, education, and health services. Information flows are enabled by technology and reference is implied ubiquitously. Within the community, organizations play a critical role in the dissemination and verification of information and reference to sharing experiences and information with community members and other organizations emphasizing partnerships and training as an enabler.

iii. Component Scoring

The findings across all interviews are summarized below and score the adaptive capacity and resilience activities of each component:

Table 3: Scoring Robust Networks | Component 2

Independent | Adaptive Capacity			Dependent | Resilience Activities		
VX1	Diversity & Flexibility	2	Y1	Actions to Increase Robustness	2
VX2	Learning & Knowledge	3	Y2	Interaction with Agents	2
VX3	Access to Assets	2	Y3	Interaction with Institutions	2
VX4	Governance	1			
	Total	**2**		**Total**	**2**
*Scores same scale as Likert used in household survey questionnaire (1-4).					

Table 4: Scoring Supportive Institutions | Component 3

Independent | Adaptive Capacity			Dependent | Resilience Activities		
VX1	Diversity & Flexibility	2	Y1	Actions to Increase Support	3
VX2	Learning & Knowledge	3	Y2	Interaction with Agents	1
VX3	Access to Assets	3	Y3	Interaction with Networks	2
VX4	Governance	2			
	Total	**3**		**Total**	**2**
*Scores same scale as Likert used in household survey questionnaire (1-4).					

iv. Co-Occurrence

The co-occurrence table (A.3.4.4) plots the number of occurrences of each independent sub-variable with dependent sub variables. It provides more detailed insight into the relationships between sub-variables of independent and dependent variables. This operation utilized the Boolean function 'AND', and subsequently only displays instances where quotes related to both codes are identified.

On average, occurrences cluster around independent variables belonging to *Learning & Knowledge* and *Access to Assets*, as well as *High-Capacity Agents* and *Robust Networks* as suggested by the frequencies.

The most prominent relationship exists between *Robustness (RN)* and *Perceptions of Risk and Change (L&K)*, followed by *Responsiveness (HA)* and *Perception of Risk and Change (L&K).* Therefore, we can infer that there is also between the characteristic of *Robustness (RN)* and *Responsiveness (HA)*. Both *Perception of Risk & Change (L&K)* and *Social Capital & Institutional Support (AA)* share strong relationships between each of the variables, *Responsiveness (HA),* and *Independence (HA)*. Therefore, we can infer that there is also a mediated relationship between *Perception of Risk & Change (L&K)* and *Social Capital & Institutional Support (AA)* and *Responsiveness (HA),* and *Independence (HA)*.

The results of the full extent of this analysis for the first twenty most significant variables of the table can be found in Annex 3.3.4. and inform the following two sections.

4.1.2 Results of Household Level Survey

This section presents the quantitative results of the household survey conducted to measure the adaptive capacity and resilience activities a household level which will be fully analysed in Section 4.2. as part of the integrated analysis. Section 4.1.2.1 will present the Descriptive Statistics, Section 4.1.2.2 the Regression Analysis and Section 4.1.2.3. the Structural Equation Modelling (SEM) Analysis.

4.1.2.1 Descriptive Statistics

A total of 141 responses were included in the analysis. The socio-demographic indicators results can be found in the annex (A.3.4.2 & A.3.4.3).

4.1.2.1.1 Component Scoring

This section presents the results of scoring analysis to be fully analysed in Section 4.2. The mean of each question was tabulated and calculated (A.3.4.) to produce the following overall score for each:

Table 5: Scoring High-Capacity Agent | Component 1

Independent | Adaptive Capacity			Dependent | Resilience Activities		
VX1	Diversity & Flexibility	3	Y1	Actions to Increase Adaptive Capacity	3
VX2	Learning & Knowledge	3	Y2	Interaction with Networks	2
VX3	Access to Assets	3	Y3	Interaction with Institutions	3
VX4	Governance	2			
	Total	**3**		**Total**	**3**

*Scores same scale as Likert used in questionnaire (1-4).

These results present the agent's perception of their latent adaptive capacity as relatively high, with only *Governance* achieving a lower level. Perception of interaction with *Resilience Activities* is similarly high for most variables, with *Interaction with Networks* lower.

4.1.2.1.2 Variable Relationships

This section presents the results of relationships analysis which will be fully analysed in Section 4.2. Survey results have been transformed into continuous variables by creating composite scale scores using the means. All composite variables were tested for internal consistency found in the annex (A.3.4.8) and were determined to be above the minimum threshold for inclusion according to Cronbach's alpha. The graphs found in the annex (A.3.4.9) visualise the covariant relationships expressed between the independent and

dependent variables which show a positive relationship between all four adaptive capacity variables when compared against each resilience activity variable. An extensive table which includes the descriptive statistics and correlation for the control, independent, dependent, and sub-variables can be found in the annex (A.3.4.11).

Correlation values between socio-demographic control variables are negligible to weak in relation to both independent and dependent variables. However, *Gender* is weakly associated with *Diversity & Flexibility* and *Governance*, with which males have a slightly more positive relationship. *Area* is also weakly associated *Access to Assets*, where it is expected that residents located towards the lower portion of the river course have lower levels of *Access to Assets*.

The relationships between independent and dependent variables all exhibit strong positive relationships and are highly correlated. The strongest relationships are between *Learning & Knowledge* and *Access to Assets* with *Interaction with Networks*. Particularly strong relationships also exist between *Diversity & Flexibility* and *Governance* with *Interaction with Institutions*, followed by *Access to Assets* and with *Interaction with Networks*.

4.1.2.2. Regression Analysis

This section presents the results of regression analysis to be fully analysed in Section 4.2. Additional information of background analysis can be found in the annex (A.3.4.12). Sub-variable regression outcomes can also be found in the annex (A.3.4.13)

Tables 6-8 present the estimates of the effect of the independent variables on dependent variables. In all regressions, β_0 has no meaning as Adaptive Capacity cannot be 0.

Table 6: Results of regression of Actions to Increase Capacity (Y1) on Adaptive Capacity (X1-4)

Dependent Variable: Actions to Increase Capacity (Y_1)					
Regressor	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Diversity & Flexibility (X_1)	0.67***	0.43***	0.28*	0.40**	0.31*
	(0.09)	(0.13)	(0.12)	(0.13)	(0.12)
Learning & Knowledge (X_2)		0.29**	0.06	0.27*	0.06
		(0.11)	(0.11)	(0.11)	(0.11)
Access to Assets (X_3)			0.37***		0.45***
			(0.08)		(0.09)
Governance (X_4)				0.04	-0.09 '.'
				(0.05)	(0.05)
Intercept	1.22***	1.07***	1.16***	1.11***	1.09***
	(0.26)	(0.26)	(0.25)	(0.27)	(0.25)
Summary Statistics					
RMSE	0.12	0.15	0.13	0.15	0.12
R^{-2}	0.27	0.23	0.40	0.30	0.41
n	139	138	137	137	136

These regressions were estimated using the data from household survey conducted in Mathare. Heteroskedasticity-robust standard errors are given in parenthesis under coefficients. The individual coefficient is statistically significant at the ***0% level, **0.1% level, *1% level or '.'5% level.

Table 6 describes the total effect of independent variables of *Adaptive Capacity* (X_{1-4}) on dependent variable *Actions to Increase Capacity* (Y_1). In the model with the highest explanatory power, the small RMSE value of 0.12 indicates that the model is a good fit. The coefficients for X_{1-4} are 0.31*, 0.06, 0.45***, and -0.9'.' respectively, holding all other factors constant. *Access to Assets* (X_3) has the largest beta value and is significant at 0.01%, indicating that it is a robust determinant for *Actions to Increase Capacity*. This is followed by *Diversity & Flexibility* (X_1) which is positively associated with at a

significance level of 1%. *Learning & Knowledge* and *Governance* do not have explanatory power for this variable.

Table 7: Results of regression of Interaction with Networks (Y2) on Adaptive Capacity (X1-4)

Dependent Variable: Interactions with Networks (Y_2)					
Regressor	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Diversity & Flexibility (X_1)	1.22***	0.43**	0.31*	0.24 '.'	
	(0.26)	(0.13)	(0.13)	(0.13)	
Learning & Knowledge (X_2)		0.87***	0.68***	0.69***	
		(0.11)	(0.12)	(0.11)	
Access to Assets (X_3)			0.30***	0.13	
			(0.08)	(0.09)	
Governance (X_4)				0.21***	
				(0.05)	
Intercept	0.67***	-1.3767***	-1.31***	-1.16***	
	(0.09)	0.2773	(0.27)	(0.26)	
Summary Statistics					
RMSE	0.14	0.16	0.15	0.13	
R^{-2}	0.27	0.59	0.63	0.66	
n	139	138	137	136	

These regressions were estimated using the data from household survey conducted in Mathare. Heteroskedasticity-robust standard errors are given in parenthesis under coefficients. The individual coefficient is statistically significant at the ***0% level, **0.1% level, *1% level or '.'5% level.

Table 7 describes the total effect of independent variables X_{1-4} on dependent variable *Interactions with Networks* (Y_2). In the model with highest explanatory power the small RMSE value of 0.13 indicates that the model is a good fit. The coefficients for X_{1-4} are 0.24'.', 0.69***, 0.13, 0.21*** respectively, holding all other factors constant. *Learning & Knowledge* (X_2) has the largest beta value and is significant at 0.01%, followed by *Governance* (X_4) at a significance level of 0.01%, indicating that both variables are robust determinants for *Interaction with Networks*. *Diversity and Flexibility* (X_1) which has a lower degree of explanatory power with a coefficient value of 0.24 at a significance level of 5%, holding all other factors constant.

Table 8: Results of regression of Interaction with Institutions (Y3) on Adaptive Capacity (X1-4)

Dependent Variable: Interactions with Institutions (Y_3)					
Regressor	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Diversity & Flexibility (X_1)	1.10***	0.80***	0.74***	0.71***	
	(0.11)	(0.15)	(0.16)	(0.16)	
Learning & Knowledge (X_2)		0.36**	0.26 '.'	0.2 '.'	
		(0.13)	(0.14)	(0.14)	
Access to Assets (X_3)			0.16	0.08	
			(0.10)	(0.12)	
Governance (X_4)				0.10	
				(0.07)	
Intercept	-0.46	-0.64*	-0.60 '.'	-0.53	
	(0.32)	(0.32)	(0.32)	(0.32)	
Summary Statistics					
RMSE	0.14	0.22	0.22	0.21	
R^{-2}	0.40	0.43	0.44	0.44	
n	139	138	137	136	

These regressions were estimated using the data from household survey conducted in Mathare. Heteroskedasticity-robust standard errors are given in parenthesis under coefficients. The individual coefficient is statistically significant at the ***0% level, **0.1% level, *1% level or '.'5% level.

Table 8 describes the total effect of independent variables X_{1-4} on the dependent variable *Interaction with Institutions* (Y_3). In the model with the highest explanatory power the small RMSE value of 0.21 indicates that the model is a good fit. The coefficients for X_{1-4} are 0.71***, 0.2'.', 0.08, 0.10 respectively, holding all other factors constant. *Diversity & Flexibility* (X_1) has the largest beta value and is significant at 0.01%, holding all factors constant, indicating that *Diversity and Flexibility* is a robust determinant for this variable. *Learning & Knowledge* (X_2) at a significance level of 5%, holding all other factors constant, and has a small coefficient value thereby making it an inferior determinant of Interactions with Institutions

These results can be interpreted to say that *Adaptive Capacity* has a significant relationship with each aspect of Component 1, and particularly so with the level of *Interaction with Networks*. This has considerable implications on the analysis in the analysis section to follow.

4.1.2.3 Structural Equation Modelling (SEM)

This section presents the results of SEM analysis to be fully analysed in Section 4.2.

Due to the relatively small sample size the model needed to be simplified to include only the main variable relationships which were subsequently compiled using item parcelling techniques. The model converged normally after 38 iterations, resulting in a proper solution, the outcome of which can be found in the annex (A.3.4.15).

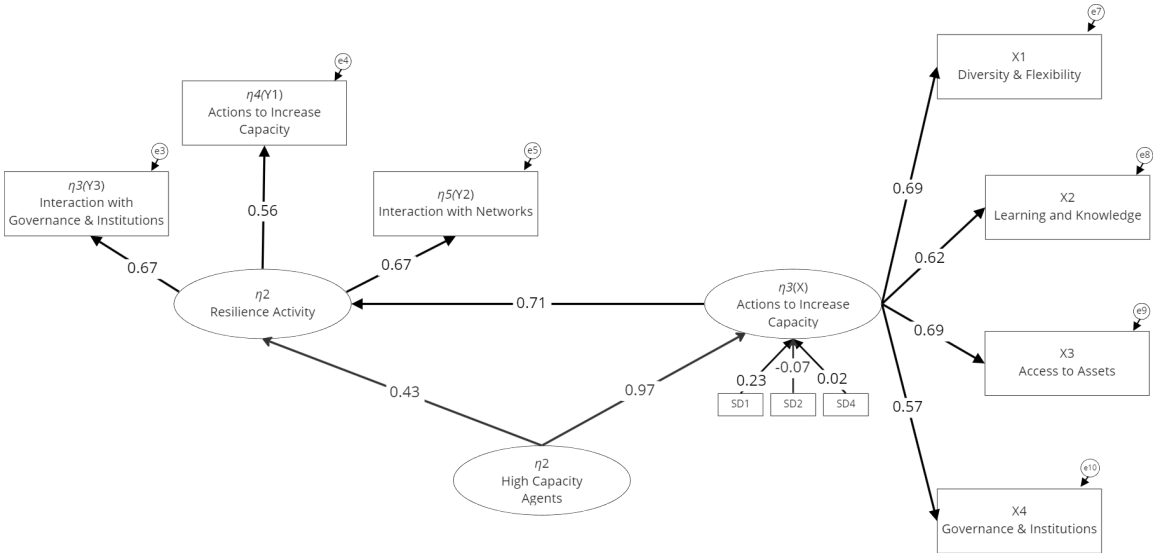

Figure 8: General structural equation model with standardized coefficients.

4.1.2.3.1 Overall goodness of fit indices

Robust Root Mean Square Error Approximation (RMSEA) estimates how much the hypothesised model deviates from a perfect model (Xia & Yang, 2019). The RMSEA reports 0.039 with a 90% confidence interval between 0.000 and 0.078. This suggests that there is good fit between the model and the data as it is below 0.05 (Gana & Broc, 2019). The robust chi-square value is 0.051, which argues in favour of the hypothesised model which is supported by the test statistics results of ML and Robustness which are 34.9 and 36.4 respectively. The correction factor is reported as 0.96 and is therefore acceptable

(>1.00 is indicative of a deviation from normality). The degrees of freedom are 24, with a p-value of 0.051, which is not significant and indicates that there are no significant errors. This argument is supported by the robust Comparative Fit (CFI) and Tucker Lewis (TLI) Indices, that compare the fit of the hypothesized model with that of the baseline model on a scale of 0-1 where 1 is best and are 0.98 and 0.97 respectively. The Standardized Root Mean Residual (SRMR) value of 0.046 confirms this as it is under 0.1.

It can therefore be concluded that there is a good fit of the model to data and that the SEM confirms the hypothesis that there is a relationship between the observed variables measured in the household survey and the latent constructs which they intend to measure.

4.1.2.3.2 Parameter estimates

The parameter estimates present the quality of the solution (Gana & Broc, 2019). The non-standardized factor loadings indicate the nature of the predicative relationship and are all positive. Z-values, except for resilient activities, are all significantly higher than 1.96 at $p<0.05$ and are therefore significant.

Table 9: Standardized Factor Loadings

Independent Variable	Dependent Variable	Standardized Factor Loading β
Diversity & Flexibility	Adaptive Capacity	0.69***
Learning & Knowledge	Adaptive Capacity	0.61***
Access to Assets	Adaptive Capacity	0.69***
Governance	Adaptive Capacity	0.57***
Actions to Increase Capacity	Resilience Activity	0.67***
Interaction with Network	Resilience Activity	0.56***
Interaction with Governance	Resilience Activity	0.67***
Adaptive Capacity	Resilience Activity	0.71
Adaptive Capacity	High-Capacity Agent	0.97
Resilience Activity	High-Capacity Agent	0.42
Heteroskedasticity-robust standard errors are given in parenthesis under coefficients. The individual coefficient is statistically significant at the ***0% level, **0.1% level, *1% level or '.'5% level.		

All standardized factor loadings are positive and greater that 0.4 which indicates there is a relevant link between all items and the factors on which they depend, therefore estimating that quality of the relationship between the latent variables and indicators is valid. The variance observed in *Adaptive Capacity* is estimated to account for 71 % of the variance seen in *Resilience Activity*, which in turn accounts for 43% of the variance seen in *High-Capacity Agents*. The variance observed in Adaptive Capacity accounts for 97% of the variance seen in *High-Capacity Agent*. This model therefore indicates that the theoretical constructs and their relationships identified in the theoretical framework can be confirmed with a reasonable amount of certainty.

All the observed indicators have a statistically significant relationship (at 0.01%) with their respective latent variables and there is a large likelihood that the reported outcome is robust. In particular it shows that Adaptive Capacity indicators identified in the literature are robust determinants for determining Resilience Activities as well as for High-Capacity Agents. This can be interpreted to evidence the argument that in order to have agents with high capacities operating within the resilience structure the adpative capacity indicators are relevant measures. Furthermore, the lesser effect of *Resilience Activity* indicators on *High-Capacity Agents* is interesting as it confirms the strength of latent *Adaptive Capacity* over the role of interaction within the struture. As this study is primarily concerned with community adaptive capacity, identified in the literature as the latent ability within the

community network to respond to change, this finding is significant. It provides a robust line of argument for the analysis to follow.

4.2 Phase 2 | Integrated Analysis and Discussion of Results

Phase 2 encompasses Sections 4.2.1, 4.2.2, and 4.2.3. which provides an integrated analysis of the findings of Phase 1 to answer all research questions. Section 4.2.1 will present the levels of adaptive capacity and resilience in each component to answer question one and two. Section 4.2.2 describes the key risk factors and interrelationships between components as per research findings to answer questions three and four. Section 4.2.3 will then contextualize these findings within the framework of complex adaptive system and discuss the relevancy of these outcomes in relation to climate resilient development to answer research question five.

4.2.1 Adaptive Capacity and Resilience Levels

In summary the total summed measures of adaptive capacity below show that the community of Mathare has a reasonably high level of adaptive capacity, and a slightly lower level of engagement in resilience activities.

Table 10: Total Score of all Components

Independent | Adaptive Capacity			Dependent | Resilience Activities	
1	Agent	3	Agent	3
2	System	2	System	2
3	Institution	3	Institution	2
	Total	**3**	**Total**	**2**
*Scores same scale as Likert used in household survey questionnaire (1-4).				

These results indicate that all components of the Mathare community governance system have both the capacity to act and are engaging in resilience activities to an adequate level as per the theoretical framework drawn from adaptation and resilience literature. According to this literature we would expect the levels of deprivation in Mathare to be decreasing and for substantial gains to be made towards climate resilient development and sustainability goals (IPCC, 2022; UN, 2015; UN, 2017). Although some progress has been made (A.2.9-A.2.10), it has been alarmingly slow and is not keeping pace with the rate of development that is needed (Hendriks, 2010; Hirst & Lamba, 1994; Siddiqi, 2022; UN-Habitat, 2020).

Table 11 : Robust Determinants by Component

Component	Most robust sub-variable determinant	Second most robust sub-variable determinant
Community Resilience	High-Capacity Agent	
High-Capacity agent	Access to assets	Diversity & flexibility
Robust Networks	Learning & Knowledge	Governance
Supportive Institutions	Diversity & Flexibility	Learning & Knowledge

One way of framing this tension is to consider the bounds of soft limits to which adaptation is subject (IPCC, 2022). Poverty, inequity, and a lack of climate literacy leads to soft limits where financial, governance, institutional, and policy environments place

constraints on adaptation activity and planning (IPCC, 2022). These constraints and their implications will be explored in the section to follow. However, it is important to note here that the results of this scoring suggest that despite significant constraints, the community has developed adequate mechanisms required to sustain adaptive capacities and resilience activity within the limits of what is possible.

4.2.2 Integrated Analysis of Contextual Risk Factors and Relationships between Variables

Resilience is understood as the total level of adaptive capacity in relation to risk (Tyler & Moench, 2012). Life in Mathare is characterised by individuals manifesting flexibility in the face of multiple risks and stresses associated with poverty; perseverance despite numerous socio-economic complexities; responsiveness through informal networking; and survival in face of crippling daily challenges. The state of deprivation in Mathare increases residents' exposure to hazards, which takes multiple forms and are often unavoidable, increasing the sensitivity of community members to their impacts. These hazards limit the capacity of community members to participate meaningfully in resilience activities.

This section will detail specific complex and compounding risks and stresses in Mathare and their impact on variables to properly contextualise the analysis of the interdependent and complex relationships. The information for this section has been gathered across all interviews and integrates results from regression analysis and SEM.

4.2.2.1 Corruption, Cartels, and Land Ownership | Institutions

Distinctive challenges surround the ownership of land in Mathare which coalesce around critical interrelationships between corruption, cartels, and institutional complexities.

Levels of Trust & Social Capital

There is very little trust around the issue of land ownership in Mathare. Many questions surround the legitimacy of land title with many respondents citing a long history of collusion between land administration officials and powerful individuals who have been granted land title (A.2.1-A.2.14). A common perception exists that there is a powerful elite who benefit from the status quo and actively maintain the system as it is (A.2.1, A.2.6, A.2.7, A.2.9, A.2.10, A.2.12-14). This elite is believed to operate as a cartel linking community level operations to external agents with more access to assets who co-ordinate cartel members, members of the police, and government administration in their service. Consequently, there is a deep mistrust of politicians who are believed to benefit from the instability owing to their relationships with cartels as well as political control of Mathare (A.2.1, A.2.2, A.2.4, A.2.6-10, A.2.12-14). Implicit in these dynamics is the significant role of access to assets and in particular social capital. *Social Capital* and *Financial Status* are key components of *Access to Assets,* which is a proven robust determinant of *High-Capacity Agents* (Section 4.1.2.2.1 & Table 9). In this context it must be noted that some high-capacity agents comprise this elite who take advantage of their position, to the detriment of the system as a whole, and can be understood as a form of maladaptation of *Responsiveness*. *Levels of trust* is one of the lowest scoring sub-variables (4.1.2.2.1) and is significantly correlated with numerous aspects of *Adaptive Capacity* and a critical component of *Governance* (A.3.4.11). The implication of these findings is that the erosion of trust within the community has significant impacts on numerous *Adaptive Capacity*

indicators and is, in part, an internal dynamic resulting from maladaptation of some *High-Capacity Agents*.

This lack of trust in Mathare is further expressed in multiple conflicts which surround land ownership, and a consequent development stalemate has evolved.

Planning Capacity

Vast portions of land have been illegally sold or informally allocated to private entities resulting in multiple parties claiming ownership - who often protect their purchase by force or lengthy legal battles. For example, the *Hospital Ward* village was informally allocated by the then member of the County Assembly to evicted residents in 1998 who were displaced from another area for the development of a school (A.2.1). However, this allocation was illegal as the land is owned by the police department who have taken legal action to claim it back (Departmental Committee on Lands, 2020) and who therefore resist any plans for its formal development thus stifling planning efforts. Multiple other examples at smaller scales exist in Mathare (A.2.1, A.2.3, A.2.7, A.2.12-14).

Privately owned land is subject to speculation, and owners are often resistant to selling their land, particularly as they are able to extract rent from slum dwellers at little to no cost to themselves. The implications are significant -

> *"So, you'll find that issues of dealing with things like floods… and disaster preparedness can be done, but they get caught up in the complexities around slum dwelling. Complexities around land ownership … But there's a huge cost. There's a huge cost to it that must be born. And therefore, the question is, who's going to bear the cost?"*
>
> 11:28 p 28 in Respondent 13

These contestations over resources stifle planning capacity in the area due to the cost that would be involved. The stalemate is exacerbated by the fact that the population of informal settlement lacks economic influence.

> *"…because what happens, let me tell you something… a lot of these decisions around investments - infrastructure or otherwise - there is a silent consideration on ROI's. So, for example, if you're going to construct a road in the slums, what's the ROI?"*
>
> 11:28 p 28 in Respondent 13

Rights and Entitlements

Most of the Mathare community are informal renters who do not have security of tenure and remain exceptionally vulnerable living in a state of precariousness. For these residents there are multiple additional risks owing to the lack of service provision and the tenuous solutions that have been developed in the community (A.1.2 – A.2.14). In addition, arson is used as an eviction method by landowners (A.2.1, A.2.4-10, A.2.12-14):

> *"But then there is, we can call it maybe the classical evictions whereby maybe you have a land here, but the structures are not yours... And maybe you want to develop that land. But now you cannot evict the slum dweller.*

You find that people cause fires... they come and burn the houses sometimes… they don't care whether people will be killed or lose properties. So, that has been happening."

1:30 p 5 in Respondent 1

Government evictions in the area have been pervasive (Hirst & Lamba, 1994). Consequently, there is a sense of deep mistrust within the community regarding development processes for fear of displacement. The Land Act of 2012 states adverse possession is possible after 12 years (Kenyan National Government, 2012). However, due to a lack of monitoring capacity, political will, and complacency (A.2.1, A.2.14), possibly due to the reasons outlined above, it is not in the interest of the government to address these issues and risk losing official ownership. Consequently, there are few mechanisms to address these challenges at the community level in Mathare.

i. Supportive Institutions

Institutions are expected to play a supporting role in connecting agents to robust networks (Tyler & Moench, 2012). In Mathare the dynamics set out above create a situation where the dominant institutions are not supportive but rather play a repressive role, limiting agents' interactions to fragile networks characterised by informality, illegality, and inadequacy. *Supportive Institutions* feature the least of all dependent variables with the lowest frequencies of mentions, lowest co-occurrences, and no outstanding relationships, despite *Interactions with Institutions* having the highest factor loading in the SEM model on *Resilience Activities*. This indicates that despite being a critical determining factor, the overall interaction with this component is minimal, and institutions are perceived to be largely absent in community resilience in terms of government intervention, as well as private or non-governmental institutions. *Diversity & Flexibility* and *Learning & Knowledge* are the two most robust determinants of *Interaction with Robust Institutions*, which are associated most prominently with *Willingness to Change*, and *Perception of Risk and Change*, respectively. In the context of considerable lack of trust and complexities surrounding corruption, cartels, and land ownership, and where *Access to Assets* is the most significant determinant of *Resilience Activity*, it can be deduced that agents who perceive risk, and possess a strong will to change, might be more willing to engage with the most robust network that seems to exist in Mathare – that of the cartels.

ii. Governance

In the absence of significant institutional support, as we have noted *High-Capacity Agents* develop slum-ecosystem governance models with implications for community resilience. Content analysis reveals that the sub-variables *Planning Capacity* and *Levels of Trust* are most frequently mentioned *Governance* mechanisms, and are associated most strongly with *Robustness, Responsiveness,* and *Independence.* It is interesting to note that these variables are not associated, as one would expect from the literature, with *Supportive Institutions* but with *Robust Networks* and *High-Capacity Agents.* This will be further discussed. *Governance* is most statistically correlated with *Diversity and Flexibility* (A.3.4.11) and both are robust determinants of *Interaction with Networks*, significant at 0.01% holding all factors constant. Together these findings indicate that individuals who exhibit a strong *Willingness to Change* might be more likely to interact with planning

mechanisms within the community network, as opposed to interacting with institutions. This will be discussed in the next section.

iii. Access to Assets

Content analysis of qualitative data indicates a prominence of *Access to Assets* as strong determinant of *High-Capacity Agents*. In the context of scarcity *Access to Assets*, including *Financial Resources* and *Social Capital* is particularly significant (Obaitor, Lawanson, Stellmes, & Lakes, 2021). This is evidenced by the high frequency of both variables; the correlation of *Access to Assets* with *Interaction with Networks* and *Institutions*; and regression results of A.3.4.13.1 which identify these mechanisms as a robust determinant of *Actions to Increase Capacity*. *Social Capital* is also a determinant of *Responsiveness* as the two variables are highly correlated and, as noted above, in the absence of supportive institutions (and in the context of deprivation and survival) these complex dynamics contribute to the prominence of cartels and corruption. Higher capacity agents have higher levels of access to assets and therefore higher adaptive capacities which enable them to be more responsive and independent - and able to interact with networks and institutions – albeit not necessarily positively. This is an important lesson: that agency, assets, and adaptation can be deployed for negative outcomes.

4.2.2.2. Lack of Service Provision and Poverty as Violence | Networks

The development stalemate outlined above contributes to the severe shortage of service and infrastructure provision in Mathare which perpetuates the ongoing immiseration of the quality-of-life and of extreme poverty. Informality can be viewed as a coping mechanism and as a function of neglect (Azunre, Amponsah, Takyi, & Mensah, 2021). In Mathare informal and often illicit business is ubiquitous and exists across all systems including those around brewing, land, electricity, water, dumpsites, security, stealing, prostitution, drugs, and smuggling. Some of these forms of livelihood are known as “Cash Crops” and are specific to each area (A.2.1, A.2.5, A.2.6, A.2.8-2.10). These activities constitute much of the economy, and multiple additional systems exist to buffer their legal fragility and ensure system functioning.

As suggested above, the absence of supportive institutions contribute to the prominence of cartels and corruption. This precarious state suggests that the introduction of alternate systems, potentially threaten existing systems which provide a means of survival for many people, and that government intervention may not be wanted by the groups that are benefitting from its absence - and keeping the system ‘functioning’ (A.2.12, A.2.14). The majority of people are just trying to survive and are highly adaptable within their limits of power as the community resilience scores suggest -

> *“But they do not have the capacity to change it… it's like you're treating a disease but you're treating only symptom. … To treat the issue in Mathare it must begin with who owns the structures.”*
>
> 11:31 p 30 in Respondent 13

Thus, gross injustice takes refuge in the complexities that exists at the nexus of poverty, neglect, and informality as they become normalized and coping mechanisms are developed at individual and systemic levels - not all of which are positive.

As one of the poorest, most vulnerable, and marginalized communities in Nairobi, many are dependent on illicit networks to provide services and livelihoods they need when there are no other options (Dodman et al., 2018; Hendriks, 2010; Myers, 2015)(A1.2.1, A.2.10). In one sense these mechanisms are fragile, as they are illegitimate and therefore undefendable in the face of law -

> *"This is the complex science around the slum ecosystem… In that the slum ecosystem is a quasi-government - so that it has its own way of control."*

25:36 p 15 in Respondent 13

This 'slum ecosystem' is comprised of multiple interdependent mechanisms which develop as a survival response to neglect, and operate by their own rules of operation (Myers, 2015)(A.2.13). This can generate detrimental behaviour and a tenuous relationship with authoritative bodies and judicial frameworks, as one respondent states -

> *"Poverty is violence. And is the worst form of discrimination. Coz if you are in poverty, you are ripped of your dignity."*

9:46 p 8 in Respondent 10

This reference to dignity is critical, as individuals are expected to cope in the face of multiple affronts. Land ownership dynamics play a significant role in the continuation of poverty in Mathare as the survival systems which have developed in the context of informality erode not only trust, but also accountability of governmental institutions who are complacent with regard to the status quo (A.2.3). This complacency is blind to the insidious violence of this poverty.

The prevalence of substance abuse, and its trade, in Mathare is understood as an individual coping mechanism (A.2.1 – A.2.3, A.2.6, A.2.8-A.2.10) -

> *"An escape to reality, and as a coping mechanism, because now you are overwhelmed by so many challenges, and you think this is too much. I want to hide myself - my head a bit - from all these troubles. So that's why as you walk around, you would see so many people are drunk."*

1:114 p 27 in Respondent 1

From a young age youth in Mathare join 'cliques' as a means of protection, and to build social capital, often developing into gangs that engage in illicit activities as a source of income (A.2.1, A.2.4, A.2.8-10).

> *"Because like when you're growing up in Mathare, as a young person, you are attached to a certain gang… And in those bases, you know, because of unemployment issues, and you want also to make a living, you find that most of you engaging in crime"*

1:60 p 11 in 1. Respondent 1

The issue of extrajudicial killings and incarceration of youth in Mathare is significant (A.2.1, A.2.3, A.2.8-A.2.10, A.2.12-A.2.13), as is the consistent reference to safety concerns and the prevalence of violence within the community (A.2.1-A.2.3, A.2.5-A2.14). The fragility of these coping mechanisms, developed in response to systemic neglect, permeates many aspects of public life in Mathare, and places hard limits on the adaptive capacities across the community as a whole.

Positive coping mechanisms have also been developed and are evidenced by the numerous community organizations that are present in Mathare. The community network has proven vital in building capacity (A.2.1-2, A.2.4-12, A.2.14), increasing information flows (A.2.4-10, A.2.12), and engaging youth (A.2.1, A.2.6, A.2.8-10). Furthermore, there is a high level of cooperation between community organizations who exhibit aspects of *Governance* mechanisms -

> *"Actually, like Ghetto Foundation is the connector of many organizations... We sit together, we discuss that thing. You know like now we are discussing about the election. We have to manage, so we are working together, and Ghetto Foundation is the umbrella for us"*

6:33 p 19 in Respondent 6

Their interaction with institutional support enables the translation of the advances being made at higher levels into action at community level, thereby providing many critical services (UN-Habitat, 2020).

i. Interaction with Robust Networks

Interaction with Robust Networks is a key robust determinant for *Resilience Activities* (4.1.2.3) which confirms the relationship as identified in the literature (Tyler & Moench, 2012). Frequency analysis highlights that the strongest sub-variable for interaction with networks is the characteristic "Robustness", followed by Safe Failure and Redundancy.

Building on the analysis of access to assets, strong correlations and numerous co-occurrences can be found between *Robust Networks* and *High-Capacity Agents*. Capacity building activities run by community organizations foster trust and build social capital - which analysis shows have significant impact on building high-capacity agents who in turn are able to participate more fully in community resilience activities. A significant part of capacity building in Mathare is linked to digitization and the critical role that digital infrastructure plays in reducing 'lock-in', and multiple aspects of *Learning & Knowledge* in general (Boschma, 2005; Pahl-Wostle, 2009; Tzioutziou & Xenidis, 2021)(A.2.1-A2.14). Innovation has occurred in communication mechanisms between scales, improving efficiency and opening up new avenues for communication and information flows (A.2.1, A.2.2, A.2.4-11) -

> *"Moja Wi-Fi came... I told them that these particular projects that you're currently doing, since people are using your platform to watch so you just have to put some COVID-19 sensitization."*

4:8 p 4 in Respondent 4

Networks of provisioning and exchange in Mathare are subject to challenges relating to cartel interference. Provision of electricity, water, security, waste management, land

tenure, and access to employment opportunities are highly influenced, or entirely managed, by cartels (A.2.1-14). The strong association with safe failure indicates that due to risks involved in addressing current systems, both in terms of consequences to residents should the networks of provision be disrupted, as well as in regard to the threat of violence wielded by cartels.

An example of institutional support to connect agents to robust networks, can be seen in the smart water metering kiosks that were implemented in 2017 (A.2.1, A.2.7, A.2.11, A.2.13). This program intended to increase the affordability and provision of water in Mathare, as well as provide a form of livelihood for residents through the implementation of digitized water kiosks that were expected to be less susceptible to interference (A.2.7, A.2.13-14). However, they have been manipulated by cartels and do not fulfil this function. This example highlights the complexities that surround the introduction of new systems into existing networks which are bolstered by cartel interference (A.2.1, A.2.4-5, A.2.7A.2.11-14).

ii. Learning & Knowledge

Learning & Knowledge is the most robust determinant of Interaction with Network, as is estimated in the SEM to account for 67% of the variance seen in *Resilience Activity*. *Perception of Risk and Change (Learning & Knowledge)* is the most significant independent sub-variable due to its high co-occurrence with both *Robustness (Robust Networks) and Responsiveness (High-Capacity Agents).* The ability to adjust and respond positively to stressors or opportunities (Whitney et al., 2017) relies on a component successfully recognizing them. This ability is an emergent property that manifests when a challenge is presented and is identified in literature as a critical component of adaptive capacity (Chaskin, 2001; Whitney et al., 2017).

Analysis revealed that *Perception of Risk and Change* was associated 374 times in total and is highly correlated with Interaction with Networks (A.3.4.11). Content analysis shows that flooding and sanitation is not perceived as one of the main threats in Mathare - although this may be related to the immediacy of the threat in relation to other chronic risks and stresses which has led to a normalization of risks. Perception is generally high in relation to fire, health risks, criminality, and political violence.

These results indicate that the degree to which people are willing to frame challenges as risks depends on their ability to take action to avert it. If there is not enough capacity to address the risk, then it is reframed or ignored as a potential coping mechanism.

4.2.2.3. Environmental Risks and Normalization as Coping | Agents

Building on the understanding above it is imperative to recognize the second aspect of violence which is normalization. Respondent 10 referred to poverty as ripping the individual of dignity. In Mathare poverty, neglect and survival is normalized to the extent that in many circumstances the coping mechanisms developed in the context of deprivation become the norm -

> *"Because there are different dynamics in which people cope in the situation here. And although many might be negative, but I think it is a*

coping mechanism ... they adapt to the situation they are in. First is normalization. People normalize whatever situation they are living in. They say - this is the way it is. So that's a phrase so many people use here. This is the way it is. So, if I cannot change it, I'm going to leave it that way."

1:113 p 27 in Respondent 1

Normalization of 'this is the way it is' when facing significant compounding risks and hazards means individuals live in a state of survival remaining completely vulnerable to shocks that go beyond the immediate challenges. This recognition implicitly acknowledges that many of the challenges are systemic and beyond the reach of individual action. A consequence of this normalization however is complacency, at all component levels, which can mutually reinforce attitudes and perpetuate the status-quo.

This can be seen in multiple arenas of decision-making regarding risk in Mathare. Individual decisions are made to meet particular needs such as: for electricity leading to illegal connections which often lead to destructive fires; for shelter leading to occupation of unfit or even hazardous land that can be subject to impacts of flooding and environmental exposure; to earn an income which can lead to engagement in illicit activities with multiple detrimental impacts including death; as well for proximity to livelihood opportunities which force people to live in extraordinarily hazardous conditions to health and physical safety-

"Sometimes you find those houses - a lot of floods, and we'll find some of them are taken by water. But sometimes they just take it for granted. They just like no - it cannot happen. But sometimes it can happen, but they just close their eyes."

6:14 p 10 in Respondent 6

Furthermore, when agents lack sufficient access to assets to cope, their independence is reduced as they are forced to rely on dubious sources of provision. If systems which surround these challenges are not robust, and an absence of governance mechanisms abandons individuals to face mounting challenges individually, then a significant amount of time goes into operating individually to solve issues, decreasing overall efficiency at the community level.

Even positive community level actions such as community clean ups can be seen to represent a normalization of a lack of service delivery, and as a coping strategy to manage the near constant threat of environmental catastrophe -

"And the resilience, the resilience comes with environment ... You need to adapt to it. Coz things are hard, and they are changing."

9:2 p 1 in Respondent 10

Normalization of, and resignation to, these challenges increases the burden that individuals have to bear, which makes the issue of complacency a critical issue to address at all levels of governance in Mathare for the systemic changes which are needed to be recognized as a city level priority. Normalization and complacency at institutional levels have severe consequences on the continuing neglect of vulnerable communities -

"Like now we see the problem with Kenya is the money is being allocated to the politicians... But now, that politician is not actually going to assist our people a lot. Because if somebody did not elect that person you are going to be side-lined… When he is assisting people, he normally asks for the voter card to see whether you have been registered as a voter."

10:16 p 9 in Respondent 3

More broadly however, normalization of these multiple issues affects how people think about their environment, the river, and the role of government which has implications for local environmental programmes, as well as for the development of larger resilience strategies for degraded urban spaces at institutional levels -

"Sure, so in terms of climate change, and … coping mechanisms. Slums, present you with a tricky situation... Because there is no coping mechanism, especially the slums in Nairobi and especially in Mathare. Yeah, it's not a topic of discussion on the table. Coping mechanism for climate change. And if you go to other places, if you go to other places, you find it can be it is a topic of the table because their livelihood depends on it. But for slum dwellers in Mathare, their livelihoods are not dependent on shifts in climate change."

10:16 p 9 in Respondent 13

Therefore, although climate change may not pose immediate and direct threats to the quality of life in Mathare, as livelihoods do not rely on effects of climate change and flooding, it is as much the result of urbanization patterns and poor planning as variable rainfall patterns. The status and position of the settlement means that direct and indirect climate change impacts will compound the challenges already being experienced.

Recognition of indirect impacts include those on health (A.1.2, A.1.4) and food security (A.1.13).

The consequences of neglect, and subsequent vulnerability and its normalization in Mathare will be made worse by the effects of climate change as increasing pressure is placed on urban systems and resources become increasingly scare, and costly (Arsel, 2022; Azunre et al., 2021; Bankoff & Hilhorst, 2022; Berry, 1973; Chu et al., 2016; Dodman et al., 2018).

i. High-Capacity Agents

The theoretical framework draws attention to the central role of agents within the resilience system as the primary actors and beneficiaries of resilience activities. Therefore, agents are expected to play a central role in the *Community Resilience* system as core components of each other component. *Actions to Increase Capacity* is a significant and robust determinant for *Resilience Activities* as well as for *High-Capacity Agents,* and two of the most robust determinants for *High-Capacity Agents* are *Access to Assets*, followed by *Diversity and Flexibility*. Thus, it is consequential to consider the effects of normalization across the community resilience system and the impact that this numbing might have on key variables.

As has been discussed, *Learning and Knowledge* also shares a strong ties to High-Capacity Agents in how the Perception of Risk and Change is significantly associated with both Responsiveness and Independence. *Learning and Knowledge* is a robust determinant for Interaction with Robust Networks. Therefore, it is important in this system to build the capacities of agents in terms of Access to Assets, and Diversity and Flexibility in order to increase Learning and Knowledge for interaction with the necessary networks. It implies that while education and training is significant, its benefits are being restricted by the curtailing of these two key variables.

iii. Diversity and Flexibility

This is the second most important robust determinant for *High-Capacity Agent,* and it features as a robust determinant for all three regressors. It is correlated with Gender and Interaction with Networks, therefore identifying as a key mechanism to build adaptive capacity and enable resilience activities. However, it is interesting to note that despite its prominence, and a high frequency of references, it has the smallest number of co-occurrences. Furthermore, the scores for this variable are low in two of the components.

As noted earlier, the lack of reference to this variable may indicate its absence. However, the notable absence of reference to this indicator may also be due, in part, to normalization as it is assumed in the context of deprivation that aspects encompassing *Livelihood & Income*, *Economic Opportunities*, and *Occupational Mobility* would be extremely limited. As a symptom of normalization, as it is notable that the question related to Perception of Independence scored very highly – despite the multiple structural challenges being faced in Mathare. This links back to the point about the coping mechanism of willingness to recognize risks that are within the realm of action. This has potentially severe consequences for the capacity of agents considering the significant of the sub-variable perception of risk and change as part of learning and knowledge.

This indicates significant impact on agent ability to interact with robust networks. The low scores in Robust Networks and Supportive Institutions indicates that these mechanisms do not have the capacity to positively influence resilience activities and therefore are also largely ignored in interviews.

4.2.3 Resilient Community Components: A Complex Adaptive System

The complexity of these interconnected and overlapping relationships are framed here by the six characteristics of urban Complex Adaptive System (CAS) and Transition literature to identify leverage points within the system that might have the most positive impact towards Climate Resilient Development.

One of the main aims of framing the dynamics above is to clarify how complex causes can produce simple effects or how simple rules can have unpredictable consequences (Anderson, Meyer, Carley, Eisenhardt, & Pettigrew, 1999; Han et al., 2021). In CAS, three fundamental elements include agents, interaction, and the environment (Han et al., 2021) which is appropriate for an analysis of the community resilience system of Mathare described above as these three properties are prominent. The significant complexity within the system is framed as a CAS to provide insight into the mechanisms of cause and effect:

4.2.3.1 Mathare Community Resilience CAS

i. Emergence through Self-Organization

In CAS theory complexity is the result of a large number of heterogenous agents who interact according to individually defined features and objectives (Han et al., 2021). Across Mathare villages have distinct identities, and each individual develops their own objectives, motivations, and mechanisms necessary to achieve their aims. The community is comprised of diverse individuals and includes not only the residents, members of community level networks, engaged institutions, and governmental representatives, but individuals within the neighbouring edges, and daily visitors. In the context of informality and lack of governance capacity, the emergent system of organization has been described as a 'slum eco-system' as a form of quasi-government with its own distinctive dynamics and way of control.

ii. Open but Distinct Boundaries

CAS are open and fluid systems engaged in constant exchange with their environment (Han et al., 2021). The community of Mathare is an open system comprised of complex arrangements of heterogenous agents mentioned above. In this sense the Mathare boundary is permeable and blurred but has a boundary none the less which is defined by a scale of those who have dealings with the community. Within Nairobi, Mathare is a marginalized community existing in a state of survival limited by a lack of governance, assets, resources, and service provision. Subsequently it has been recognized that learning and innovation is curtailed by the relative isolation in which many people live. Therefore, although the borders may be permeable, a definite state of 'lock-in' prevails (Boschma, 2005), which has produced detrimental normalization of coping mechanisms, that perpetuate the stigmatization and further marginalization of the community system.

iii. Complex Components

In CAS a key consideration is the degree of multiplicity of agents as well as of their interactions and relationships (Han et al., 2021). The population of Mathare residents is large, and as has been discussed, the community includes the broader community of integrated stakeholders. For integration and analysis this broader population has been grouped into three main component groups, *High-Capacity Agents*, *Robust Networks*, and *Supportive Institutions*, as per the literature on community resilience systems. In this system

each component is comprised of internal interactions taking place between levels *Adaptive Capacity* and *Resilience Activities*, but which are highly influenced by the interdependent relationships that exist across all components.

iv. Non-linear dynamics

A significant effect of *component complexity* is the degree to which non-linearity – that is the degree of disproportionality between inputs and outcomes - exists across a system (Han et al., 2021). One way of assessing these dynamics is to account for positive and negative feedback loops, which can multiply the effect of particular inputs (Han et al., 2021).

A feedback loop exists between *Robust Networks* and *High-Capacity Agents* through which both components directly benefit from each other's development. *Diversity & Flexibility* is a key adaptive capacity in both components and shares significant relationships with aspects of *Learning & Knowledge,* making inputs at the intersection of these two sub-variables a key leverage point for outcomes that will affect both components. Their associated primary sub-variables, *Perception of Risks & Change* and *Willingness to Change,* have significant implications for the ability of individuals to raise their level of capacity in *Diversity & Flexibility* to interact meaningfully with *Robust Networks* and increase overall *Community Resilience*. Additionally, the most significant determinant of *High-Capacity Agents* is *Access to Assets*, which shares a strong correlation with *Interaction with Networks*. *Social Capital*, the primary sub-variable of *Access to Assets*, and is highly positively correlated with *Willingness to Change*. However, *Social Capital* also changes *Willingness to Change* in the same direction. Consequently, a feedback loop exists at the intersection of *High-Capacity Agents* and *Interactions with Networks* where inputs at the level of the sub-variables *Social Capital* or *Willingness to Change* will multiply effects throughout the system, with potentially significant outcomes on *Resilience Activities* of both components. In this case the feedback can be positive or negative, as the components move in the same direction.

Unfortunately, more complex feedback loops also exist across the system which can produce unproductive cycles of lock-in, and which require more significant system changes to restructure the effects. Using the same example of *Robust Networks* and *High-Capacity Agents* and focusing on the aspect of *Access to Assets* and the relationship between its primary sub-variable, *Social Capital* with *Perception of Risk & Change*, a very different picture is produced. *Social Capital*, the primary sub-variable of *Access to Assets*, has a significant negative correlation with *Perception of Risk and Change* where, as *Social Capital* changes, *Perception of Risk and Change* moves in the opposite direction. Consequently, an unproductive feedback loop exists surrounding *High-Capacity Agents* where, as *Access to Assets* might increase, *Learning and Knowledge* and *Diversity and Flexibility* would decrease – reducing the interaction of *High-Capacity Agents* with *Robust Networks* and *Resilience Activities*. This can be understood in the context of cartel influence and the specific context characterised by misunderstanding, lack of trust, and normalization of coping mechanisms to larger socio-economic dynamics which contribute to the complexities surrounding intervention.

v. Adaptability through dynamic interactions

CAS are, by definition, adaptive. This means that these systems are capable of adjustment necessary to internal struggles and external threats while maintaining their core functions through continual transformation and dynamic adaptation (Han et al., 2021; McDaniels et

al., 2008). In Mathare the level of adaptability emerges through the engagement of adaptive capacities in resilience activities within each component, as well as by the relationships and interactions between each component, the structure of which has been confirmed. The mechanisms of these actions are determined by this structure of the system, as well as in response to external disturbances, and reflect the non-linear dynamics identified as feedback loops. This can be the case for intentional external inputs as well as unexpected disturbances.

vi. Sensitivity to initial conditions

A combination of feedback loops and non-linear relationships create conditions of uncertainty, which are described as sensitivity to initial conditions. Through this lens, this characteristic describes the current state of a CAS via a combination of historical system structure and new pathway developments (Han et al., 2021). For example, in the case of the water kiosks intervention where institutions tried to intervene, but the dynamics surrounding the existing networks were so robust that no headway could be made, resulting in institutional retracting. The unintended consequences of feedback loops, dynamic interactions, and adaptability affected the ability of the institutions to meaningfully support networks at community level and connect agents who are subject to these forces of slum ecosystem dynamics. In this sense cartels are significant posing a challenge to the theory as they are an incredibly adaptive and resilient subsystem within the community and are a disrupting and destabilizing factor. This subsystem highlights the significance of ensuring an assessment of the entire system is conducted – not just as components in isolation – in order to measure the key measurables and assess how system works together.

4.2.3.2 Resilient Community Components: A Complex Adaptive System

In order to enable Climate resilient development in Mathare transformational adaptation is required. The level of adaptive capacity within a system determines the system response (resilience activities), when exposed to disturbances (McDaniels et al., 2008). 'Management' of this system requires an acknowledgement of the complexity of this environment and the autonomy of the actors within the system. The dynamic interactions, non-linear relationships and numerous feedback loops have resulted in fractured 'institutional norms', and complex development pathways. Marginalization, and the lack of supportive institutions have the effect of producing various emergent properties as coping mechanisms at the systemic level of the community interactions. This peripheralization and neglect embeds a 'lock-in' effect which normalizes survival mechanisms that strip individuals of their dignity. By framing this research on community resilience as a CAS, key conclusions regarding the level of resilience can be drawn.

This analysis shows that the adaptive capacity of the current system has met its threshold for what is feasible to be addressed at the community scale, indicating that soft limits have been reached. If real transformation to a state of increased resilience is to be made, then a range of constraints, (which primarily consist of financial, governance, institutional and policy constraints) will need to be systematically addressed. Institutions need to play a far more supportive role by removing the key barriers identified and supporting community level networks and agents to build the required adaptive capacities. Increased systemic robustness and adaptation to the realities of urbanization impacts, and climate risks that go beyond the

immediate challenges of every day and call for policy shifts that reframe system capacities for transition towards patterns of Climate Resilient Development in Mathare.

This will require bold action. The IPCC states that, "transitioning from incremental to transformational adaptation can help overcome soft adaptation limits" (IPCC, 2022: 29) and that the window to enable climate resilient development pathways is rapidly narrowing (IPCC, 2022: 32). To overcome the challenges in Mathare transformational approach is needed to leverage key points in this system which revolve around the issues of embedded cartels, poverty, and normalization, which translates into an acute need to address institutional neglect, to recognize coping mechanisms of poverty, and to develop strategies to decrease isolation.

Chapter 5: Conclusions and recommendations

5.1. Conclusions

This study set out to establish the influence of the current adaptive capacities and resilience activities on community resilience in three component levels of governance in Mathare which were posited to be necessary for a transition towards climate resilient and sustainable development. The value of the study was intended to be an empirical contribution to both the application of theoretical developments in the conceptualisation of adaptive capacities and resilience activities on community resilience, and specifically to this complex locality in order to inform effective strategic responses at the levels of both policy and action.

This research has demonstrated the applicability of the key current theoretical constructs to this locality. The theoretical framework has provided an effective basis for the analysis of adaptive capacities and resilience activities in Mathare. In particular, the theoretical framework provided an adequate basis for a research design that was able to establish the levels of resilience in each component level in Mathare and the interrelationships within and between these. The study was able to establish factors associated with, and mechanisms which influence, community resilience in Mathare. It explored the interconnections of resilience components within a community network from an urban resilience standpoint. It identified leverage points based on empirical evidence, in-depth case study, and statistical analysis to draw conclusions as to the mechanics of relationships in the context of this post-colonial sub-Saharan African city, where informal settlements are in a state of deprivation and are at significant risk.

Key findings (explained in Chapter 4) include

Corruption, Cartels, and Land Ownership | Institutions

There is an acute need to address soft limits on institutional reform around land management and service delivery practice in Mathare. The impact has been shown to significantly impact on key community resilience indicators including: levels of trust, social capital, planning capacity, rights and entitlements, supportive institutions, governance, and access to assets.

Lack of Service Provision and Poverty as Violence | Networks

Multiple coping mechanisms have been developed in response to an acute need for robust networks across all domains, many of which compound the existing risks, and introduce new ones. System functioning is maintained through precarious systems that are fragile and

symptomatic of larger structural issues. These networks need to be recognized for the role that that play and be supported to build core capacities to support community resilience. Learning and knowledge is critical and must be supported as it is connected to multiple positive feedback loops between Robust Networks and High Capacity Agents.

Environmental Risks and Normalization as Coping | Agents

Individuals are neglected and unrecognized and have subsequently normalized negative coping mechanisms that often perpetuate violence of different forms. Support initiatives that contribute to integrating Mathare into the city to break normalization and lock in, as it is shown to have detrimental effects across multiple adaptive capacity indicators. Communication infrastructure is critical to support mechanisms that have the potential to break the effects of cognitive, organizational, and social lock-in present in Mathare.

Resilient Community Components: A Complex Adaptive System

The Community Resilience System in Mathare is a complex adaptive system which is characteristically unpredictable. However key leverage points do exist and have been identified. Transformative resilience is needed. Soft limits need to be removed, and institutions need to play a far more supportive role to connect agents to systems in Mathare so that the system can benefit from the feedback loops identified.

Climate resilient development involves questions of equity and systems transitions (IPCC, 2022) which go beyond city or even national scale, and the findings of this research can be seen to have implications at a broader scale. Global inequities and the climate crisis requires transformational transitions in our approach to the development of cities around the world. Recognition that planning of our global systems of trade and provision were developed in more stable socio-economic and climatic periods, requires recognition that sustainable development depends on achieving a level of global levels of equity and adaptive capacities to maintain system function into the next century. Institutions at a global scale will need to play a far more supportive role.

Further research could include testing these results in a similar context, or at a different scale, to compare findings and identify points for clarification or refinement. Quantitative analysis of the institutional and community network capacities and resilience activities would add value for cross comparison. This study could be developed into a more comprehensive and detailed assessment of the adaptive capacities and resilience strategies on each component for policy development.

These findings may assist in the development of strategies that will enable individuals or groups to self-organize, increase knowledge, and contribute to the appropriate planning in this urban context. Specific recommendations in this regard follow.

5.2 Recommendations

The most critical issue to be addressed is land ownership and security of tenure. Bold action and significant investment are needed to transform the limiting factors that shape life in Mathare. Climate change will compound the challenges being faced and is expected to increase with every degree of warming (IPCC, 2022). The best time to act is now. Planning policy must be developed to address these challenges and break the status quo.

The significant role of community networks in the provision of critical services must be recognized and incorporated into the transformational development strategy for Mathare. These networks not only provide necessary services, but also engage agents in networks which provide opportunities for learning and diversification of capacities. Specific policies that support their development and integration would benefit the community as a whole, and would include supporting mechanisms of ICT infrastructure, and the dissemination of powers, capacity building and increased funding. Learning and Knowledge is a key leverage point and must be capitalized on to break lock in and improve integration.

This is no easy task as the systems which have developed in Mathare are complex and robust. However as one respondent describes :

"...it can be done. It just requires people with the right thinking... And who are brave enough to break ground"

11:46 p 45. Respondent 13

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Annex 1: Research Instruments and Time schedule

A 1.1 Field Work Time Schedule

Date	Activity	Location	Partners
May	Research Design	Rotterdam	IHS
31 May - 3June	Introduction to Mathare, participation in ongoing Urban Resilience project.	Mathare	International Centre for Frugal Innovation in Africa (ICFI); Ghetto Foundation.
6 June	Planning Meeting	Mathare	ICFI; Ghetto Foundation.
7 June	Quantitative Survey Starts	Mathare	International Centre for Frugal Innovation in Africa (ICFI); Ghetto Foundation.
7 June	1. Community Interview 1	Mathare	Mathare Social Justice Coalition
8 June	2. Community Interview 2	Mathare	Delightsome Community Initiative
9 June	3. Community Interview 3	Mathare	Generation Shapers
10 June	4. Community Interview 4	Mathare	Muungano
10 June	5. Community Interview 5	Mathare	Moja Wi-Fi
13 June	Quantitative Survey Ends	Mathare	International Centre for Frugal Innovation in Africa (ICFI); Ghetto Foundation.
13 June	Survey Reflection Meeting	Mathare	ICFI & Ghetto Foundation
16 June	6. Institutional Interview 1	Westlands	Nairobi Water
16 June	7. Institutional Interview 2	Westlands	Mazingira Institute
17 June	8. Community Interview 6	Mathare	Ghetto Foundation
20 June	9. Community Interview 7	Mathare	Community Elder
21 June	10. Institutional Interview 3	Mathare	Mathare Assistant Chief
21 June	12. Community Interview 8	Mathare	Red Cross – Emergency Services?
27 June	Survey Reflection Meeting	Mathare	ICFI & Ghetto Foundation
28 June	12. Community Interview 9	Mathare	Mathare Foundation
28 June	13. Institutional Interview 4	Westlands	ICFI
28 July	14. Institutional Interview 5	Online	UN-HABITAT
28 June	Leave Nairobi, Kenya		
August	Data Analysis	Rotterdam	IHS
19 September	Draft Submission	Rotterdam	IHS
17 October	Second Submission	Rotterdam	IHS

A 1.2 Household Quantitative Survey Questionnaire

The following survey was carried out using a digital application on a cell phones and which were automatically recorded.

Questions are presented in the order they were asked with the codification related to the operationalization table indicated.

1. Name of interviewer

_____

2. Name of respondent

_____

3. Location

4. Gender (SD.1)

   Male | Female | Intersex

5. Age (SD.2)
6. Area

_____

7. Distance from river (SD.3)
8. Religion (SD.4)
9. How many shillings do you make on average p/day? (VX1.2)

0-100 | 100-500 | 500-1000 | 1000+

10. I have many sources of income (VX1.3)

Disagree | Slightly disagree | Slightly agree | Agree

11. I have many skills to swap or sell (VX1.5)

Disagree | Slightly disagree | Slightly agree | Agree

12. I have many economic opportunities available to me (VX2.1)

Disagree | Slightly disagree | Slightly agree | Agree

13. The resources I have are enough for me to get by. (VX1.4)

Disagree | Slightly disagree | Slightly agree | Agree

14. I am willing to travel far distances every day to earn an income (VX2.2)

Disagree | Slightly disagree | Slightly agree | Agree

15. I can do my income generating activity anywhere (VX4.1)

Disagree | Slightly disagree | Slightly agree | Agree

16. How far do you travel each day to earn income? (VY39)

less 1km | 1-3km | 3-5km | 5+km

17. How much of the year are you in Nairobi? (VX6.1)

A few weeks | A few months | Most months | Always

18. What is your house made out of? (VX14.1)

I don't have a house | Mud & Wood | Tin / Iron Sheet | Bricks/Stone

19. House structure

(Photographs attached)

Sample

20. My household assets are very valuable to me (VX14.2)

Disagree | Slightly disagree | Slightly agree | Agree

21. I am dependent on the river/stream/dam for water (VX3.1)

Agree | Slightly Agree | Slightly Disagree | Disagree

22. I am dependent on local trees for firewood (VX3.2)

Agree | Slightly Agree | Slightly Disagree | Disagree

23. I depend on water or wood to earn money (VX3.3)

Agree | Slightly Agree | Slightly Disagree | Disagree

25. What devices do you have? (VX11.2)

None | Dumbphone | Smartphone | Laptop | Others (checklist)

26. I can connect to the internet whenever I need to (VX11.1)

Disagree | Slightly disagree | Slightly agree | Agree

27. I am confident using a smartphone (VX8.1)

Disagree | Slightly disagree | Slightly agree | Agree

28. I am confident using a computer (VX8.2)

Disagree | Slightly disagree | Slightly agree | Agree

29. I use formal banking (VX16.1)

Disagree | Slightly disagree | Slightly agree | Agree

30. I use applications to access formal banking (VY20)

Disagree | Slightly disagree | Slightly agree | Agree

31. I can get formal credit/loans (VX16.2)

Disagree | Slightly disagree | Slightly agree | Agree

32. I participate in informal saving groups (merry-go rounds) (VY30)

Disagree | Slightly disagree | Slightly agree | Agree

33. I have an international relative that sends me money (VX 17.1)

Disagree | Slightly disagree | Slightly agree | Agree

34. I have electricity as much as I need (17.2)

Disagree | Slightly disagree | Slightly agree | Agree

35. I use applications to get hold of electricity (VY25.1)

Disagree | Slightly disagree | Slightly agree | Agree

36. I can use a toilet whenever I need (VX17.3)

Disagree | Slightly disagree | Slightly agree | Agree

37. I can get hold of health care when I need it (VX17.4)

Disagree | Slightly disagree | Slightly agree | Agree

38. I use applications to access healthcare (VY24)

Disagree | Slightly disagree | Slightly agree | Agree

39. There are lots of places to get healthcare in and around Mathare (VX14.5)

Disagree | Slightly disagree | Slightly agree | Agree

40. I can always buy food for me and my family when we need it (VX17.5)

Disagree | Slightly disagree | Slightly agree | Agree

41. I can always get clean water when me and my family need it (VX17.6)

Disagree | Slightly disagree | Slightly agree | Agree

42. I use applications to access clean water (VY25)

Disagree | Slightly disagree | Slightly agree | Agree

43. There are lots of places to get clean water in and around Mathare (VX14.4)

Disagree | Slightly disagree | Slightly agree | Agree

44. I use multiple sources of clean water (VY28)

Disagree | Slightly disagree | Slightly agree | Agree

45. I use applications to get specific information about water availability (VY25.0)

Disagree | Slightly disagree | Slightly agree | Agree

46. I use education/general information applications (google/coursera/etc) (VY19)

Disagree | Slightly disagree | Slightly agree | Agree

47. I use social media applications (facebook/whatsapp/tiktok/etc) (VY21)

Disagree | Slightly disagree | Slightly agree | Agree

48. I use news apps (youtube/tukonews/etc) (VY22)

Disagree | Slightly disagree | Slightly agree | Agree

49. I use weather apps (accuweather/google/ etc) (VY23)

Disagree | Slightly disagree | Slightly agree | Agree

50. I use apps to get specific information about flooding (VY23.1)

Disagree | Slightly disagree | Slightly agree | Agree

51. I use transport apps (Bolt/Uber/Ava/Lithu/food delivery apps/etc) (VY26)

Disagree | Slightly disagree | Slightly agree | Agree

52. I use any apps to make money directly (e.g. watching adds for data/freelancer/fiver/upwork/remotask/etc) (VY27)

Disagree | Slightly disagree | Slightly agree | Agree

53. I feel that the internet provider is reliable (VY34)

Disagree | Slightly disagree | Slightly agree | Agree

54. I feel that the water provision is reliable (VY35)

Disagree | Slightly disagree | Slightly agree | Agree

55. I feel that community organizations are reliable (VY36)

Disagree | Slightly disagree | Slightly agree | Agree

56. I feel that the government is reliable (VY37)

Disagree | Slightly disagree | Slightly agree | Agree

57. What is your level of education completed? (VX15.1)

None | Primary | Secondary | Tertiary

58. I have specific skills training (VX15.2)

No | Yes

59. I think education is important (VX12.4)

Disagree | Slightly disagree | Slightly agree | Agree

60. I am doing specific skills training currently (VY10)

No | Yes

61. I am doing general education programs currently (VY9)

No | Yes

62. I have learnt a lot about traditions and living in Mathare from my community elders (VX20.1)

Disagree | Slightly disagree | Slightly agree | Agree

63. I have a lot to teach the younger generation about traditions and living in Mathare (VX20.2)

Disagree | Slightly disagree | Slightly agree | Agree

64. I think I would be happier if I had the opportunities to grow and develop further (VX7.1)

Disagree | Slightly disagree | Slightly agree | Agree

65. I think I would be happier if Mathare could develop further (VX7.2)

Disagree | Slightly disagree | Slightly agree | Agree

66. A healthy natural environment helps me a lot (VX7.4)

Disagree | Slightly disagree | Slightly agree | Agree

67. I am willing to increase my level of education (VX7.5)

Disagree | Slightly disagree | Slightly agree | Agree

68. I am willing to try learn new skills (VX7.6)

Disagree | Slightly disagree | Slightly agree | Agree

69. I have learnt new skills that I use in past 5years (VY50)

Disagree | Slightly disagree | Slightly agree | Agree

70. I try solutions/ideas that I am not sure will work just in case (VY12)

Disagree | Slightly disagree | Slightly agree | Agree

71. I know about flooding and how to prepare for it (VX9.2)

Disagree | Slightly disagree | Slightly agree | Agree

72. Does it flood every year? Or more or less? (VX10.1)

No | Yes

73. I feel safe when flooding happens (VX10.4)

Disagree | Slightly disagree | Slightly agree | Agree

74. There is enough rain every year for our needs (VX10.2)

Disagree | Slightly disagree | Slightly agree | Agree

75. How many times a week do you access water (VY38)

Never | Once a week | A few times a week | Always

76. I have heard about climate change and know what it means (VX9.1)

Disagree | Slightly disagree | Slightly agree | Agree

77. I know many environmental organizations (VX25.1)

Disagree | Slightly disagree | Slightly agree | Agree

78. I feel close to nature (VX25.2)

Disagree | Slightly disagree | Slightly agree | Agree

79. I feel closer to nature by doing… (Range of answers manually filled in)

80. I feel it is my responsibility to take care of nature (VX25.3)

Disagree | Slightly disagree | Slightly agree | Agree

81. I feel the environment in Mathare is healthy (VX19.2)

Disagree | Slightly disagree | Slightly agree | Agree

82. I think waste management is managed well in Mathare (VX25.4)

Disagree | Slightly disagree | Slightly agree | Agree

83. I participate in community cleanup/waste management activities (VY16)

Disagree | Slightly disagree | Slightly agree | Agree

84. I feel there are leaders in flood management (VX26.1)

Disagree | Slightly disagree | Slightly agree | Agree

85. I feel there are leaders in environmental issues (VX26.2)

Disagree | Slightly disagree | Slightly agree | Agree

86. I feel there are leaders in water/sewage/roads/electricity (VX26.3)

Disagree | Slightly disagree | Slightly agree | Agree

87. I feel like government acts well during floods (VX28.1)

Disagree | Slightly disagree | Slightly agree | Agree

88. I feel government acts well in supplying water (VX28.2)

Disagree | Slightly disagree | Slightly agree | Agree

89. I feel the community works together to deal with floods (VX28.3)

Disagree | Slightly disagree | Slightly agree | Agree

90. I feel the community works together to deal with getting clean water (VX28.4)

Disagree | Slightly disagree | Slightly agree | Agree

91. I plan for the future (VY3)

Disagree | Slightly disagree | Slightly agree | Agree

92. I organize the household (VY2)

Disagree | Slightly disagree | Slightly agree | Agree

93. I feel like I have the ability to the solve problems I face (VX12.2)

Disagree | Slightly disagree | Slightly agree | Agree

94. I feel that in time problems will get better if I keep trying (VX12.3)

Disagree | Slightly disagree | Slightly agree | Agree

95. I have already solved some of my problems (VY1)

Disagree | Slightly disagree | Slightly agree | Agree

96. I have many friends in the neighbourhood that help me when needed (VX18.4)

Disagree | Slightly disagree | Slightly agree | Agree

97. I have many friends outside Mathare that help me when needed (VX18.5)

Disagree | Slightly disagree | Slightly agree | Agree

98. I know important people that help me when I face problems (VX18.6)

Disagree | Slightly disagree | Slightly agree | Agree

99. I am currently looking for solutions to flooding and water access (VY5)

Disagree | Slightly disagree | Slightly agree | Agree

100. I have a way to keep track of my resources (VY32)

Disagree | Slightly disagree | Slightly agree | Agree

101. I have a way to know if my solution is working (VY33)

Disagree | Slightly disagree | Slightly agree | Agree

102. I have the right to vote (VX18.3)

No | Yes

103. I always vote (VY45)

Disagree | Slightly disagree | Slightly agree | Agree

104. I feel a sense of togetherness and support in Mathare (VX21.1)

Disagree | Slightly disagree | Slightly agree | Agree

105. There is a lot of trust in Mathare (VX21.2)

Disagree | Slightly disagree | Slightly agree | Agree

106. I feel men and women are treated equally in Mathare (VX22.1)

Disagree | Slightly disagree | Slightly agree | Agree

107. I have good interactions with the opposite gender (VY52)

Disagree | Slightly disagree | Slightly agree | Agree

108. I have good interactions with other ethnicities ((VY53)

Disagree | Slightly disagree | Slightly agree | Agree

109. I have good interactions with other nationalities (VY54)

Disagree | Slightly disagree | Slightly agree | Agree

110. I feel that people in Mathare plan changes together (VX24.1)

Disagree | Slightly disagree | Slightly agree | Agree

111. I feel that people in Mathare make decisions together (VX23.1)

Disagree | Slightly disagree | Slightly agree | Agree

121. I feel that there is outside support from government or institutions (VX18.1)

Disagree | Slightly disagree | Slightly agree | Agree

113. I feel that it would be good if there was more outside support from government or institutions (VX7.3) Disagree | Slightly disagree | Slightly agree | Agree

114. I feel like the government plans for change (VX24.2)

Disagree | Slightly disagree | Slightly agree | Agree

115. I feel like the government makes good decisions (VX23.2)

Disagree | Slightly disagree | Slightly agree | Agree

116. I participate in community planning (VY16)

Disagree | Slightly disagree | Slightly agree | Agree

117. I participate in community awareness activities (VY17)

Disagree | Slightly disagree | Slightly agree | Agree

118. I want to participate in community programs (VX7.9)

Disagree | Slightly disagree | Slightly agree | Agree

119. I participate in political activities (VX18)

Disagree | Slightly disagree | Slightly agree | Agree

120. I want to participate in political activities (VX7.10)

Disagree | Slightly disagree | Slightly agree | Agree

121. I want to learn about new technology (VX7.11)

Disagree | Slightly disagree | Slightly agree | Agree

122. I try to first solve my problems with technological solutions (VY27)

Disagree | Slightly disagree | Slightly agree | Agree

123. I am always looking for new ways to collaborate (VY6)

Disagree | Slightly disagree | Slightly agree | Agree

124. I get Information from Government (VY46)

Disagree | Slightly disagree | Slightly agree | Agree

125. I use e-citizen to get services from the government (VY27.2)

Disagree | Slightly disagree | Slightly agree | Agree

126. I give information to the government (VY47)

Disagree | Slightly disagree | Slightly agree | Agree

127. I have had visits from government officials in the last year (VY48)

Disagree | Slightly disagree | Slightly agree | Agree

128. I have had visits from community researchers to in the last year (VY49)

Disagree | Slightly disagree | Slightly agree | Agree

129. I have protested/campaign for rights in the past year (VY42)

Disagree | Slightly disagree | Slightly agree | Agree

130. I have protested/campaign for services in the past year (VY43)

Disagree | Slightly disagree | Slightly agree | Agree131. I have participated in government schemes in the past year (VY55)

Disagree | Slightly disagree | Slightly agree | Agree

132. My general level of health is good (VX19.2)

Disagree | Slightly disagree | Slightly agree | Agree

133. I feel independent to live how I want (VX1.6)

Disagree | Slightly disagree | Slightly agree | Agree

134. I feel like I can make the changes I want to see in Mathare happen (VX12.2)

Disagree | Slightly disagree | Slightly agree | Agree

135. I like living in Mathare (VX5.1)

Disagree | Slightly disagree | Slightly agree | Agree

136. I feel safe when at home (VX5.2)

Disagree | Slightly disagree | Slightly agree | Agree

137. I spend most of my income on my own needs (VY13)

Disagree | Slightly disagree | Slightly agree | Agree

138. I spend most of my time on my own needs (VY14)

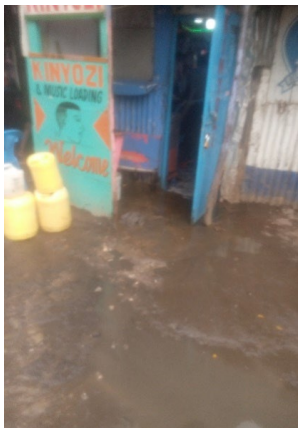
Disagree | Slightly disagree | Slightly agree | Agree

139. I participate fully in household decisions (VY15)

Disagree | Slightly disagree | Slightly agree | Agree

140. River/water channels and storm drains*

(Photographs attached)
Sample:



Annex 2: Interview Transcription Excerpts

Full transcriptions available on request. Only excerpts have been included here.

A.2.1 Community Interview 1 | Ghetto Foundation

1 02:37
Ya, that's how we started like now the community work. Because Mathare did not receive so many services that the local government then offered to other estates. We could see them, maybe the local government workers along the Juja road, but now getting inside the Mathare, they could not. So we had so many challenges with garbage disposal, we had a lot of issues with sewer blockages which were unattended, you know. Whenever there was an outbreak of diseases, so many people could be affected, especially by typhoid, or malaria due to mosquito breeding. Also, dysentery and cholera, so many diseases that affected the people. And also you see they are no public hospitals in Mathare.

Jessica Metcalfe 03:33
Are there still none hey, theres clinics?

1 03:35
Yeah, there are so many private clinics right now. And also the same to that time, so, many people could incur a lot of costs in getting medical care, you know, buying drugs and such things. So people born and brought up in Mathare and also going to now access to basic education. These are things that we solve and thought we could start for our community. Maybe give back and make our community good. Because we used to visit our friends who lived from other areas, and they need in totally different environment than ours. And so because also we wanted them, when they came, they come to our area and they see that change. So that was the drive that we had. Although our capacity was very small, as compared to maybe what the government can do or maybe other bigger organizations that are tasked with that work. So we could do the little we can. We could organize maybe like cleanups every Saturday. When other people are not in school, they could come and clean. So the only challenge remained now after cleaning where are we going to take the garbage that we have cleaned? So most of the time we took them to the river.. which was also not good because we... initially the rivers we have here in Mathare had very clean water.

Jessica Metcalfe 05:07
Like when you were younger?

1 05:08
Ya, when we were younger. We could go swimming in the river. We could go fishing. They had some fish, small fish. We used to go there and fish. We had the vegetation along the river where we could go, you know, looking for birds and would carry salt and matchbox, and some ugali so that when we went for hunting for the, for the birds, you could just cook them there. We enjoyed our Mixture. Ya, the whole of that area across the river was not there that came recently.

Jessica Metcalfe 05:44
Really, like all that building?

1 05:48
Yeah, that was not there so, it was vegetation. That came around 1998 thats when the then MP allocated people to go there and live.

Jessica Metcalfe 06:02
Oh, really? So they gave that land to people?

1 06:04
They give to those people who were evicted from the... see where we had the school? Along, as you go to Mlambo Kubwa, there is a place we have the school and then we have the space behind it. So that space behind it where we have the garbage. That's space behind it was a village. Ppeople were there. So after they were evicted, and the houses are demolished, some were relocated there.

Jessica Metcalfe 06:35
Why were they relocated - why were they evicted from that space in particular?

1 06:39
Because it is a public school for the mosque. And also the the school. So that's why they were taken there. But then also political games were at play. Yah I think the then MP also wanted to gain some mileage. So...

Jessica Metcalfe 06:59

through moving people? Or through creating new housing?

1 07:03
No, they just gave people the space. So they were to build for themselves. Yah, so I think that's - just wanted to show the people that he is working, and you know he is caring.

Jessica Metcalfe 07:18
Did those people get like land title? Like do they own that land?

1 07:22
Ah to date They don't have any, any papers or documents showing that that land belongs to them. The land is also, has been, each and every time, you know, emotive issues coming out because the are looming cases of them being evicted also from that area, because also it is near the police depot. So the police have also been claiming the area belongs to to them. But now because the police are government and also the land belongs to government. That issue has also taken - every time it takes some twists.

Jessica Metcalfe 08:06

Yeah. So people never know what to expect really?

08:08
So people don't know what to expect and maybe one day they will wake up and see tractors demolishing, so people still live in fear and anxiety not knowing.

08:22
Sho, its terrible. And people in Mathare? It's the same isn't it? Like? I mean, it's not - have evictions ever happened in Mathare?

08:31
Ya! So many, so many times. But now it's very tricky how evictions happens here in Mathare. Because normally they are political. You find that there are people being evicted from one area because they belong to a certain tribe. And yeah, they support a certain political party or partake... they have those parties. So whenever there is like now, there is the coming election, and this is the campaign periods. So, like this year has been so special, we have not heard about those things. But in the previous years, there are those on their alignment. People start aligning themselves according to tribal lines, according to party lines. And that's why you find that there are dominance of communities in each and every village. So when you go and come to this village, there is a dominance tribe. And you go to the other there is a dominant tribe. So that's how people have regrouped themselves and live, like in a comfort zone, you know where they feel safe.

09:44
So it's partially because people did it naturally to themselves, but it's also partially because people were moved when there was like, integration happening?

09:50
Yeah, because there was those tension, like in 2007 when we had post election violence here and so, people were fighting according to.. We have this tribal discrimination... So from there, people started now to grouping and living inthat group. But then there is, we can call it maybe the classical evictions whereby maybe you have a land here, but the structures are not yours. And maybe you want to develop that land. But now you cannot evict the slum dweller. You find that people cause fires... they come and burn the houses sometimes.. and so they don't care whether people will be killed or lose properties. So that has been happening, that has been happening.

10:47
So, before any of the other issues come it's like - just being here so precarious. Like you may - your house may be here when you come home, or may not. May be moved and may not?

10:55
Ya, yes. Many people go to work and come back and you know, they don't know where their houses were. You cannot get any of your property. Because you went to work, and when you're at work, you know, some fire came out. And most of the causes of fires are not mostly established. So it's very interesting to see that there are some people who can do that. Come and burn the house so that they can acquire the land back. Yah. And that is partly because also the justice system doesn't work very well. It is also a very long and a tedious process. So most people don't want to go to court because even if you go to court, then the case will be pushed and pushed and pushed.

11:04
Yeah. And how do you prove it? Like, like, in that case? How do you? This there's not enough infrastructure to prove how I actually started so it's like,

11:56

Yah, and also I'm talking of the owners of the land. Even if they go to maybe to the court for justice for them to reclain the land back still it takes some time. So that's why maybe they take the shortcut and they want to burn the houses and maybe evict people.

12:18
How do those people get ownership though? Because as far as I understand, like Mathare is deemed an informal area... so there's - who owns the land if it's - because it's people squatting technically?

12:28
Yeah.

12:29
Is it government land? Or is it owned by private? Like people?

12:34
We have different types of ownership here in Mathare. We have like government land, like now on the other side of the river. That's totally on government land. So people don't have any documents on that. Then on this side, like now this building we are in... We have private ownership. Like these people, some of them have titles... Title deeds to the land the occupy

13:05
Okay, so like these buildings, which are like big buildings are owned by the land owners?

13:10
Yeah, and not even big buildings, but also the, the iron sheet houses there are there are some who also have the title deeds they have the documents. And then we have other land that is also societal, owned by like, cooperative societies. They came and bought that long time ago and they divided and subdivided the land, or maybe they developed the land.

13:10
Okay. And so they are less at risk because they have title, they have an agreement to own that land?

13:41
Yes, they have the documents, they have the documents. So they can develop the land they can build anything they want.

...

25:37
We use our, as I said, we are diverse in the way we work. We use our own experience, because like, most of us have been in different ventures, different businesses. So we use our own experience and tell them - give our own stories, how you are able to come out of, you know, because also some of us were engaged in crime in one way or the other... When you are growing up. Because like when you're growing up in Mathare, as a young person, you are attached to a certain gang.

26:18
Yeah.. they're called clicks, I think?

26:20
Ya. We call them clicks. Here we call them like base. So this is my base. Like, for me, I belong to Manokhi base (Laughs). So, we have also can be Motor(?), we have (?). We have different bases. And in those bases, you know, because of unemployment issues, and you want also to make a living, you find that most of you engaging in crime.

26:50
And you young, you kind of, you know, you think always it's not that it's fun, but you kind of - you do what you need to do.

27:57
Yeah. And also you have to eat. Yah, because maybe you you're dependent on yourself, you have to pay the rent. Maybe you're a young person and you have a girlfriend. So you want to entertain the girlfriend. So with all those pressures, you find yourself indulging in crime.

27:14
But women also participate in crime?

27:41
Very much. Very much. Here also, most of them have participated in organizing and carrying the report. Also in maybe like, planning, planning where maybe I'm also surveying where you want to go and commit that crime. So they have participated very much

27:44
So in that way, it's Gender Equality? (Laughs)

27:53
Ya there is gender equality in crime (Laughs). What a man can do a woman can do better.

…

1 29:45
Like a 70% of the people in Nairobi in the informal settlement in the Eastlands of Nairobi now

Jessica Metcalfe 29:54
Yeah, and it's crazy. I mean, that is a colonial legacy. Like I was looking at that map from - whatever, like the 1930s or 20s and Mathare existed, Kibera existed, and it was all like 5% of the city land was given to 80% of the population. And it hasn't changed.

1 30:11
Yah. It hasn't changed, which hasn't changed. And that's same same thing that is happening now. Because still the way it used to be like a squatter... It is the same way. So it is like now there's still the servants quarters that work in other peoples area, and they come back to the servants quarter.

Jessica Metcalfe 30:33
Yeah, it's weird, I was, I was thinking about it, that it's like the colonial setup, just got replaced by international agencies and other elites.

1 30:45
Yah.

Jessica Metcalfe 30:46
Like, even though the colonial is technically left, all those - all that space, and all those systems and infrastructures are just taken over by another small population of elite people, but nothing really changed. It seems like the dynamics are the same.

1 30:59
Yeah, like during the COVID time, there was a time they surrounded Eastleigh with police so that that people will not get inside there. So it's like they were saying there is COVID in Eastleigh. But it is like they were protecting the people from, so that people from Mathare cannot go there. So they were thinking that people from Mathare will spread COVID to...

…

New recording

1 0.12
legitimacy and people. So mostly it is referrals. And also those youths who have been trained who have gone through the entrepreneurship training here. Also the refer others. And maybe where, even if they get other connections from other organizations - so they are able to put our name on the map

…

Jessica Metcalfe 21:08
So you feel like people have learned like, when you have these peace, like, what did you call them? Peace...

1 21:13
Peace dialogues?

Jessica Metcalfe 21:16
Do you talk explicitly about 2007 and that stuff?

1 21:19
Yes, yes. We even have photos and videos of what happened, and we show people. Like now, Sunday, there is the one that will be done in Ruaka. You know Max? The one who was.. he's organizing one on the other side of the river on Sunday. So there shall be showcasing of the pictures of 2007. And also the videos, and also speeches, and people talking on the importance of peace during elections. And you see now also to tackle revenge, because there are those those small children who lost their relative. Like, maybe you are two years by then, and you lost your parent out of the violence. And now you see it is like 14 years later, you are now a teenager. So maybe you want to do the revenge. So that's why it was important for this dialogues to continue, you know, so that it can sink in the people's mind that peace is very important. Ya, peace is very important.

…

1 42:56
Yes, I think because of the disruptive weather now we don't have those heavy rains nowadays. So of late I have not seen like that serious floods along the rivers. We do have but sometimes when it rains, you know, people have to move from the houses they live.

Jessica Metcalfe 43:19
Yeah. So when it does rain people just take the valuables and go to high ground and wait for it to..

1 43:25
Ya, wait for the water to recess and to go back.

...

1 44:32
Yeah, I think when it rains, there are diseases that comes with it. And especially because of water contamination .Because even the water piping, most of the pipes go through the same the sewer. Sometimes this water is exposed to the sewer

…

1 45:00
Yah some you know have also been like... you know there are also people using this water. So sometimes they also fault them and they're able to connect the water to the different areas. So in the process you find the water is contaminated. So when it rains especially the heavy rains feel that the water sometimes is also brown

Jessica Metcalfe 45:33
Coming out the pipes? Ya, out the pipes ya. So with that water we find is not fit for consumption. But now because we don't have alternative.. maybe you don't have the luxury of boiling the water.. ya, you find that many people are affected. In fact there is cholera. Sometimes there is issues of stomach ache Having parasites and stuff?

1 46:02
ya having parasites and.. And also when it is in the dry season to find that is there is that kind of flu that we also get.. and also we experience like dry throats.. they are itchy. And I think that is brought by now inhaling the dust that is contaminated also. Becasue many people also use... they use the open fields fordefecation. So you find that also the soil and the dust is contaminated.

Jessica Metcalfe 46:50
Interesting ya I suppose even here like if it's dry and then things start drying and then it gets airborne?

1 46:53
Ya it gets airborne. So that pollution in the air pollution and the soil pollution affects people very much. So you find that most people are coughing especially the children. When they go to school, they - because the the flu is contagious. In a class of 40 children, like all of them, are coughing, you know they having a runny nose.

...

1 48:18
Oh, we still have the last.. oh the last one now is also we have a component of human rights work and also the activism. So there are so many social injustices in the community that we try and address. We have issues of extrajudicial killings, where we have so many young people are
killed by police

Jessica Metcalfe 48:43
Is it these police on the mountain? Or is it just police in general from around anywhere?

1 48:49
The police from around we have so many police stations around so all the police from those stations. We have so many cases of our young people being killed by police. You know, the Kenyan constitutions are, the Constitution is very clear. When you are arrested you are supposed to be taken to police cell. And then you are taken to court for you to follow now the judicial process and get prosecuted. But that doesn't happen. So we find that we are losing a lot of young people through extra judicial killings.

Jessica Metcalfe 49:32
Sometimes the innocent?

1 49:33
Yeah, most of them are innocent. Sometimes the police know they have done a blunder.. You know, put things on you liek a fake gun. Some knives or some other (inaudible) waepons, because not only the police have the weapons. So they'll put on you and you know, you'll be prosecuted on that. After murder you, thats to prove that you are a criminal and you posed a danger to them. Yah, we are also have so many cases of gender based violence. Whereby we have conflict between households, and also neighbors. So these are issues that we are addressing as an organization. We do documentation, we do case studies, and we also help victims to go and report the case and also maybe seek justice... as well as access treatment. Because we find that so many people have normalized also gender based violence. So, people
are suffering in silence. And so, out of our advocacy process, they have started now coming out, and you know, without fear, saying that this is happening. Especially from relatives - abusing relatives, like husband or wife, or maybe parents, or maybe close relatives that you may be living with. Ya. We also address other social injustices, like lack of water in the communities, lack of access to clean water in the community. Maybe issues of land, evictions, and demolitions. Issues of food, like now the cost of food is very high in Kenya right now. We used to buy a two kg packet of maize flour for like 110, it is now going for 20 shillings. So you'll see that kind of inflation is very high, and not everybody is able to afford that. Especially now that we are coming from the COVID-19, you know, effects. Many people were laid off from their

employment they we're in, and also those who are going back to their businesses, the business is very low. So these issues need to be addressed. So ya. And many other issues... that are there are maybe children not able to access education. The Constitution says, everyone, every child must have access to basic education. A decent education. And also access to health facilities, not everybody is able to access health facilities.

...

1 56:30
The main challenge is that it's like the government doesn't understand the role of a community based organization. The role they play, because as far as I'm concerned, the community based organization play a very critical role in the communities, and also in a country. We are I can say the first time we responders to anytime there is an emergency or a disaster. Because like, when maybe people are suffering here, maybe because of food, because of diseases, the community based organization are the one that have the first hand experience. They are the one who respond first. Even before the government knows what is happening. Maybe the government comes in when there's now a tragic thing has happened and you know it is across the board and everybody's talking about it. But you know most of the issues that we deal with, are the people who are affected are very silent, and they're not able to stick it out. And because we are aware, and we do automatic, we are able to support them. So if the government can come in handy and try to support also the community based organizations. And see them as people who have come to complement thier activities, not as competitors.

Jessica Metcalfe 58:13
So do you think that's the prob. They see you as competition?

1 58:17
Yeah, the government most of the time, you know, misconceive things or maybe they are misguided in their priorities. Sometimes there are things the government does. And you start wondering why this?

...

1 1:08:05
Yeah. You know the Member of Parliament is elected by the people. The member of county assembly is also elected. But the Chief - the Chief is appointed by the government. And also the sub chiefs are now.. those are the workers of the government. So they're not appointed by the people.

Jessica Metcalfe 1:08:28
And they have more power? Lots of power?

1 1:08:32
Yeah, they are powerful because the chief's office is called the Office of the President. It's the office of the president now here. So he's like the president of this area. And, you know, the directives comes from the President, they trickle down to the Ministry of security, trickle down onto those provincial administrative...

Jessica Metcalfe 1:09:01
So if your member of parliament and your county member of county parliament are elected, and they are from one party... but then the national government is something else, then they'll put somebody from that party as the chief? And then there's like conflict? Has that ever happened?

1 1:09:18
Yes that normally happens, because like now we have a Member of Parliament here - he is from a party. But now the ward administrators are not the the ward boss. We can now call the member of county assembly. Yeah, are from different parties. So normally they dont work together they have different interests. I see. So that's part of the challenge.

A.2.2 Community Interview 2 | Community Elder

2 04:02
This area is not good sometimes when floods come, we come with a lot of heavy because of joint many joint of river. So when rain comes, we get floods. When there no rain, no floods, but when rain coming, we have a flood. We come to our people, our people come to destroy and ah, from that time everybody is a victim because when it flood in that river even upper, up here, everybody is a victim.

Jessica Metcalfe 05:20
Because of those channels that run in between houses? Yes.. Those overflow? Ya, ya.

1 05:27
Yeah, then we know this is, this is not a good structures. When they come somebody who you can go out and get a vessel he put in under the bed, he tried to, to get water because the structure not good. Then crimes. So, to this moment is too high because because of lack of poverty, poverty make high, crime network.. what do you call it.. killing extra judicial killing. It is very high because of crime

Jessica Metcalfe 06:22
By the police?

1 06:23
Yeah. By police even more.

...

2 09:27
Because we want to discuss our village. Then that information, we get through to Chief. We say this is the fact to be in this month, we get this crime, we get this flood, we get this, the disaster, in this poverty, and to a childrens not go to school, Everybody report anything with you.

Jessica Metcalfe 09:49
Okay. And then when you report, what happens with that information? Does the chief - do you feel like there's response?

2 09:57
Yes, a chief is ready respond. If you have a crime sometimes have a crime.. you say, Danny, let me use that Danny, Danny is a thief. Danny, he tried to do crime every day at our village. So chief what you see, what do you do.. He called the police. And the police come and arrest Danny.

Jessica Metcalfe 10:26
Okay.

2 10:27
Ya.

Jessica Metcalfe 10:27
And the police trust the chief?

2 10:31
Yes, because that is a national government and this is a national government. Okay. But here national government to work together. Ya

...

Jessica Metcalfe 11:36
Okay. And do you feel that everyone in that line is doing what needs to be done to solve the issues?

1 11:45
Yes. We come, sometimes we come and we solve the issues. Because, when we see the floods we come together, we have a police, we have a chief, we have a community, we have a disaster management. We have Red Cross, and ah volunteers.

...

Jessica Metcalfe 12:19
So and you said that the structures aren't strong. So, I know. I understand that along the river. Sometimes houses are washed away..

2 12:29
And destroyed.

Jessica Metcalfe 12:29
Yeah. Um, when that happens, how do you support those families that lost their houses?

2 12:37
Sometimes eh, like, what do you call it.. sponsor, lets call sponsors.
…
Jessica Metcalfe 13:36
Because, I mean, do you think that flooding doesn't happen often enough that people don't think it's a problem? Or do you think people just like they don't have a choice. So they go back?

2 13:48
Yeah. But you see some people even, that is a.. that house.. in that river, is very cheap. So you go and see some house. That is 500.

Jessica Metcalfe 14:04
Okay

2 14:04
Another this house is 2000

Jessica Metcalfe 14:06
Okay.

2 14:07
Or 5000 something. So, we are going, we are going there because of cheap.

...

2 19:29
This water of a Mathare, sometimes come with politics, if you use politicking everything not good. Because we have water kiosk. Sometimes we have a, like what do you call it? Muungano Mathare?

Jessica Metcalfe 19:52
Oh, yeah. I spoke to _____

2 19:54
Ya, have a water kiosk but you, when you see people of Mathare want free. Not want to pay.

Jessica Metcalfe 20:08
Okay.

2 20:09
So, if you, if _____ have a water kiosk somebody come here and cut this pump and got to get the free water. You understand? So, if you - then, some time Kenyans who are very corrupt because the, Julie have this kiosk. Cartel come here, cut the pump, and this cartel go back, go to the Office of Water

Jessica Metcalfe 20:47
really??

2 20:48
Ya, and he do corruption

Jessica Metcalfe 20:51
Mmmm wow okay..

2 20:52
With this cartel of water.

...

2 35:28
Yeah, sometime. Somebody come to- Chair lady? I have a problem! For what? Hey, my mom, is very sick. She have a cancer. She come to die, what do you want to do? I don't have money. Ai. So we go there. We try to mobilize community. Please, please 10, 10, 20, 30 bob, 50 bob because I don't have money.

Jessica Metcalfe 35:53
Yeah.

2 35:54
I said I have this money.

Jessica Metcalfe 35:57
Yeah. Yeah.

2 35:58
So I do.. if you get 5000 - go to hospital.

Jessica Metcalfe 36:06
Wow okay, because there's no public hospital? You have to pay if you want to go to hospitals

2 36:11
Ooh you have to pay! Like my Oh, going to cancer, diabetic, ARVs you know, that is that is many.

Jessica Metcalfe 36:24
Okay. A lot of people have with HIV.

2 36:28
Yes. So you look like everybody's (inaudible) Like you are gods.

Jessica Metcalfe 36:35
Wow. Sho, that's hard. Do you, do you get any, like, training from government on how to deal with these issues? Like, because I guess you're like a psychologist? You're like a therapist in lots of ways.. besides for actually helping. Do they, do they help you? Do they train you at all?

2 36:55
No

Jessica Metcalfe 36:56
Okay

2 36:56
That is voluntary from god. Because sometimes mothers come she has a labour, when you were.. they don't have a groups, they don't have a anything
…
2 41:36
We work on them. But you know, planting... if you... if government you must be very careful because there is activist, there is a social justice, there is a... if a group come and don't support the government.. you hear. Ah village elder this is a group, here a government. So group, group you. Government group you.

Jessica Metcalfe 42:18
Okay. I see. So people split?

2 42:20
Yes. So mostly, me what I said some time work with the government. Closer with the government, if you want something to succeed? Work with the government. Because if you work against the government, you cannot work.

Jessica Metcalfe 42:44
And so do you feel like some of those organizations don't try to work with government?

2 42:48
Yeah. Because come, coming activist.. you come to burden government you come to push government? You see, you want government tomorrow? You cannot.

A.2.3 Community Interview 3 | Chiefs Assistant

3 00:47
I am the area senior assistnt chief. In my work as the chief actually I just worked with the community, whereby when the community have a problem, they normally come to me, so that we can be able to assist one another. So my actually, my main job is actually to coordinate all the government functions. I also coordinate all the community development. Thast my work. Actually, I'm the government we represent the community of like our ward.

Jessica Metcalfe 01:27
Okay. Yeah. Okay. That's amazing. So you said you work with the community organizations, and you also coordinate the government departments? Yes. So which departments are there?

3 01:41
Right now? The department are like the teaching - if the students in school. Also in the government as the function like now the state function, that's my workcoordinate it on the ground. Also the community development on the ground. I'm supposed to coordinate that. Okay. Anything on the ground, it's my work.

Jessica Metcalfe 02:09
Okay. And then in terms of the community organizations? Do you just support Ghetto foundation? Like with what what they doing? You give them support?

3 02:18
Actually they are supposed to work with me, because they are part of me. If they are in my area of (?) like Mabathini. They're supposed to work with me.

Jessica Metcalfe 02:29
Okay, so like, when I first arrived with Jan, and everyone, there was a community meeting, where Ghetto Foundation invited you and all the other community elders to like, first get permission. Yeah, for us to be here. So is that kind of, like keeping order and keeping communication open? And

3 02:47
Of course yes, because like now, when they invited me when they call me, they could not do it without my without my consent. They tell me so I can join them. So that when, there's a form we can assist one another. And if they want to be linked to the government I am the only one who can bring them.

Jessica Metcalfe 03:10
Okay. So what resources does government like supply for Mathare? It's like, yeah, what in those different departments?

3 03:22
Yeah, the resources that the government may provide the community. Actually, sometimes they bring the relief food. If there is no relief food, they can also like now, theres what we call the (Swahili), where the youth are working. They consider youth and actually when we employ those youths, you consider the most vulnerable youth. Because actually when they get job, the environment, then you can see now there were there are a lot of insecurity. But when you engage them, you find that there'll be no insecurity there will be peace. So we normally consider them in terms of employment when opportunity arises, because it's not always. Like now theres election. Now, we consider them because of this election. So that job is not going to continue. Also, there is also actually like, that's one of the IBC whereby now we put them on board so that when you're doing directions so that they can assist. But when that election is not there, these youth you see are idol, that when you see a lot of inecurity.

Jessica Metcalfe 04:46
Yeah, yeah. Okay. So it's sort of like you coordinate with like, when there's government positions, you try to link the youth up to those positions so that they can benefit Yeah, as long as they around

3 04:59
Yeah because actually youths are the most people who are being used by the politicians. So we normally target the youth so that they cannot be used - to avoid them to be used. Because when you get them when they are busy, you will not find them. Yeah, but when they are idol. Its very easy to be used. Yeah.

Jessica Metcalfe 05:53
Yeah, it's actually interesting. Other people say the same thing. And also with the issue of, I don't know what the word is, but the drug stuff. That it's it's kind of like a way to try because mostly the kids or young men and woman get involved to make money because it's the one way that they know that they can also make cash. So if you can try get them before they get involved then. Okay, so in terms of government, like planning for that kind of thing. I understand, I spoke to ----- the other day and she said that as a village elder, she kind of has a cluster of people that she sort of speaks to you and she understands the issues and she reports up to you and the chief. So what happens with those reports?

3 06:19
We normally have to report to us what we normally do we forward those reports to the next step.

Jessica Metcalfe 06:30
Okay, what is the next step up?

3 06:32
The next step we have like me now I've got my boss who is now the DCC. The deputy county commissioner.

A. 2.4 Community Interview 4 | Moja Wi-Fi

4 03:22
I'm a community youth leader working Mathare. Not only here in Mabathini but all across Mathare - six wards. So basically, I used to be a student at the University of Nairobi. But I had to drop out of school because of school fees issues.

Jessica Metcalfe 03:47
What were you studying?

4 03:48
Yeah, engineering, electrical engineering. I had to drop out. Because, like, I had, like my grandparents, they were the ones who used to like, educate me towards the university, but he had to die. So I had to just to drop out of school, and then I had to focus on developing my community. That time, I was working as a community health volunteer working here in the slums in terms of health related issues. Then across the line, I came to meet the Moja Wifi team here in Mathare thinking and then they had to approach like some of our mothers who I've been working with okay with this particular person so that we can be, we can we can use as a focal point or focal point, man. Yeah. So that you can be able to access Mathare. So, our mom's had to had to specify me. So I worked with them. I've worked with them, like for four years and some more months.

Jessica Metcalfe 04:56
So can you speak a little bit more about your work as a community health volunteer? Who was that with? And what Did you do?

4 05:06
So what we used to do in that commitment volunteer? I used to help the sick in terms of getting them to hospitals, to government facilities. I used to go to - I have been, I've been used as a link. Between my community, and the health facilities in terms of distributing medicines, in terms of distributing meds. In terms of distributing health services to our community. In addition to that, I was also given a first aid kit. Yah.

Jessica Metcalfe 05:45
So how did you get into that? And who did you do that with? Was it a government thing? Or was it...

4 05:51
Okay, my how I got into that. My passion is my community. Is helping my community. So like, anything that it's coming to help our community I'm into it, like 100%. Because I believe that communities my thing. I was sponsored by a German project in my in my high school. Education. So I just have to give back to my community.

Jessica Metcalfe 06:16
Amazing. Okay, cool. And you said something about the mothers? What did you mean by that?

4 06:25
Okay, there are these mothers who I usually help, in terms of, they need this particular type of service. So go out and source out and then I come up with okay this is that. Okay, you want this particular help, you want this particular thing, in terms of health related issue, yah, I'll be there.

Jessica Metcalfe 06:44
Okay, and how did you - so you worked with mothers, worked with families, worked with youth mainly? And so when they brought up different issues how did you find resources for that?

4 06:56
I just go out and source out

Jessica Metcalfe 06:58
So you just speak to different organizations?

4 07:01
Okay, usually we use like the mobile, mobile social network. Then I've got like friends also who work with big organizations. Okay, my community needs this... Okay, like what can be done? Like, during the COVID-19, I had to approach one of the Hindu Foundation, they came and really helped Mathare. Then I also last (inaudible) who were distributing face mask and the sanitizers. So I just have to work, I just have to manouver. And also Moja Wifi also came in that COVID-19 and also helping our community.

Jessica Metcalfe 07:40
So you connected with Moja WiFi during COVID? How did that happen?

4 07:45
Okay, how it happened during COVID-19 Majo Wifi came.. I told them that these particular projects that you're currently doing, since people are using your platform to watch so you just have to put some COVID-19 sensitization. So, when you watch the community, in Mathare they want to get information. And also I came on also told them that in Mathare we are experiencing some sensation - movement was was cut off.

Jessica Metcalfe 08:29
Oh okay. Like when you're locked inside the house? Yeah.

4 08:32
So us we were locked in Mathare. You could not access Eastleigh. And Eastliegh in just near by. So I just had to, I just had to give them this information that our young mothers, our young families they are crying because of hunger. So what we can do as an organization? Let's say and source out food and give it to our community. And that's how they came.

Jessica Metcalfe 08:52
And so you made connections with bigger organizations? Which organizations did you work with?

4 09:03
Okay, currently, I'm working with since I've been working with Moja WiFi, I had to... I was also connected to Visha Social Organization, thats a Hindu organization. Then you have Bedan(?) Music Family. Then you have Behati Music Kenya. Then you work with like the county government of Nairobi.

Jessica Metcalfe 009:27
That you're working with? That are being supportive?

4 09:29
Yeah, like, during that connection. I was also given a role, a task to play by Nairobi County. They gave me a job.

Jessica Metcalfe 09:41
Oh, wow. So you're on the licensing board for them? Oh, isn't that quite a complicated?

4 09:47
Ah, it's not complicated because I just have to work around Mathare. So this my community. Yeah, when you need license, I'm just going to help you. I'm just going to connect you.

A. 2.5 Community Interview 5 | International Centre for Frugal Innovation

5 01:02
Normally, the challenges included unemployment, other issues to deal with health, issues to do with fire, I mean, security. And I think these are the major ones that I can confidently say that those are the major challenges that cut across almost all the households. Like, unemployment is a major challenge to putting food on the table. And a lot of struggle around that for people to be able to sustain themselves. And then health is not as much pronounced, but you would still feel it from the distance. And then security or rather, insecurity is at a very high level. People feel insecure in most cases, especially walking. And if you're walking, you're not sure if you'll get to your destination safe, or with your phone, or with your item. And, you know, issue to deal with you're not even sure if you leave the house, you're find it safe. Because people can break in and steal from you. What is the other one that I mentioned?

Jessica Metcalfe 01:26
Fire.

5 01:27
Fires, frequent fires. Mostly originating from electricity, because electricity is not formally connected by the service providers, the legal service providers. So quote-unquote, that "Mathare Power Company". You, know, the one that, that a connection. Which mostly, they are not legally acceptable.

Jessica Metcalfe 02:57
So that's what starts fires?

5 03:00
Most of the cables are naked. Are not covered at all. Coz even the costs of that for many people.

Jessica Metcalfe 03:12
So when you spoke to people, what was their - because you asked the non digital solutions and the digital solutions.

5 03:18
Yes my dear we did.

Jessica Metcalfe 03:19
So maybe let's start with the non digital solutions.

5 03:24
Non-digital solution for unemployment, for instance. Basically people.. non-digital solutions for unemployment was people going to wash clothes for others,.

Jessica Metcalfe 03:39
It was mainly the women?

5 03:41
Mostly women. I don't know if it was by coincidence, that majority of the people in the feild, or I interacted with were women. It was so funny. I do not know where the men where.

Jessica Metcalfe 03:54
Do you think... I mean, did you speak to ---? Or do you have any like insight into why that might be the case?

5 04:04
Not really, no clarity. We tried to interrogate that question yesterday in our discussions if you heard. But they were skeptical about giving details, why there's so many women and especially single women within the setup. You cannot understand, why there are so many women unemployed not working and single parents.

Jessica Metcalfe 04:30
So, so they say they do lots of washing.

5 04:34
They do lots of washing. They wash for their neighbors or across to the neighbouring...

Jessica Metcalfe 04:39
Eastleigh?

5 04:40
Eastleigh. Yeah, and then wash peoples clothes from there, or do chores for a payment. Yo know do house cleaning and all that..

Jessica Metcalfe 04:49
Was there anybody who's stood out that did something different?

5 05:02
Doing something different, maybe not. Maybe those who had a small kiosk.

A. 2.6 Community Interview 6 | Delightsome Community Initiative

6 05:01
Okay, first of all, I'm so grateful to meet you. And you are most come to my place. We are now in Eastleigh, most of the people that are here are Muslims. So my name is John Kiki Kimani. And I'm a father of four. I'm the founder of this organization, the delightsome community initiative, which is a CBO committed Community Based Organization. We normally work most with the street families, elderly and sick. We do a lot of activities. We do sport, we do integration for these kids

Jessica Metcalfe 06:16
Integration?

6 06:17
Integration. Maybe if we meet a kid here and you talk with him or her. And he said that he want to go back home. Integration, integration go back home. So it's part of rescue. We rescue, we take them back home. So that's part of it. And as you as you understand, Mathare and here is the same. I am in Mathare, I do my program in Mathare. This just where I feed them, not only - I have three days where we do feeding programs, and our aim is not only giving them food. Our aim is making them - when you start giving them food, making them come nearer. You understand their problems. Because before we give them food, you have time with them, we talk we have the problem. Maybe somebody will just tell you, I want to go back to school. That's our area, we take them to school. Maybe if someone wants to go to rehabilitation center, or want to leave drugs. So we talk with other organization we are partnered with them. So we take them, maybe find someone who can maybe do like a life skill course, or maybe want to make maybe wiring, or mechanic. So we have that connection. But it isn't ours because we have partners. And if we take someone there, he doesn't pay. Okay, so that's our area of work. And so instead of that, we also look the elderly, we visited them we go to them. You know some people they just forgot about the elderly. So we go there, we talk with them. Sometime we give them food. Sometime we take them to the hospital, maybewe find an elderly in the house alone. We make sure we look for someone who would be looking fo her. That's part of us. And we don't have boundaries. We just go where they are. Even sometimes we go up to country. Sometimes we have somebody call us and say Kiki, we have someone here who needs your assistance. We just go there. And we assist. Yes. The problem we don't have resource but we deppend on well-wishes. Like the food we have seen here cooking. It is not my money, or our money. They just - someone can call me, even yesterday. Some will call me - Kiki, Can you give me the budget today? Tomorrow maybe we can cook. I give them the budget and we cook for them. After that we call a day. That's how I live yes.

Jessica Metcalfe 09:43
It's amazing work that you do. And it's a lot of work.

6 09:47
Each day I wake up around four.So me, I make sure everything is in order because I'm in charge.

Jessica Metcalfe 09:59
And you do this everyday?

6 10:00
I do! And I thank God cause its not that easy. But I think I'm strong because I wake up very early in the morning every day to make sure they get something, like porridge and make sure they must get porridge - if there's no food they take porridge. So I always pray for many, many friends. Many friends who can just come on board and help me maybe to.. to chip in what is she can. Tomorrow. I don't have anything. I'm planning to have for like, wheat for porridge. So maybe tomorrow, we'll give them porridge in the morning. I'll tell them please today no lunch. We can talk on Friday. Maybe at the night, maybe somebody will call me. Kiki, can we give you a bit of budget and I'll send you the money we buy the food.

Jessica Metcalfe 10:29
Okay, so thank you. And I have so many questions. The first one I guess is - so I'll start with like the logistics so you try to feed people three times a day or twice a day if you can.

6 11:28
Two times.

Jessica Metcalfe 11:31
Breakfasts and lunches?

6 11:34
But yesterday I give them breakfast lunch, and supper. Yesterday somebody gave me two goats. Yes, we cook we make big ugali.

Jessica Metcalfe 11:47
So can I ask you - the people that donate a lot, is it people from the community here in Eastleigh?

6 11:55
Not so much, not only here.

A. 2.7 Community Interview 7 | Muungano Wa Wanavijiji

7 03:35
But now our government is disappointing. Everything corruption, corruption every other day, they start an initiative. But corruption. It takes it all..

Jessica Metcalfe 03:51
Yeah. --- was telling me, I think it was Tuesday. He was like, yeah, if you go look at the budget, you'll see this all these things that are supposed to have been built in Mathare.. And they not there, so and I was like, Okay, let me look...

7 04:02
Even when they like.. according to how the county works they supposed to now, like one day, they tell us today we have budget there, we should come and then we give them these, what we prioritize like us Mathare until this site, but you find them they come they have already written what they will do. And when we try to oppose they say it's already been passed. And then we ask, what about the ones which have not finished they say they will finish. Like we have a bridge there, its connecting the Hospital Ward, Mathare, Mathare in this ward is Mabathini. So it connects the people from Mabathini to Hospital ward. That bridge started, was started building.. It's almost 10 years. We have more than three MPs who have been allocated funds for that bridge.

Jessica Metcalfe 05:04

Is it a foot bridge or for cars?

7 05:05
No, even the cars. But it is also being used, but it's not complete - its halfway.

Jessica Metcalfe 05:13
I think I've seen that I was there.. I walked

7 05:16
Near when you're going to the NYS camp.

Jessica Metcalfe 05:20
Is that where the police is?

7 05:22
Yes. Yes. More than 10 years.

Jessica Metcalfe 05:26
Crazy. And also, like, there's all the waste pile up that happens on either side of that bridge, that just goes straight to the river.

7 05:32
Yes.
…
7 07:08
Like Muungano wanavajiji is part of the slum dwellers international. Slum dwellers International they have a lot of like NGO in other countries, but ours here in Mathare, it's called - or no let me not say about Mathare... in Kenya under Muungano wanavajiji, so its a movement. We have so many groups, which have joined together to advocate advocate for the rights, but we, we do it so much in housing, and sanitation, yah. Like we lobby for water. And also, we encourage the groups to save money so that they can buy like a land, we have permanent structures where they can move. Yeah, and also we have also youth where they are being trained on photography, and writing what... anything to do with writing. Taking pictures. So we have we have many categories? If, let's say, the youth they have their own things. Us like women we have our own thing. We deal with advocacy. That kind of thing,

Jessica Metcalfe 08:15
Okay, so you're quite big and quite organized.

7 08:18
Ya like, in every slum, we have more than 10 groups,

Jessica Metcalfe 08:22
Okay. And in those different categories..?

7 08:25
Yeah, we also sometimes have even exchanges we go to other areas, we see what they are doing. We exchange ideas. Like ours now, the the down we are now Muungano wanavajiji it's a group of 40 members. It's mixed, youth the men, and whatever. So we have been here for more for more than 10 years. We do weekly savings. Through our weekly savings, we have been able to purchase rental houses, we will have more than five rental houses, which we get more than 2500 for each. We also have that water kiosk. Because we have also been able to partner with other other groups. We put the money together, and then we bought a land in Katani. So, initially we wanted to buy on our own but the director advised when you buy something on your own, we wont reach our goals because at this time rate, the the land issues, meaning they are so much expensive, but if you accumulate all your money together and then you take a loan from us, and then we'll be able to buy equally for you and then we will pay. So initially we bought the land for 10 million, 11 million.

Jessica Metcalfe 09:25
How big is the land?

7 09:37

How many acres? 10. So, right now they fundraising fund so that they can start building for us and then we pay them. So...

A. 2.8 Community Interview 8 | Mathare Foundation

8 02:01
I think that's fine. If you've got questions you can ask me, I'll be able to respond to them as to the best of my knowledge.

Jessica Metcalfe 02:12
It's perfect. Thank you. So basically, well maybe do to start off by telling me about yourself and who you are. And

8 02:23
So my name is ----. I'm the founder and director of Mathare Foundation. We started this organization back in 2013. So our main focus is training and ceating opportunities for young people in photography, performing arts and sports.We've been able to do about 30 projects since then. Our most recent project was in collaboration with the French Embassy in Nairobi Its called Breaking Gender Barriers. And basically, it was a project that focus on female leadership, female inclusion and development of role models through sports. So we had a football league for girls and women under the age of 13 years, under 16, and over 16 years. So it was not only football, but it also had training on how they can be football coaches, also how they can be referees of the matches, the games that we played and also firt team. We also had some aspect of life skills training, because being born in the slums of Mathare, many people have like low self esteem. So trying to give them that confidence. Having them speak about the issues that affects them most. It's something that is at the core of our program. So we had that training, also, understanding the issues of life skills, deals with teamwork, how do they collaborate? How do they work together? How do they support one another. And we also adapt some human rights training for the girls and women. We reach about 800 girls, and women in total. We also had the training on human rights or gender balance, of course, the issue of gender balance in Kenya. It's supposed to be like, not more than two thirds of one gender should occupy certain positions.

Jessica Metcalfe 04:42
Oh, is that like the law?

8 04:43
Yeah, its a law. However, we still far from that, because we have men who are very dominant in different forms of government, even to the nonprofit world. There's so many men taking leadership positions than women. So I think also our program was addressing this issue, which is very important because globally, it's an issue that is even batted about. That's why we see that a lot of programs or a lot of projects, focus on empowering the girl child and empowering women. So that is something that is the core of our program. And I think with the challenges that young people face in the slum, you will find that - it's very unfortunate, you will find that, without intervention of these, organizations Ghetto Foundation, Mathare Foundation or more foundation, just to mention a few. So many lives could have been lost. Because, for me, these organizations are like safe spaces, they're like, alternative homes for these young people. Because when they are down there in the slums, it's very unfortunate you'll find like, especially the boys you'll find they are 10 years, 11 years, 12 years, and they're stealing. They're taking drugs, some of them dont go to school. And the result is one, they end up being killed. And two they don't seem to learn. But when they come to these centres, they learn something, and then they change their perspective. I'm very proud to say that some of the young people that we started with in their journey, some of them are in the university. Because they focused on what we're doing, not what is happening down there in the slums. And I asked them a question, like, how do they carry themselves when they are in the slum? And what do other young people talk about that? So they see themselves different, and even the other people see these people to be very different from them. And they see they're living the same locality, they're living, their living condition is more or less the same. You just decided to take a different path. So for me, I think this kind of intervention that you have in the slums are very important, but a very unfortunate - I might say, I'm angry with the president of Kenya. The current president, because he declared Kenya to be a second middle class country. So he compared Kenya with countries like Czech Republic. And we are not yet there. So that meant, like, if I'm not wrong the World Food Program, they had projects that they were supporting in Kenya, but they had to pull out.

Jessica Metcalfe 07:42
Oh wow, because he changed the classification?

8 07:45
Yes. And even it's affecting most of these organizations.

Jessica Metcalfe 07:49
When was that done?

8 07:50
I think a couple of years back. So it is having a very bad effect to the work that we are doing in the community. And so if you look at most organizations are dying

Jessica Metcalfe 08:05
Really? Because they're not getting the funding?

8 08:09
There's nothing. Very little. Because the COVID pandemic, which came then it affected a lot of things, of course. And then the issue of classification that the President came with. So with the little knowledge that I have, and with a little knowledge that I can share, with the experience that I have running the Mathare Foundation since 2013. And also before that I was in another youth program the Youth Alliance Sports Association. So my life, I've been doing projects like, even when I was still in primary school, still in high school. So and you see what most people don't understand. I think that people who think, even in Mathare, they think, organization, are - how do we put this, they're money making. But that's not the case. Because if this organization don't exist, then there's a very big problem. Because some of the things that we do, that is not our role. Its the role of the government. But if we sit and wait, then the repercussions will not be good for this community.

Jessica Metcalfe 09:34
So I mean, just picking up on that relationship with government, do you have any support from government? What is your engagement with them?

8 09:44
That question everyone asks. To be honest with you. There is not any funding that comes through the government to support this organization. And if there is any, our system is very, very, very corrupt.

A. 2.9 Community Interview 9 | Generation Shapers

9 03:53
You also have a place that brings, brings people in Kenya illegally.

Jessica Metcalfe 03:59
Really??

9 04:00
From Ethiopia, Somali

Jessica Metcalfe 04:03
Like, helps them cross the border illegally, people who want to come here, not like people smuggling,

9 04:08
Ya, but also it connects...

Jessica Metcalfe 04:10
...because like, people against - like human trafficking, people against their will and people who want to be.. Wow, that's intense..

9 04:18
So theres a lot of activities, illegal activities happening.

Jessica Metcalfe 04:22
Okay. Okay.

9 04:24
But we hope soon things will get better. As we elect good leaders, visionary leaders. That's, that's how I doing the politics, because I have that leader. We have been serving with him in an organization. Yeah, he has an organization, you know, some part of as I said before, I have no limits when it comes to organizationn, that is working with the community, so I just start doing any organization. So like, I don't have that boundary

…

9 05:39
Yeah, we have good leaders. I think we can, we can, we can tackle these illegal illegal things happening in Mathare you know? That's how we that's how we do we lose a lot of youths. Coz they is a lot of money in the community, but they are not part of people who have money. So they have to take it by force. And that's how we lose the lives of the youth around here Mathare

Jessica Metcalfe 06:11
Like, from I'm trying to rob the businesses that are illegal?

9 06:14
Ya, some (inaudible). And the cops here, they don't, they don't care if you are a snatcher. Or you are a robber. Yeah. So I think, because the reason why Im with this er, aspirant, because we share a lot in common.

Jessica Metcalfe 06:34
Okay

9 06:35
Yeah. And we part of him, he told you, you just go ahead and register, and we will be with you, we will do the campaigns together to make sure that we have these positions so that we can change the community.

A. 2.10 Community Interview 10 | Mathare Social Justice Centre

10 03:01
To my understanding of like, you wanted to know how everybody copes in these hard times... how they are going to be where they are.

Jessica Metcalfe 03:09
Yes exactly, pretty much. Yeah.

10 03:16
Yeah. Dependency. That's all I could say... like. People relate on each other; you see on ideology too. If you focus on something and they see you are moving a step. Maybe then even them, they try to be like you, somehow.

Jessica Metcalfe 03:34
Mmm (agreement)

10 03:35
So... hm. And the resilience, the resilience comes with environment. You adapt it. You need to adapt to it. Coz things are hard, and they are changing.

Jessica Metcalfe 03:41
Yeah, exactly.

10 03:44
You were down there one-day? You went down there?

Jessica Metcalfe 03:45
To the river?

10 03:46
Yeah.

Jessica Metcalfe 03:47
I've been near the river, but I haven't actually been able to go to the river yet. I've seen it, like last week when we were doing household interviews...

10 04:07
Maybe then walking down the river, you'll see the how savango(?) is.

Jessica Metcalfe 04:08
Yeah.

10 04:09
Yeah. But savango is crowded, and people are encroaching even into the riparian land... and inside the river too. They just need to throw more stones, more stones, then it makes the rive tiny.

Jessica Metcalfe 04:24
Okay.

10 04:25
Then they make a house there. When the floods come, everything goes.

Jessica Metcalfe 04:35
Okay, so how often do the floods happen? I've heard different things from different people. Is it every year? Or is it, kind of...

10 04:44
Its whenever there is a heavy rainstorm.

Jessica Metcalfe 04:47
Yeah, I mean the last...

10 04:49
If it comes, it hasn't rained in two years, but when it will rain heavy...

Jessica Metcalfe 04:56
Yeah, and it happens quickly, it's like a flash flood?

10 05:02
Yeah.

Jessica Metcalfe 05:02
Yeah, okay. So, form your perspective what do people do, is that the work that you do? Maybe let's start there. What is the work that you do? What is your organisation like?

10 05:11
Yeah, we are the Mathare Social Justice…

Jessica Metcalfe 05:15
You're from Mathare Social Justice?

10 05:17
Yeah, Ecological Justice. Ya so we've been doing ecological work since 2014. Planting trees, and cleaning dumpsite, and cleaning the dumpsite to be a clean space. We've done that to like 5 places and they have been successful. Ya, but it takes a long time for a dumpsite, for it to transform from a dumpsite to a green space… Ya. It takes a lot of time.

Jessica Metcalfe 05:50

And do you use that green space to like, plant plants that will slow the water? Or do you use it to plant, like, food? Or both?

10 06:00
Mostly like trees and bamboo along the river. Coz bamboo can hold the water down.

Jessica Metcalfe 06:09
So, you're planting to slow the flow, basically?

10 09:12
Ya, ya.

Jessica Metcalfe 09:18
Okay. And have you found that that's been successful?

10 09:19
It's been effective. Yeah.

A.2.11 Institutional Interview 11 | Nairobi Water

11 02:40
My name -----. I am working with Nairobi City water and sewerage company. As a water engineer in charge of Westland area, or the west side of Nairobi city. Previously, have been in charge of- being the engineer in charge of informal settlements region, or general informal settlements, which is a department that is catered to services - to provide services for water and sewer for the homeless, administering in the whole of Nairobi

Jessica Metcalfe 03:24
Have you worked specifically in Mathare at all?

11 03:27
Yes, I've worked in Mathare. And when I was there, I had - that was the last time before I left was in 2017. And when I had two major projects. We were building, I think we're supposed to be put two, put two number water kiosks. With the help of WASUP, water sanitation for the urban poor, and the water services Trust Fund. They're the ones who are funding the project. In collaboration with Wassup. Also, we were doing installation of automated water dispensers. We call them ATMs, water, ATMs or PPD's, which is prepaid water dispenser. By the time I left, I think we had, i think around 24 I'm not sure. Right now, there could be more.. but at that time, we had 20. Especially in Mathare, Mabathini area. Also we did some in the other side of the valley which is Kitanguru, the other side of the valley closer to Tikka road. And also we did a few pipelines improvement projects here and there. And then beyond that, generally operation and maintenance. Any leakages any bursts that occur.. yes any leakages or bursts, sewer issues that occur within Mathare that needed to be unblocked, this kind of thing.

Jessica Metcalfe 05:05
Okay, so, I have two questions from that. The first one is that the water dispenser I've heard about them from speaking to people in Mathare. And there seems to be quite a lot of complexity around them in terms of the management or governance of them. So I understand that they were.. could you explain to me maybe rather, how they were supposed to - or how they were envisioned to work.

11 05:30
How they were?

Jessica Metcalfe 05:31
How they were supposed to be working those water ATMs because you got a tag that then load money onto?

11 05:36
Oh ya, ya ,ya, what happened, there was this arrangement with you see, there are some existing kiosks before the project I was telling you about. So that project involves building new kiosks and renovating the existing one. So the total number of water kiosks was supposed to be 42.

Jessica Metcalfe 05:55
Okay, and can I just ask you those, water kiosks they were like built structures? like..

11 05:59
Yes they're built structures, permanent structures. A small one room station, I think, almost like five meters by five meters maximum, okay. And then on top, it has a roof slab. And it has a 10,000 litre tank that has a scope of the project, you if it's an existing one, you renovate, and install a 10,000 meter. So that means at any given point, because you know, mother is on the lower side, like a valley. So, any flow of water into Mathare by gravity, the pressures are really good. So that means the water can go up a few meters. So, that means the tank could actually fill even without any form of pumping.

Yes. So that was the idea behind it. Then now, the next thing was, yes, we are providing water kiosks. So how do we make this water affordable to the people, because you see, right now, if you buy water in Nairobi, I think the cheapest you can do is like 20 shillings for 20 liters gerry can. So our aim was to have it at 50 cents per 20 liters, like almost 100 times cheaper or something. So, we partnered with the existing water vendors, those who are willing, and those who are running the kiosk. To submit, that means that this group, like me and you, we form a group and go to the area administrative person, we would like to be in charge of this water kiosk, because you see, it's a community thing. So we would, we wanted the community to feel like they are in this project with us. So they would submit the name of - it had to be a group of people that is merging for administrative purposes, to the administrative person, and the administrative person would forward them to us to us for vetting, you'd sit down with administrative person, and also the village elders, call them so that we can vet if these groups are really, people we can actually sit down with and have this project funding them.

So once you identify the group, they are given the kiosks and the mandate to run it. And they do sensitization with our help to, and were given this a normal key for that I would give to any other community person, but then they people run in a group, they had one key for that is a master one.

Jessica Metcalfe 08:33
Okay, that's a tag?

11 08:34
Yes, yeah, the digital tag, but the master digital tag eh. That they would load or we would load remotely, credit onto it, the money so that they can be able to distribute that money now to the rest of the community. The idea of doing this is, I think that we're supposed to share our 40/60% in terms of revenue,

And the idea behind t was they're able to make money and maintain the kiosks the same time the other people are able to draw water from this kiosk at a very cheap price. This was supposed to kill off any water vendors or illegal people who sell water illegally because most of the people who sell water in Mathare are people who have just stolen the water they do not have the mandate and they are not registered because you have a tariff for water vendors, and a tariff for water kiosks and they are not included anymore. So that means they're using the making doing business with free water.

A. 2.12 Institutional Interview 12 | Mazingira Institute

12 19:58
There people were homeless on the street with Climate change and homelessness... So what it shows is really how important adequate housing is. For the ammenities, how important that is. Because the the impacts of climate change are local. It happens globally, global warming - but it effects people locally and the therefore the whole... in the context of climate change, we'll see the significance of housing takes a new form, which hadn't been the case before. So one of the arguments is that if you really want to make sure that the population that is worse off anywhere in the world, is that you make sure that they have adequate housing - which they dont. And because they're the ones that are going to be hard hit. So now from a human rights standpoint, in particular, you want to look at social justice centre, so if you make a case for, like we've been doing, a case for housing - housing is absolutely fundamental for human wellbeing, health, comfort and safety.

Jessica Metcalfe 21:52
So has Mazingira Institute been working on that?

12 21:55
Its. just the way we've been measuring it and the but then the so,

Jessica Metcalfe 22:14
So, can I ask you - has Mazingira Institute been working in Mathare on housing rights?

12 22:19
Well when we work on housing rights, we work on the region, we worked on the coalitional that works at the global level, we have a global level of work, regionally in the country, different levels.

Jessica Metcalfe 22:40
So in Mathare, or in any formal areas, and?

12 22:40
It doesn't matter wherever we... yes Mathare all the informal settlements. You have to get know about how human rights frameworks work. We have a very strong bill of rights in our new constitution. So the right to adequate housing is in the bill.

Jessica Metcalfe 22:43
So in terms of actually making sure that that happens... the what are the actual..

12 23:21
You cant ensure it will happen because its a state obligation, okay. And so that, that means we have to do three things that, first of all, is to - of course, one thing is to fulfill the right to adequate housig, because it's people who do that. And we respect and protect people who don't have adequate housing from any other kind of threat. So all these frameworks are there, we use them. We have been into public interest litigation, particularly on forced evictions. This is one thing to be worked all the way from the 80s campaign against forced evictions and worked at the international level. There are UN guidelines for what is called The Right to Housing was detailed. We've worked with Habitat International Coalition who sent everyone on here last month you know, the Africities Conference... and what we did on forced evictions in Africa, which since 2013. And now from the way we map through our coalition have been over 11 million. We have this kind of data. And how we do that in terms of monitoring, reporting urgent action. Well, I'm just telling you different levels and it's a continuous role. The work on understanding the state of Nairobi including Mathare Valley and all the settlements. I mean I was part of the first study of Mathare way back in the 60s, I was studying.

Jessica Metcalfe 25:40
Hmm, and how would you compare to now?

12 25:42
The dynamics of what goes on in there and in informal settlements, etc. And in terms of interventions, and community organizing, and those kinds of experiments... so we're not really directly doing anything in Mathare Valley at the moment, what we're doing is connected to our urban food system. And we do have groups into urban agriculture, quite, quite well developed. We also know the situation what it is in terms of production. And in terms of keeping animals, the consequences of that, and the work we've done in terms of public health, in different settlements. So in terms of actually, the moment, our work is very much connected to food and agriculture.

A.1.13 Institutional Interview 13 | Kenya Catalytic Jobs Fund

13 12:25
Yes. So the kiosks, the kiosks are all fitted with what we call smart meters. Okay? Now with the smart meters, the users are given a card - a smart card and then they load the smart card with money. But because the, because the kiosk meters are also operating under the pro poor tariff kiosks are only permitted in low income areas, you will not find a water kiosk in high income, in higher income areas. So the kiosk meter comes to the low income there with a low, with a pro poor tariff. Okay? With that pro poor tariff if, if a poor household ask the smart, has the smartcard they are able to buy a 20 litre jerrican of water at two Kenya shillings

Jessica Metcalfe 13:22

Okay, yeah.

13 13:25
So which means that if they go to the nearest Nairobi water company, for example, in Kibera and Mathare there are water companies offices there for, for Nairobi water. They go there you present your card with the money in cash, they load up for you. Okay?

Jessica Metcalfe 13:44
Yeah, I just wanted to talk about that because it was really interesting. We did - or I was involved in some household interviews, and then I did a survey and then I interviewed a lot of community, organization people. And everybody basically said the same thing that those water kiosks are.. A lot of them, besides for I know there's Mangano, something that runs some of them.

13 14:17
Muungano wa Wanavijiji?

Jessica Metcalfe 14:18
Yes!

13 14:19
Ya, Muungano wa Wanavijiji, ya.

Jessica Metcalfe 14:21
But there's also quite a complicated ecosystem of cartels that have tapped into the kiosks. And basically.. so that, combined with the fact that lots of residents don't know that they can get tags for themselves, end up paying the 10 shillings or whatever it is for for a jerrycan. So, yeah, I mean, that's just seems really like..

13 14:51
So what happens basically.. is whereas those, you know, the solutions exist...
The, the, the faut is shared by both sides. One, Nairobi Water Company, or other Water Companies, haven't done enough to to popularize the kiosks because if that is not their business. So once once I give you a smart meter as a kiosk owner I don't come and tell you how to market the kiosks to reach more people.
So yeah, so because thats, because that's not, that's not what they do. They don't Water is not sold, is not sold as like a product like that. Its sold as service.
And, and what also happens is that the water companies are quasi-public-quasi-private. Okay. They are, they are set up as, as private companies but they operate like public institutions Okay?

Jessica Metcalfe 16:12
Okay.

13 16:14
Without the incentive to go out and market because their functions and their, and thier operations are not profit based. And therefore, they have no they have no drive, they have no incentive to go and get the customers and make money, and make profit.
Okay, they're not they're not profit making. Yeah. So, so water as a service is caught up as both a private good and a public good.

Jessica Metcalfe 16:42
Okay interesting.

13 16:45
As a as a private good, you pay for it. As a public good, it is enshrined in the constitution as your right. .
So the so the companies are caught in between provision of a right and in needing to pay for it and making profit.

Jessica Metcalfe 17:05
Do you think that's.. so sorry, yes?

13 17:08

Yeah. That's why the water companies are perennially, perennially running it what we call the NRW the non-revenue water. Today as we speak, the total cost of non-revenue water in Kenya is 10 point 8 billion shillings.

A.1.14 Institutional Interview 14 | UN Habitat

14 12:15
Yeah. So basically, like okay, focusing on Mathare alone. Mathare is a very diverse neighborhood, as you already saw. We have many cultures. We have people from different tribes from different parts of the country living in Mathare, and like in many other major slum settlements. And so, one of the main challenge that we face, or Mathare faces is the issue of land ownership. Most of the land in Mathare is private. So what this means is that even the government or even the UN Habitat or any other agency or organization that wants to have like, infrastructure development, then they would have to first negotiate with the landowners. Often what this means is they will request or demand for compensation, so that you can use or even lay a pipe on their land. Say you're putting the water or you're laying water pipes, so you really have to negotiate with the landowners. So that's the major major challenge because as I say, in order for any developments, to take place - physical projects, then you first have to clear with the issue of land. So that is the main issue that I see. But otherwise the opportunities are many. The opportunities are many. And the majority of the people, I would say even like 80% of the residents in Mathare are tenants. Yeah, they are tenants. So they are not the structure owners. They are not like the land owners. So they just tenants. And then to be honest, they don't really give, they're not really concerned about housing development because what this will do, if the houses may be improved, then that means that the rent will also be increased. So it's not a win for them as such. But of course everybody wants to live in a good house. Everybody wants to raise their families in a decent house. So this has been one of the major challenges. So for example, in Kibera, you saw or maybe you heard, the government is embarking on a slum upgrading project in Kibera. Well, they can afford to do that because Kibera is mainly government land. But they cannot do the same in Mathare until there's like an agreement with the landlord. But not the whole ofMathare. But some parts. Some parts of Mathare have government land, but most - like the valley like the area of Ghetto foundation, that is private.

Jessica Metcalfe 15:22
That's Mabathini Ward?

14 15:24
So Mabathini and Mlambo Kubwa is one, yeah. So it's privately owned. But then when you go to the other side, the Hospital Ward, the ward across the river, that's government land.

Jessica Metcalfe 15:40
Okay. Yeah, cuz I think it was Samuel told me that people were, there was some there was a school and a mosque that were built at some point. And then people were moved to the other side to Hospital Ward. When the people were like allocated land at some point. So the government

14 15:57
Its not the government that allocated them land. Its the politicians. It's the politicians. The government did not allocate the land. To date, they still an ongoing case in court. The police, because all that land belongs to the police, they want those people moved. So I remember growing up, I was a child and I remember like one of the local politicians who was elected as the counselor back then, he's the one who sort of like subdivided and allocated this land to his friends, and of course, also sold most of it. So it was illegally acquired.

Jessica Metcalfe 16:40
Okay. So it seems like this is tension between administration and politicians. Like what's legal and what politicians sort of make happen? How does that work? Because how is it that government politicians can get away with doing something like that? Is it because it's, I don't understand that.

14 17:03
Yeah, here politics in this country is very tricky. Politicians are very powerful here. Especially if they are aligned to the ruling party's. So say that's one tool of mobilizing your voters. So like now we are approaching the elections in Kenya in actually less than two weeks we'll have the elections. And and so people have been complaining about the high cost of of living. And just a week ago, the President announced some measures where they reduced the prices of maize flour for 230 to 100 shillings. Meaning so they have the monopoly to

manipulate even the prices of commodities. So this is how strong like politicians are here. So everybody wants to join politics because once you're in politics, you become untouchable. If you are an elected member of parliament or I'm an elected senator, you mostly you will get away with a lot of things. And it's really bad because then, you know, once they're elected, they actually don't deliver services to the people, you now. And they start now doing all these small things to enrich themselves. But nonetheless, going back to Mathare. So, Hospital Ward, most of it was allocated by politicians, and not government.

Jessica Metcalfe 18:46
So, sorry, no, I just wanted to go back to also that question of the interaction with the land owners because I understand that if, if either government or an outside agency wanted to buy the land from from private owners or develop it with them, why do you think that land land owners would would be averse to working with some agency to develop that land?

14 19:25
Ya so one thing, one thing I know for sure, is that I mean, you saw the proximity - like Mathare is basically in the CBD. Yes, it's like 7-10 minutes drive from the city center. So it's very prime in terms of the location and now looking at what is happening in Eastleigh, the gentrification and you know, and so people will want to hold on to their land because it appreciates. That is one reason as to why they will not want to sell. There are a number of them who are already selling. Some are being given like very lucrative offers. Say like, NGOs and churches are building schools. So you have some landlords willing to sell. Now, when it comes to the mixed use, like developing with the owners, this is not something that has been raised here. It's not a model that has been embraced in this country where, you know like, this mixed use of land and, like joint development. This is something that needs to be introduced here. Perhaps in some areas, but I can't tell you about really successful case study of where, you know like, the landlords have given out their land to be developed with them. Very few, very few. And often, often it will be a case between an individual and the bank.

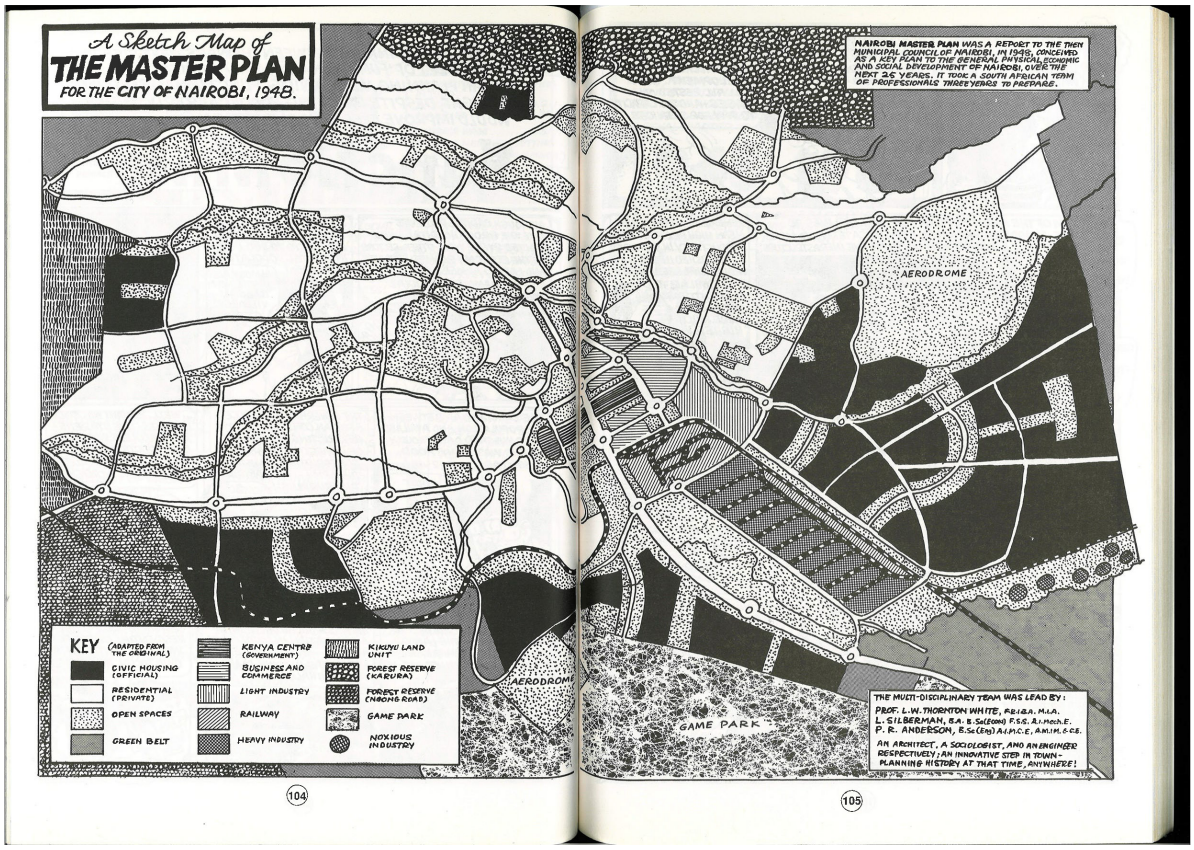
Jessica Metcalfe 21:08
Interesting, like as part of some financial deal?

14 21:20
Yes. So so like maybe the bank will. I've seen banks do this, they will come develop the house and they will take like the first, the ground floor, and set up a bank.

Annex 3: Additional Graphs, Figures, Tables and Explanations

A 3.1 Additions corresponding to Chapter 1

A3.1.1 1948 Master Plan of Nairobi



A 3.2 Additions corresponding to Chapter 2

none

A 3.3 Additions corresponding to Chapter 3

A3.3.1 Detailed Independent Operationalization Table for Quantitative Data

X1	**Diversity ad Flexibility**	
x1.1	**Livelihood and Income Diversity**	Whitney (2017)
	Level of Employment	
	Level of Income	Whitney (2017)
	Level of Income Diversity	Whitney (2017)
	Perception. - Level of resources adequate	Chaskin (2001)
	Perception. - Level of tradable skills	
	Perception. - Level of independence	
x1.2	**Economic Opportunities**	Whitney (2017)
	Perception. - Level of economic. opportunities	
	Perception. - Level of willingness distance travelled for income	
x1.3	**Level of Dependence on Natural Resources**	Whitney (2017)
	Level of dependence on natural water source	
	Level of dependence on harvested firewood	
	Level of dependence for livelihood	
x1.4	**Occupational Mobility**	Whitney (2017)
	I can do my work anywhere?	
x1.5	**Place Attachment**	Whitney (2017)
	Perception. - Sense of home	
	Perception. - Sense of comfort/safety	
	Perception. Health of environment	
x1.6	**Migration Patterns**	Whitney (2017)
	Amount of time spent in Nairobi p/y	
x1.7	**Willingness to Change**	Whitney (2017)
	Perception. - benefit of personal change	
	Perception. - benefit of community change	
	Perception. - benefit of gov support	
	Perception. - benefit of environmental change	
	Level of willingness to increase education	
	Level of willingness to attend training	
	Level of Willingness to experiment	
	Level of Willingness to try new skill	
	Level of Willingness to participate in community	
	Level of Willingness to participate in political activities	
	Level of willingness to use technology	
X2	**Learning and Knowledge**	
x2.1	**Resource Monitoring & Feedback Mechanisms**	Whitney (2017)
	Perception. - Level of knowledge re. cell phone	
	Perception. - Level of knowledge re. computer use	Chaskin (2001)
x2.2	**Knowledge of Disturbance**	Whitney (2017)
	Perception. - Level of knowledge re.CC	
	Perception. - Level of knowledge re. flooding	
	Perception. - Level of knowledge re. drought	
	Perception. - Level of knowledge re. water availability	
x2.3	**Perceptions of Risk & ability to anticipate change**	Whitney (2017)
	Perception. - Frequency of flooding	
	Perception. - Frequency of drought	
	Perception. - Frequency of water scarcity	
	Perception. - Level of safety (flooding)	
	Perception. - level of future planning	
x2.4	**Diversity of Knowledge and information sources**	Whitney (2017)
	Level of Access to Internet	
	Level of Access to smart device	
	Level of Knowledge of social support networks	
x2.5	**Recognition of Causality and Human Agency**	Whitney (2017)
	Perception. - Level of sense of commitment	Chaskin (2001)
	Perception. - Level of Agency	
	Perception. - Level of ability to solve problems	
	Perception. - Level Value of education	
x2.6	**Intergenerational learning capacity**	Whitney (2017)
	Perception. - Level of learnt knowledge	
	Perception. - Knowledge to teach	
X3	**Access to Assets**	
x3.1	**Household Material Assets**	Whitney (2017)
	Level of construction material	
	Level of household assets	
	Perception. - No. of sources of water	
	Perception. - No. of sources of health care	
x3.2	**Levels of Education & Training**	Whitney (2017)
	Level of education	
	Further Training	
x3.3	**Financial Status & Access to sources of credit**	Whitney (2017)
	Access to banking	
	Access to credit/loans	
x3.4	**Access to Markets**	Whitney (2017)
	Access to international relative transfer	
	Access to electricity	
	Access to sanitation	

	Access to health care	
	Level of food security	
	Access to clean water	
x3.5	**Social Capital & Institutional Support**	Whitney (2017)
	Perception. - Institutional Support	
	Proof of Address	
	Right to Vote	
	Level of bonding	
	Level of bridging	
	Level of linking	
x3.6	**Natural Capital**	Whitney (2017)
	Level of health	
	Perception. Health of Environment	
x3.7	**Cultural Memory, traditions and assets**	Whitney (2017)
	Perception learnt from elders	
	Perception knowledge to teach	
X4	**Governance**	
x4.1	**Levels of Trust, Networks**	Whitney (2017)
	Perception. - Social Inclusion	
	Perception. - Sense of community	Chaskin (2001)
	Perception. - Level of trust in community	
x4.2	**Gender & Race Relations**	Whitney (2017)
	Perception. - Level of Gender Equality	
x4.3	**Levels of Participation & quality decision making**	
	Perception. - Quality of decision making – COM	
	Perception. - Quality of decision making -GOV	
x4.4	**Planning Capacity**	Whitney (2017)
	Perception. - Community ability to plan	
	Perception. - Gov. ability to plan	
x4.5	**Presence of local Environmental Institutions & Social Norms**	Whitney (2017)
	Perception. - Knowledge about env. Orgs	
	Perception. - stewardship	
	Perception. - conservation	
	Perception. - waste management	
x4.6	**Quality of Governance and Leadership in environmental policies and agencies**	Whitney (2017)
	Perception. - Leadership in flood management	
	Perception. - Leadership in environmental issues	
	Perception. - Leadership in infrastructure challenges	
x4.7	**Accountability of managers and governance bodies**	Whitney (2017)
	Perception. - Government Responsibility - floods	
	Perception. - Government Responsibility - water access	
x4.8	**Active Risk Management and Adaptive Governance Processes**	Whitney (2017)
	Perception. - Government Action - floods	
	Perception. - Government Action - water access	
	Perception. - Community Action - floods	
	Perception. - Community Action - water access	

A3.3.2 Detailed Dependent Operationalization Table for Quantitative Data

Y1	**Actions to Increase Capacity**	
y1.1	**Responsiveness**	Tyler (2012)
	Level problem solving	
	Level of participation organizing	
	Level of participation in planning	
y1.2	**Resourcefulness**	Tyler (2012)
	Level of Active search for alternatives	
	Level of Active search for collaboration	
y1.3	**Capacity to Learn**	Tyler (2012)
	Level of participation in educational program	
	Level of participation in training activities	
	Level of experimentation new solutions	
	Level of experimentation with new skills	
y1.4	**Independence**	Ribiero (2019)
	Amount of income spent on others	
	Amount of time spent on others	
	Participation in household decisions	
Y2	**Interaction with Networks**	
y2.1	**Flexibility & Diversity**	Tyler (2012)
	Level of Participation in community activities	Chaskin (2001)
	Level of Participation in awareness activities	
	Level of Participation in political activities	
	Level of Use of education apps	
	Level of Use of banking apps	
	Level of Use of social media	
	Level of Use of news apps	
	Level of Use of weather apps	
	Level of Use of flooding info apps	
	Level of Use of health care apps	
	Level of Use of water access apps	
	Level of Use of electricity access apps	
	Level of Use of transport apps	
	Level of Use of income generating apps	
	I try to first solve my problems with technological solutions	
	Level of use of e-citizen	
y2.2	**Redundance & Modularity**	Tyler (2012)
	No. of sources of water used	
	No. of sources of health care used	
	Participation in saving groups (merry-go rounds)	
y2.3	**Safe Failure**	Tyler (2012)
	Level of experimentation	
	Level of Resource Monitoring	
	Level of Feedback Mechanisms	
y2.4	**Robustness**	Ribiero (2019)
	Perception. reliability - internet	
	Perception. reliability - water access	
	Perception. reliability - community orgs	
	Perception. reliability - government & institutions	
	Access to water	
y2.5	**Multiscalar Connectivity**	Adhern (2010) & Ribiero (2019)
	Distance travelled to earn income	
	Distance travelled to make everyday purchase	
Y3	**Interaction with Institutions**	
y3.1	**Rights & Entitlements**	Tyler (2012)
	Applied for water card	
	Campaign for rights	
	Campaign for services	
y3.2	**Decision Making Processes**	Tyler (2012)
	Participation in Community Orgs	Whitney (2017)
	Participation in voting	
y3.3	**Information Flows**	
	Information from gov.	
	Information to gov.	
	No. of visits from official	
	No. of visits from researchers	
y3.4	**Application of New Knowledge**	Tyler (2012)
	Acquired new knowledge	
	Used new knowledge	
y3.5	**Inclusion**	Ribiero (2019)
	Positive interaction with other genders	
	Positive interaction with other ethnicity	
	Positive interaction with other nationality	
y3.6	**Adaptive Planning & Design**	Adhern (2010)
	Participation in gov. schemes	

3.3.3 Detailed Operationalization Table for Qualitative Data

Independent Variables & Sub-variables For Community Adaptive Capacity (Component 2& 3)		**Dependent Variables & Sub-variables Robust Networks Component 2**		**Independent Variables & Sub-Variables Supportive Governance Component 3**	
Diversity & Flexibility		**Actions to Increase Robustness**		**Actions to Increase Support**	
Livelihood and Income Diversity	Whitney (2017)	Flexibility & Diversity	Tyler (2012)	Rights & Entitlements	Tyler (2012)
Economic Opportunities	Whitney (2017)	Redundance & Modularity	Tyler (2012)	Decision Making Processes	Tyler (2012)
Level of Dependence on Natural Resources	Whitney (2017)	Safe Failure	Tyler (2012)	Information Flows	Tyler (2012)
Occupational Mobility	Whitney (2017)	Robustness	Ribiero (2019)	Application of New Knowledge	Tyler (2012)
Place Attachment	Whitney (2017)	Multiscalar Connectivity	Adhern (2010) & Ribiero (2019)	Inclusion	Ribiero (2019)
Migration Patterns	Whitney (2017)				
Willingness to Change	Whitney (2017)				
Learning and Knowledge		**Interaction with Agents**		**Interaction with Agents**	
Resource Monitoring & Feedback Mechanisms	Whitney (2017)	Responsiveness	Tyler (2012)	Responsiveness	Tyler (2012)
Knowledge of Disturbance	Whitney (2017)	Independence	Ribiero (2019)	Independence	Ribiero (2019)
Perceptions of Risk & ability to anticipate change	Whitney (2017)	Capacity to Learn	Tyler (2012)	Capacity to Learn	Tyler (2012)
Diversity of Knowledge and information sources	Whitney (2017)	Independence	Ribiero (2019)	Independence	Ribiero (2019)
Recognition of Causality and Human Agency	Whitney (2017)				
Intergenerational learning capacity	Whitney (2017)				
Access to Assets		**Interaction with Institutions**		**Interaction with Networks**	
Household Material Assets	Whitney (2017)				
Levels of Education & Training	Whitney (2017)	Rights & Entitlements	Tyler (2012)	Flexibility & Diversity	Tyler (2012)
Financial Status & Access to sources of credit	Whitney (2017)	Decision Making Processes	Tyler (2012)	Redundance & Modularity	Tyler (2012)
Access to Markets	Whitney (2017)	Information Flows		Safe Failure	Tyler (2012)
Social Capital & Institutional Support	Whitney (2017)	Application of New Knowledge	Tyler (2012)	Robustness	Ribiero (2019)
Natural Capital	Whitney (2017)	Inclusion	Ribiero (2019)	Multi-scalar Connectivity	Adhern (2010) & Ribiero (2019)
Cultural Memory, traditions and assets	Whitney (2017)	Adaptive Planning & Design	Adhern (2010)	Multifunctionality	Adhern (2010)
Governance					
Levels of Trust, Networks	Whitney (2017)				
Gender & Race Relations	Whitney (2017)				
Planning Capacity	Whitney (2017)				
Presence of local Environmental Institutions & Social Norms	Whitney (2017)				
Quality of Governance and Leadership in environmental policies and agencies	Whitney (2017)				
Accountability of managers and governance bodies	Whitney (2017)				
Active Risk Management and Adaptive Governance Processes	Whitney (2017)				

A 3.3.4. Explanation of Interview Coding Guide

The following definitions were used to guide interview coding analysis.

Definitions of Independent Variables

Diversity & Flexibility
Funding & income diversity: Reference to existence or absence of different sources of monetary and asset streams.
Economic opportunities: Reference to existence or absence of possible sources of income generating activities.
Level of dependence on natural resources: Reference to a dependence or independence on natural resources for any particular reason. Includes plants, land, water which may or may not have been incorporated into a formalized management/delivery plan.
In an urban context natural water source is replaced maybe with free? Hence the tapping and illegal connections – people depend on getting free water?
Place attachment: Reference to the level of sentimental bond or pragmatic dedication to restriction to Mathare expressed.
Willingness to change: Reference to level of desire to alter circumstances and adapt

Learning and Knowledge
Resource Monitoring & feedback: Mechanisms for management of information relating to resources assets and within the community
Knowledge of disturbance: Level of recognition and of disturbances all forces that interfere with existing socio-economic and environmental status quo.
Perception of risk and ability to anticipate change: Level of understanding of the impact that a disturbance may have, as well as the amount of change that may occur / may have occurred.
Diversity of knowledge and info sources: How
Recognition of causality and human agency: Reference to level of recognition of the impact actions can have on the system as a whole or interactions within it
Intergenerational learning capacity: Reference to engagement with intergenerational teaching or learning within the community.

Access to Assets
Material assets: Reference to material possessions
Levels of education and training: reference to level of education
Financial status & access to resources: reference to financial status
Access to markets: Connection to external networks from which income can be derived. Income defined as money earned through trade
Social capital and institutional support: Assistance received through social transactions which have power behind them. Either financial, material or physical support.
Natural capital: reference to natural environmental benefits
Cultural memory: reference to living memories of cultural significance
Traditions and assets: references to the benefits derived from living memories of cultural value

Governance & Institutions
Levels of trust in networks: reference to level of trust, or distrust between individual, organizations, or institutions
gender and race relations: I added inn class relations – people explicitly talking about social segmentation according to bias
levels of participation and quality decision making: reference to participation in planning and decision making other tan household or individual decision making process

planning capacity: reference to the ability to plan
presence of environmental institutions and social norms: reference to presence thereof
quality of governance: reference to quality thereof
accountability of managers: reference to accountability thereof
active risk management and adaptive governance processes: reference to presence thereof

Definition of Dependent Variables

High-Capacity Agents
Agents are defined as individuals in Mathare operating independently or as part of a community organization in personal capacity or for personal gain. Accounted for in terms of behaviour and assets that contribute to an individual's form of growth as opposed to the collective. Envisioned as single nodes in the network with individual capacities.
Responsiveness: Reference to circumstance displaying recognition and reaction to opportunities and challenges presented
Resourcefulness: Reference to circumstance of an innovative use of assets and resources for personal benefit (not limited to legal recourse)
Capacity to learn: Reference to circumstance that exhibited ability to acquire and incorporate new knowledge or skills into behaviour.
Independence: Reference to circumstance that exhibited social, economic and/or environmental freedom for individual decision making and action.

Robust Networks
Networks include all connecting components within the community that allow for exchange of some kind to take place.
Examples: Social networks, formal relationships, infrastructure, service providers - includes cartels.
Flexibility and diversity: Number of connections ability respond and learn in situ.
Redundance and modularity: Number of different types of connections that is able to replace one connection stream if disturbed.
Safe failure: Ability to experiment with small scale solutions without severe consequences**.**
Interaction with training / engagement / dialogues
Robustness: State of infrastructure & social connections in terms of ability to provide intended / beneficial transaction
Multi-scalar connectivity: reference to presence thereof

Supportive Institutions
Institutions in context evaluated as large and established bodies with broader than city scale credibility with access to significant sources of funding and/or support of various forms.
Examples: Mazingira Institute, Red Cross, UN Habitat, Nairobi Water, Government Administration
Rights and entitlements: Reference to legal and illegality, including both references to engagement with or reference to criminality as well as human rights. Reference to police or institutions and governance mechanisms which interact with the law.
Decision making process: reference to presence thereof
Information flows: reference to presence thereof
Application of new knowledge: reference to presence thereof
Inclusion: reference to presence thereof
Adaptive planning: reference to presence thereof

A 3.4 Additions corresponding to Chapter 4

A 3.4.1 Respondents table

Table | Respondents Representation

Respondent number:	*Representation*	*Organization*
Community		
1	Community Research Organization	Ghetto Foundation
2	Community Elder	Chiefly Administration
3	Chiefs Assistant	Chiefly Administration
4	Youth Development	Mathare Foundation
5	Internet Service Provider	Moja Wi-Fi
6	Resilience Researcher	International Centre for Frugal Innovation
7	Feeding Scheme	Delightsome Community Initiative
8	Co-operative | Water Sellers	Muungano Wa Wanavijiji
9	Youth Organization	Generation Shapers
10	Environmental Group	Mathare Social Justice Centre
Institutional		
11	Water Provision	Nairobi Water
12	Human Rights	Mazingira Institute
13	Economic Development	Kenya Catalytic Jobs Fund
14	Slum Development	UN Habitat

A3.4.2 Content Coding Frequency Table

Table | Frequency Table

All Gr=905; GS=14	**Absolute**	**Table-relative**
1. Diversity & Flexibility Gr=364; GS=7	364	9.44%
2. Learning & Knowledge Gr=594; GS=6	594	15.40%
3. Access to Assets Gr=642; GS=7	642	16.64%
4. Governance Gr=494; GS=8	494	12.81%
HIGH-CAPACITY AGENT Gr=672; GS=4	672	17.42%
ROBUST NETWORK/SYSTEM Gr=578; GS=4	578	14.99%
SUPPORTIVE INSTITUTIONS Gr=513; GS=6	513	13.30%
Totals	3857	100.00%

A3.4.3 Content Coding Key Findings

Table 2: Diversity & Flexibility		
Willingness to Change (163)		
Often these opposing attitudes would be found in the same individual.		
	Positive References A desire: for community to change and development; to partner and participate in community activities and impact change; to pursue education, training and to try different approaches.	
	Negative References an unwillingness: to negotiate; to engage in planning activities; to change behaviour. Often these opposing attitudes would be found in the same individual.	
Livelihood and Income (114)		
	Primarily statements regarding the forms of work in Mathare and are where the most gendered perspective is apparent. Criminality was often referred to as livelihood, noting an even gender balance.	
	Women's Work	*Men's Work*
	includes clothes washing and house cleaning (particularly in Eastleigh, a wealthier adjacent neighbourhood), as well as prostitution.	includes construction work around the city, and gardening, security, and maintenance for wealthy neighbourhoods (particularly in Muthaiga). A common opinion exists that men tend to engage in drinking alcohol instead of searching for work.
	Other references to sources of livelihood	
	motivation for moving to Mathare - driving rural urban migration; in the form of paid training activities; derived from funding opportunities; significant impact on those co-operatives who run water kiosks; corruption mentioned, with emphasis on police; emphasis on efforts for job creation in youth including community initiatives of boda-boda's (motorcycle taxi), garbage collection, government scheme (Kazi Mtaani Youth Employment Program) and networking.	

Table 3: Learning and Knowledge	
***Perception of Risk and Change* (374)**	
	Reference in relation to risks youth engaging in crime; rampant crime; unemployment; loss of youth to violence and imprisonment; extra-judicial police killings; challenge of funding activities; political violence; drugs; cartels; fire; flooding; diseases including cholera and diarrhoea; negative coping mechanisms; suicide; corruption; Covid-19; poor housing material; insecurity; poverty; hunger; teenage pregnancy; sexual harassment; lack of trust; lack of access (physical & safety); displacement; and aggravation.
	Reference in relation to change Increasing population, densification and decreasing social cohesion; urban rural migration; change in weather patterns; decreased rain; changing stereotypes; changed environment including loss of trees and river pollution; new technology; land grabbing; policy changes; and increased social justice laws.

***Recognition of Human Agency (*284).**	
	Positive References Community work; unblocking trenches and clean ups; entrepreneurial activity; activism; fund raising; solution finding; research; hardworking; rate of change; kiosks; co-operatives; saving schemes; networking; role of education in youth; and Covid-19 response.
	Negative References Where agency was limited included: freedom of movement; planning ability; whistleblowing; corruption; impact of alcohol and drugs; negative self-esteem; prejudice; and power relations.

Table 4: Access to Assets	
***Social Capital and Institutional Support* (392)**	
	Positive References Highlighted the importance of building trust within community and individuals' network to function as well to draw in resources. Significance of social capital as form of security as a 'known' person.
	Negative References There were many references to lack of institutional support pertaining to land title, security of tenure and evictions; a lack of political support expressed as a sense of abandonment and marginalization within the larger Nairobi community; limited ability to affect change, no social capital, or power with links to individuals who could influence decision making
Financial/Economic Status* (216*)	
	Negative References generally low, with multiple negative effects and increased challenges aggravation of risks. Financial status of community as a challenge to investment as a source or non-revenue expenditure, with a perceived low rate of return. Referred to in relation to class barriers, differential treatment, and criminalization of the community within the city.

Table 5: Governance	
***Planning Capacity* (233)**	
	Positive References Successful planning of community clean ups and other initiatives co-operatives 'Merry-go-round' saving groups with the aid of institutional support Enumeration activities and flood mitigation through re-planting of embankments
	Negative References The absence of planning: unplanned urbanization and increased population. allocation of land and management.

	prevalence of evictions. lack of resources/ capacity to plan at administration level. lack of coordination of resources. The impact of lack of trust on planning capacity with social activist and administration.
***Levels of Trust* (203)**	
	Positive References How trust is used to build collaboration and partnership to tackle issues through consistency
	Negative References Frequent mention of impacts of land management issues – eviction (use of fire). political motivations; tribal tension; and insecurity of tenure impact of crime and insecurity. class tension – feeling of denigration from the wealthy. lack of trust in police, politicians, chief system, and service providers. similar but inverse lack of trust of social activist groups from administration.

Table 6: High-Capacity Agent

***Responsiveness* (407)**	
	Positive References Individuals taking action despite small capacity Individuals who respond to every opportunity to network or seek livelihood opportunities External institutions responding to lack of services by providing professional services (rescue, education, health) Drive to increase education and make a difference Passion.
	Negative References Individuals whose response is only to promise of money Individuals who respond by engaging in criminal activity, political violence, or drug abuse. A lack of responsiveness attributed to impact of drugs Normalization of issues, incapacity to act at the scale needed Feelings of dejection; low self-esteem
***Independence* (363)**	
	Positive References Education, skills development, and livelihood opportunities linked to increasing independence
	Feelings of lack of dependence Subject to restrictive forces: threat of violence from evictions, cartels, police, thieves – dependence of joining a 'clique' for protection (social capital) Lack of accessibility to critical services Lack of resources, always searching for assistance; health and environmental risks which reduce independence Shocks require external assistance, dependency; dependency on community & neighbours when a shock hits, social capital Relationship with chief and political system one of dependency for access to resources drug dependency; implication of class and race issues Isolation

Table 7: Robust Networks	
***Robustness* (437)**	
	This is the most frequently referred to variable by a large margin and is relevant to most topics and key risks discussed. It is a key feature of all service provision both formal and informal, including cartel activities; community organization and initiatives; Social support mechanisms of institutional support.
Safe Failure and Redundancy & Modularity (141)	
	References to both sub-variables are minimal in comparison to Robustness.
	Safe Failure Positive: Scale of interventions at community level Feeling of ability to try intervening Cross disciplinary experimentation Funding applications Social capital as safety Water kiosks – Institutional initiative Willingness to partner *Safe Failure Negative:* Lack of safety net Severity of impact if fail High stakes Prevalence of violence
	Redundancy & Modularity Positive: Prevalence of partnerships Presence of multiple organizations Presence of multiple institutions Multiple sources of water *Redundancy & Modularity Negative:* Limiting role of Chief Lack of mixed-use development Lack of enforcement

Table 8: Supportive Institutions	
***Rights and Entitlements* (205)**	
	Land management issues Rights of slum dwellers: Human rights Extrajudicial killings Corruption and accountability Social justice and the right to adequate housing, education and health services The impact of significant structural change with a new constitution, and strong bill of rights introduced in 2010, and a new system of government in 2013 Pro-poor water tariffs and government strategies to assist; complications of public and private goods.
***Information Flows* (200)**	
	This is often referred to in the context of sharing experience:

	From and between community organizations Access of individuals to sources of information (social capital or training) and tendency to share In administrative channels from community elders to chief Significance of peace dialogues Partnerships Significance of community organizations being close to the ground and able to gather and verify information quickly Quality and flow of information subject to corruption and self-enrichment as important information doesn't always get to most vulnerable Significant role of WhatsApp and technology in communication.

A 3.4.3 Qualitative Coding Correlation Table

	DA_Capacity to Learn Gr=124	DA_Independance Gr=363	DA_Resourcefullness Gr=223	DA_Responsiveness Gr=407	DG_Adaptive Planning & Design Gr=106	DG_Application of new knowledge Gr=90	DG_Decision Making Process Gr=105	DG_Inclusion Gr=165	DG_Information Flows Gr=200	DG_Rights & Entitlements Gr=205	Diversity & Flexibility Gr=64	DN_Flexibility & Diversity Gr=121	DN_Multiscalar Connectivity Gr=119	DN_Redundance & Modularity Gr=141	DN_Robustness Gr=437	DN_Safe Failure Gr=141
Coping Mechanism Gr=50	3	28	19	35	6	4	3	5	8	9	4	9	2	10	33	16
I1_Dependance on Natural Resources Gr=30	6	12	9	16	6	4	2	1	4	4		5	2	6	19	10
I1_Economic Opportunities Gr=100	18	54	54	55	15	13	12	25	21	21	11	19	14	21	56	13
I1_Livelihood & Income Gr=114	13	59	56	49	12	11	9	19	18	31	9	23	16	20	57	17
I1_Migration Patterns Gr=21	2	6	7	9				4	3	5	1	1	6	4	6	1
I1_Occupational Mobility Gr=11	1	6	5	4	1	1	0	1	3	1	3	2	5	0	4	1
I1_Place Attachment Gr=60	7	32	13	42	7	6	8	14	11	12	3	10	11	9	31	15
I1_Willingness to Change Gr=163	47	82	55	120	37	36	24	49	49	47	10	47	32	31	90	40
I2_Diversity of knowledge sources Gr=58	23	20	15	36	16	21	12	17	32	10	7	14	25	15	28	14
I2_Intergenerational Learning Gr=42	13	16	15	23	4	12	2	11	11	7	3	7	8	8	24	8
I2_Knowledge of Disturbance Gr=94	15	39	21	55	16	14	14	18	27	25	10	14	19	15	59	18
I2_Monitoring & Feedback Mechanism Gr=77	12	14	13	44	20	16	13	12	41	19	10	17	27	13	40	20
I2_Perception of Risk & Change Gr=374	53	183	84	221	49	37	57	70	92	106	21	57	44	71	236	86
I2_Recognition of Human Agency Gr=284	56	160	105	173	44	43	31	64	79	75	24	54	51	59	167	65
I3_Access to Markets Gr=96	7	40	44	48	14	7	11	25	17	22	13	26	23	18	49	11
I3_Cultural Memory Gr=40	6	16	2	20		5	4	12	11	7	3	5	1	5	18	9
I3_Education & Training Gr=67	42	35	20	36	5	19	3	21	33	6	6	14	16	10	27	9
I3_Financial Status/Economic Status Gr=216	15	111	63	89	21	8	26	46	23	69	13	33	25	31	124	45
I3_Material Assets Gr=144	8	68	53	57	21	11	21	24	21	50	15	23	14	31	88	21
I3_Natural Capital Gr=43	8	12	9	31	5	5	2	5	4	10		5	1	8	27	13
I3_Social Capital & Institutional Support Gr=392	64	186	118	216	59	47	48	103	112	97	39	66	81	82	203	77
I4_Accountability of Governance Bodies Gr=171	14	61	32	82	30	14	37	24	43	69	12	18	21	23	90	39
I4_Active Risk Management & Adaptive Governance Gr=65	11	20	12	37	14	13	10	9	23	16	7	11	7	14	41	18
I4_Environmental Institutions & Norms Gr=31	3	7	4	21	3	2	5	4	8	4	4	5	2	7	17	9
I4_Gender/Race Relations Gr=39	5	14	4	17		4	1	13	9	9	2	6	2	4	15	2
I4_Level of Participation in Decision Making Gr=48	2	14	6	23	12	6	12	21	13	15	4	4	10	8	17	8
I4_Level of Trust Gr=203	10	102	40	84	26	9	39	48	37	81	10	28	18	25	105	39
I4_Planning Capacity Gr=233	20	73	50	127	42	26	55	56	63	74	16	33	32	46	136	51
I4_Quality of Govt/Leadership in Policy Gr=132	15	42	18	71	27	13	35	30	32	53	9	21	17	20	70	31
Normalization Gr=48	7	29	20	25	9	3	8	2	5	12	5	7	2	7	31	15
Quote NB Gr=351	34	132	79	169	47	26	55	52	65	77	12	58	38	47	160	69

A3.4.4 Observed and Inferred Relationships Table

Table | Strength of Observed and Inferred Relationships in Descending Order of Strength

Observed Relationships		Inferred Relationships	Inferred Relationships
Independent	Dependent	Independent Variables	Dependent Variables

1	Perceptions of Risk and Change (I2)	Robustness (DN)	Perceptions of Risk and Change (I2)	Social Capital & Institutional Support (I3)	Responsiveness (DA)	Robustness (DN)
2	Perceptions of Risk and Change (I2)	Responsiveness (DA)	Perceptions of Risk and Change (I2)	Recognition of Human Agency (I2)	Independence (DA)	Robustness (DN)
3	Social Capital & Institutional Support (I3)	Robustness (DN)	Perceptions of Risk and Change (I2)	Planning Capacity (I4)	Responsiveness (DA)	Independence (DA)
4	Social Capital & Institutional Support (I3)	Responsiveness (DA)	Perceptions of Risk and Change (I2)	Financial Status (I3)	Information Flows (DG)	Responsiveness (DA)
5	Social Capital & Institutional Support (I3)	Independence (DA)	Perceptions of Risk and Change (I2)	Levels of Trust (I4)	Information Flows (DG)	Independence (DA)
6	Perceptions of Risk and Change (I2)	Independence (DA)	Perceptions of Risk and Change (I2)	Willingness to Change (I1)	Information Flows (DG)	Resourcefulness (DA)
7	Recognition of Human Agency (I2)	Responsiveness (DA)	Social Capital & Institutional Support (I3)	Recognition of Human Agency (I2)	Rights & Entitlements (DG)	Independence (DA)
8	Recognition of Human Agency(I2)	Robustness (DN)	Social Capital & Institutional Support (I3)	Planning Capacity (I4)	Rights & Entitlements (DG)	Robustness (DN)
9	Recognition of Human Agency(I2)	Independence (DA)	Recognition of Human Agency (I2)	Planning Capacity (I4)	Rights & Entitlements (DG)	Responsiveness (DA)
10	Planning Capacity (I4)	Robustness (DN)				
11	Planning Capacity (I4)	Independence (DA)				
12	Financial Status (I3)	Robustness (DN)				
13	Willingness to Change (I1)	Responsiveness (DA)				
14	Social Capital & Institutional Support (I3)	Resourcefulness (DA)				
15	Social Capital & Institutional Support (I3)	Information Flows (DG)				
16	Social Capital & Institutional Support (I3)	Independence (DA)				
17	Financial Status (I3)	Independence (DA)				
18	Perceptions of Risk and Change (I2)	Rights & Entitlements (DG)				
19	Recognition of Human Agency(I2)	Resourcefulness (DA)				
20	Levels of Trust (I4)	Robustness (DN)				

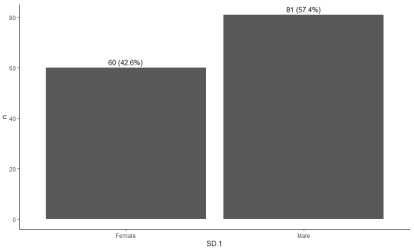
A 3.4.5 Demographics

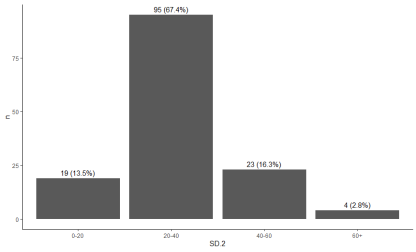
Table X : Demographic data of respondents

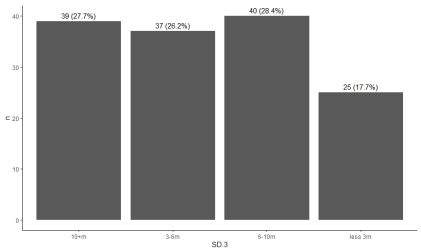
SD.1 Gender	**Male**	**Female**			
	57.4 %	42.6%			
SD.2 Age Group	**0-20**	**20-40**	**40-60**	**60+**	**Mean**
	13.5%	67.4%	16.3%	2.8%	2.085
SD.3 Distance from river	**0-3m**	**3-6m**	**6-10m**	**10m+**	**Mean**
	17.7%	26.2%	28.4%	27.7%	2.66
SD.4 Religion	**Muslim**	**Christian**	**All Others**		
	10.6%	85.8%	5.3%		

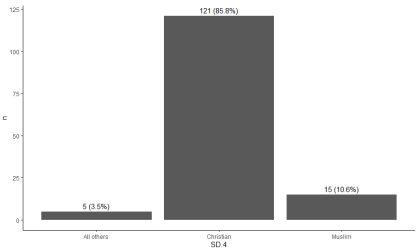
SD.5 Village	1	2	3	4	5	6	7	8	9	10
	4.3&	23.4%	2.8%	12.1%	10.6%	24.1%	4.3%	7.1%	9.2%	2.1%

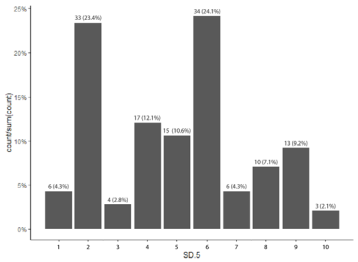
A 3.4.6 Graphs of Survey Results











A 3.4.7 Detailed Scoring

Table X : Detailed Adaptive Capacity scoring of using means

VX1	**Diversity & Flexibility**		**3**
VX1.1	**Livelihood and Income Diversity**		
	1.1	Level of Employment	
	1.2	Level of Income	2
	1.3	Level of Income Diversity	2
	1.4	Percp. - Level of resources adequate	2
	1.5	Percp. - Level of tradable skills	2
	1.6	Percp. - Level of independence	4
V1.X1.2	**Economic Opportunities**		
	2.1	Percp. - Level of economic. opportunities	2
	2.2	Percp. - Level of willingness distance travelled for income	4
VX1.3	**Level of Dependence on Natural Resources**		
	3.1	Level of dependence on natural water source	1
	3.2	Level of dependence on harvested fire wood	1
	3.3	Level of dependence for livelihood	2
VX1.4	**Occupational Mobility**		
	4.1	I can do my work anywhere?	4
VX1.5	**Place Attachment**		
	5.1	Percp. - Sense of home	3
	5.2	Percp. - Sense of comfort/safety	3
	5.3	Percp. Health of environement	2
VX1.6	**Migration Patterns**		

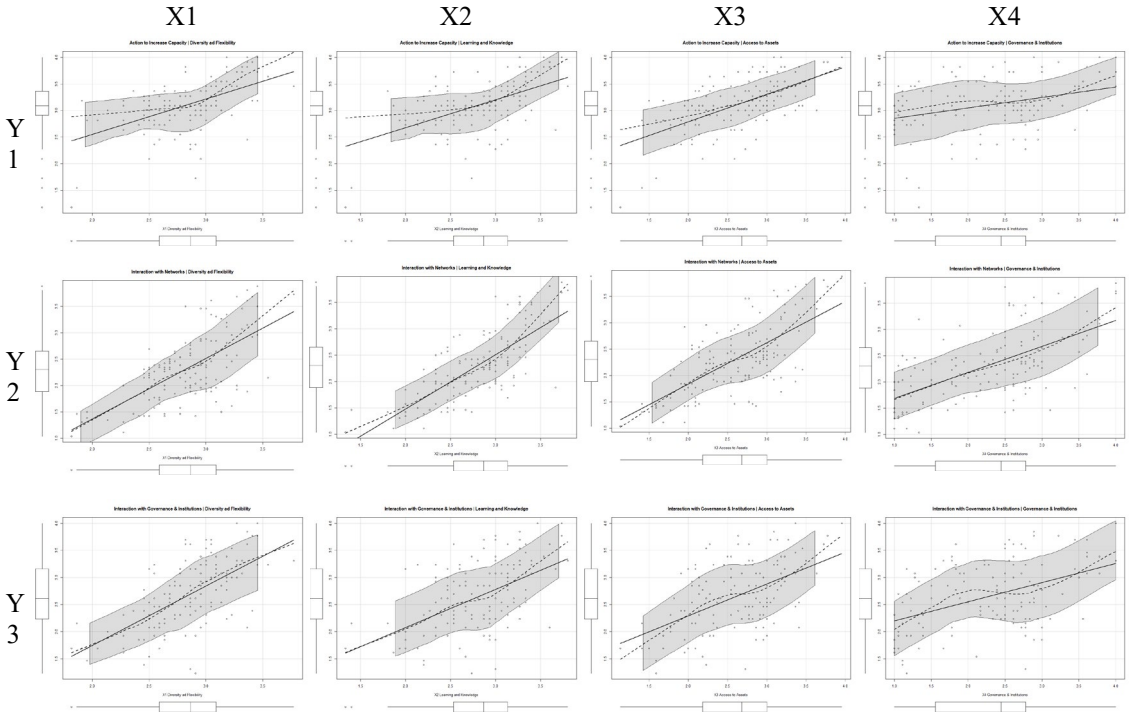
	6.1	Amount of time spent in Nairobi p/y	1
VX1.7	**Willingness to Change**		
	7.1	Percp. - benefit of personal change	4
	7.2	Percp. - benefit of community change	4
	7.3	Percp. - benefit of gov support	4
	7.4	Percp. - benefit of environmental change	4
	7.5	Level of willingness to increase education	4
	7.6	Level of willingness to attend training	4
	7.7	Level of Willingness to experiment	
	7.8	Level of Willingness to try new skill	4
	7.9	Level of willigness to participate in community	3
	7.10	Level of Willingness to participate in political activities	3
	7.11	Level of willingness to use technology	4
VX2	**Learning and Knowledge**		**2**
VX2.1	**Resource Monitoring & Feedback Mechanisms**		
	8.1	Percp. - Level of knwldge re. cell phone	3
	8.2	Percp. - Level of knwldge re.computer	1
VX2.2	**Knowledge of Disturbance**		
	9.1	Percp. - Level of knwldge re.CC	2
	9.2	Percp. - Level of knwldge re. flooding	2
	9.3	Percp. - Level of knwldge re. drought	3
	9.4	Percp. - Level of knwldge re. water availability	2
VX2.3	**Perceptions of Risk & Ability to Anticipate Change**		
	10.1	Percp. - Frequency of flooding	3
	10.2	Percp. - Frequency of drought	2
	10.3	Percp. - Frequency of water scarcity	1
	10.4	Percp. - Level of safety (flooding)	1
	10.5	Percp. - level of future planning	1
VX2.4	**Diversity of Knowledge and Information Sources**		
	11.1	Level of Access to Internet	2
	11.2	Level of Access to smart device	3
	11.3	Level of Knowledge of social support networks	
VX2.5	**Recognition of Causality and Human Agency**		
	12.1	Percp. - Level of sense of commitment	4
	12.2	Percp. - Level of Agency	3
	12.3	Percp. - Level of ability to solve problems	4
	12.4	Percp. - Level Value of education	4
VX2.6	**Intergenerational Learning Capacity**		
	20.1	Percp. - Level of learnt knowledge	1
	20.2	Percp. - Knowldege to teach	3
VX3	**Access to Assets**		**3**
vx3.1	**Household Material Assets**		4
	14.1	Level of construction material	3
	14.2	Level of household assets	3
	14.4	Percp. - No. of sources of water	3
	14.5	Percp. - No. of sources of health care	1
vx3.2	**Levels of Education & Traning**		
	15.1	Level of education	3
	15.2	Further Training	3
vx3.3	**Financial Status & Access to Sources of Credit**		
	16.1	Access to banking	1
	16.2	Access to credit/loans	1
vx3.4	**Access to Markets**		
	17.1	Access to international relative transfer	1
	17.2	Access to electricity	1
	17.3	Access to sanitation	4
	17.4	Access to health care	1
	17.5	Level of food security	1
	17.6	Access to clean water	4
vx3.5	**Social Capital & Institutional Support**		
	18.1	Percp. - Institutional Support	3
	18.2	Proof of Address	1
	18.3	Right to Vote	4
	18.4	Level of bonding	3
	18.5	Level of bridging	3
	18.6	Level of linking	3
vx3.6	**Natural Capital**		
	19.1	Level of health	3
	19.2	Percp. Health of Environment	1
	Cultural Memory, traditions and assets		
		Perception learnt from elders	
		Perception knowledge to teach	
VX4	**Governance & Institutions**		**2**
vx4.1	**Levels of Trust**		

	21.0	Percp. - Social Inclusion	0
	21.1	Percp. - Sense of community	3
	21.2	Percp. - Level of trust in community	2
vx4.2	**Gender & Race Relations**		
	22.1	Percp. - Level of Gender Equality	1
vx4.3	**Levels of Participation & Quality Decision Making**		
	23.1	Percp. - Quality of decision making - COM	2
	23.2	Percp. - Quality of decision making -GOV	2
vx4.4	**Planning Capacity**		
	24.1	Percp. - Community ability to plan	2
	24.2	Percp. - Gov. ability to plan	2
	25.2		
vx4.5	**Presence of Local Environemental Institutions & Social Norms**		
	25.1	Percp. - Knowledge about env. Orgs	2
	25.2	Percp. - stewardship	3
	25.3	Percp. - conservation	4
	25.4	Percp. - waste management	1
vx4.6	**Quality of Governance & Leadership in Environmental Policies & Agencies**		
	26.1	Percp. - Leadership in flood management	2
	26.2	Percp. - Leadership in environmental issues	2
	26.3	Percp. - Leadership in infrastructure challenges	2
	Accountability of managers and governance bodies		
		Percp. - Government Responsibility - floods	
		Percp. - Government Responsibility - water access	
vx4.7	**Active Risk Management and Adaptive Govenance Processes**		
	28.1	Percp. - Government Action - floods	2
	28.2	Percp. - Government Action - water access	2
	28.3	Percp. - Community Action - floods	2
	28.4	Percp. - Community Action - water access	3
		Total Adaptive Capacities	**2**

A 3.4.8 Internal Consistency Table

INDEPENDENT VARIABLES				DEPENDENT VARIABLES		
Level	Code	**Adaptive Capacity**	**Internal C. Score**	Code	**Adaptive Action**	**Internal C. Score**
1	**VX1**	**Diversity & Flexibility**	**0.77**	**VY1**	**Actions to Increase Capacity**	**0.66**
2	vx1.1	Livelihood and Income Diversity	0.62	vy1.1	Responsiveness	0.52
	vx1.2	Economic Opportunities	0.33	vy1.2	Resourcefulness	0.11
	vx1.3	Level of Dependence on Natural Resources	0.75	vy1.3	Capacity to Learn	0.54
	vx1.4	Occupational Mobility	NA	vy1.4	Independence	0.76
	vx1.5	Place Attachment	0.77			
	vx1.6	Migration Patterns	NA			
	vx1.7	Willingness to Change	0.7			
1	**VX2**	**Learning & knowledge**	**0.77**	**VY2**	**Interaction with Networks**	**0.9**
2	vx2.1	Resource Monitoring & Feedback Mechanisms	0.81	vy2.1	Flexibility & Diversity	0.88
	vx2.2	Knowledge of Disturbance	0.64	vy2.2	Redundance & Modularity	0.43
	vx2.3	Perceptions of Risk & Ability to Anticipate Change	0.35	vy2.3	Safe Failure	0.83
	vx2.4	Diversity of Knowledge and Information Sources	0.58	vy2.4	Robustness	0.8
	vx2.5	Recognition of Causality and Human Agency	0.49	vy2.5	Multiscale Connectivity	NA
	vx2.6	Intergenerational Learning Capacity	0.72			
1	**VX3**	**Access to Assets**	**0.83**	**VY3**	**Interaction with Institutions**	**0.77**
2	vx3.1	Household Material Assets	0.57	vy3.1	Rights & Entitlements	0.94
	vx3.2	Levels of Education & Training	0.4	vy3.2	Decision Making Processes	0.57
	vx3.3	Financial Status & Access to Sources of Credit	0.73	vy3.3	Information Flows	0.61
	vx3.4	Access to Markets	0.8	vy3.4	Application of New Knowledge	NA
	vx3.5	Social Capital & Institutional Support	0.74	vy3.5	Inclusion	0.71
	vx3.6	Natural Capital	0.41	vy3.6	Adaptive Planning & Design	NA
1	**VX4**	**Governance & Institutions**	**0.92**			
2	vx4.1	Levels of Trust	0.82			
	vx4.2	Gender & Race Relations	NA			
	vx4.3	Levels of Participation & Quality Decision Making	0.67			
	vx4.4	Planning Capacity	0.76			
	vx4.5	Presence of Local Env. Institutions & Social Norms	0.55			
	vx4.6	Quality of Governance & Leadership in Env. Policies & Agencies	0.84 0.82			
	vx4.7	Active Risk Management and Adaptive Governance Processes				

A.3.4.9 Covariance Graphs



All graphs visualise the covariant relationships expressed between the independent and dependent variables in a scatterplot with added marginal boxplots, fitted estimated mean and variance lines.

A.3.4.10 Correlation Table with Variables

Table 1 | Descriptive Statistics and Correlations

Variable	Code	mean	V	SD	CV	SD.1	SD.2	SD.3	SD.4	SD.5	X1	X2	X3	X4	Y1	Y2	Y3
Control Variables																	
Gender	**SD.1**	2.72	2.22	1.49	0.55												
Age	**SD.2**	2.09	0.41	0.64	0.31	0.05											
Distance from River	**SD.3**	2.66	1.14	1.07	0.4	-0.1	0.04										
Religion	**SD.4**	2.82	0.22	0.47	0.17	-0.14	0	-0.15									
Area	**SD.5**	4.96	6.12	2.47	0.5	-0.11	0.03	0.08	0.04								
Independent Variables																	
Diversity & Flexibility	**X1**	2.83	0.13	0.36	0.13	0.25**	-0.05	-0.01	-0.02	0.05							
Knowledge & Learning	**X2**	2.86	0.19	0.43	0.15	0.15	-0.05	0.01	0.01	0.03	0.7****						
Access to Assets	**X3**	2.61	0.3	0.55	0.21	0.18*	0.03	0.03	-0.02	-0.22**	0.59****	0.66****					
Governance	**X4**	2.28	0.63	0.79	0.35	0.27**	-0.06	0.04	-0.01	-0.19*	0.48****	0.46****	0.66****				
Dependent Variables																	
Action to Increase AC	**Y1**	3.1	0.22	0.46	0.15	0.12	0.08	-0.03	0.09	-0.12	0.52****	0.5****	0.61****	0.34****			
Interaction with Networks	**Y2**	2.32	0.41	0.64	0.28	0.16	-0.01	0.02	-0.02	0	0.65****	0.75****	0.67****	0.61****	0.48****		
Interaction with Governance & Institutions	**Y3**	2.65	0.39	0.63	0.24	0.03	-0.05	0.05	0.02	0.19*	0.64****	0.57****	0.51****	0.45****	0.5****	0.62****	

****. Correlation is significant at the 0.0001 level (2-tailed).
***. Correlation is significant at the 0.001 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N = 141; V= Variance; SD = Standard Deviation; CV= Coefficient Variance

A.3.4.11 Detailed Correlation Table with Variables and sub-variables

Table 1 | Descriptive Statistics and Correlations

Variable	Code	mean	V	SD	CV	SD.1	SD.2	SD.3	SD.4	SD.5	X1	X2	X3	X4	X.v1.1	X.v1.2	X.v1.3	X.v1.4	X.v1.5	X.v1.6
Control Variables																				
Gender	**SD.1**	2.72	2.22	1.49	0.55															
Age	**SD.2**	2.09	0.41	0.64	0.31	0.05														
Distance from River	**SD.3**	2.66	1.14	1.07	0.4	-0.1	0.04													
Religion	**SD.4**	2.82	0.22	0.47	0.17	-0.14	0	-0.15												
Area	**SD.5**	4.96	6.12	2.47	0.5	-0.11	0.03	0.08	0.04											
Independent Variables																				
Diversity & Flexibility	**X1**	2.83	0.13	0.36	0.13	0.25**	-0.05	-0.01	-0.02	0.05										
Knowledge & Learning	**X2**	2.86	0.19	0.43	0.15	0.15	-0.05	0.01	0.01	0.03	0.7****									
Access to Assets	**X3**	2.61	0.3	0.55	0.21	0.18*	0.03	0.03	-0.02	-0.22**	0.59****	0.66****								
Governance	**X4**	2.28	0.63	0.79	0.35	0.27**	-0.06	0.04	-0.01	-0.19*	0.48****	0.46****	0.66****							
Independent Sub - Variables																				
Diversity & Flexibility																				
Livelihood and Income Diversity	**X.v1.1**	2.34	0.37	0.61	0.26	0.11	0.09	0.03	-0.02	0.01	0.67****	0.54****	0.55****	0.22**						
Economic Opportunities	**X.v1.2**	2.87	0.62	0.79	0.27	0.2*	0.11	-0.03	0.06	-0.22**	0.64****	0.46****	0.6****	0.44****	0.52****					
Level of Dependence on Natural Resources	**X.v1.3**	1.54	0.71	0.84	0.54	0.18*	-0.03	-0.03	-0.17*	0.21*	0.41****	0.17*	-0.06	0.33****	0.03	0.08				
Occupational Mobility	**X.v1.4**	3.59	0.84	0.92	0.26	0.02	-0.1	-0.01	0.08	-0.17*	0.46****	0.4****	0.4****	0.34****	0.2*	0.48****	-0.06			
Place Attachment	**X.v1.5**	2.71	1.49	1.22	0.45	0.07	-0.11	0.04	0.03	0.28***	0.7****	0.45****	0.3****	0.27**	0.42****	0.24**	0.29***	0.26**		
Migration Patterns	**X.v1.6**	1.43	0.28	0.53	0.37	-0.06	0.06	-0.02	-0.09	-0.22**	-0.31****	-0.26**	-0.12	-0.07	-0.14	-0.18*	-0.12	-0.18*	-0.43****	
Willingness to Change	**X.v1.7**	3.61	0.19	0.44	0.12	0.14	-0.11	0	0.02	0.02	0.63****	0.49****	0.41****	0.18*	0.2*	0.25**	-0.01	0.33****	0.33****	-0.28***
Knowledge & Learning																				
Resource Monitoring & Feedback Mechanisms	**X.v2.1**	2.79	1.41	1.19	0.42	0.14	-0.07	0.06	-0.07	-0.12	0.39****	0.7****	0.41****	0.26**	0.26**	0.3***	0.12	0.28***	0.11	-0.02
Knowledge of Disturbance	**X.v2.2**	2.27	1.22	1.1	0.49	0.14	-0.04	0.07	-0.04	0.23**	0.49****	0.63****	0.33****	0.54****	0.28***	0.15	0.41****	0.19*	0.4****	-0.2*
Perceptions of Risk & ability to anticipate change	**X.v2.3**	2.24	0.53	0.73	0.33	-0.16	-0.03	-0.06	0.14	0.37****	0.04	0.01	-0.25**	-0.41****	0.22**	-0.05	-0.04	-0.21*	0.22**	-0.21*
Diversity of Knowledge and information sources	**X.v2.4**	2.54	0.83	0.91	0.36	0.16	-0.01	0.1	0.02	-0.11	0.34****	0.7****	0.48****	0.28**	0.29***	0.26**	0.02	0.23**	0.05	-0.02
Recognition of Causality and Human Agency	**X.v2.5**	3.64	0.21	0.46	0.13	0.08	0.04	-0.07	0.03	-0.07	0.55****	0.63****	0.55****	0.33****	0.34****	0.37****	-0.03	0.47****	0.42****	-0.25**
Intergenerational learning capacity	**X.v2.6**	3.23	1	1	0.31	0.14	-0.02	-0.06	-0.04	-0.26**	0.4****	0.5****	0.62****	0.5****	0.33****	0.45****	0	0.34****	0.21*	-0.14
Access to Assets																				
Household Material Assets	**X.v3.1**	2.78	0.46	0.67	0.24	0.03	0.11	0.03	0.01	-0.37****	0.25**	0.33****	0.73****	0.37****	0.27**	0.44****	-0.31***	0.31***	0.04	0.04
Levels of Education & Training	**X.v3.2**	2.62	1.08	1.04	0.4	0.26**	0.07	-0.09	-0.01	-0.11	0.59****	0.46****	0.58****	0.27**	0.64****	0.54****	0.09	0.26**	0.27**	-0.08
Financial Status & Access to sources of credit	**X.v3.3**	2.23	1.55	1.25	0.56	-0.02	0.07	0.04	-0.07	0.29***	0.38****	0.47****	0.32****	0.02	0.44****	0.11	0.16	-0.01	0.3***	-0.18*
Access to Markets	**X.v3.4**	2.34	0.69	0.83	0.35	0.17*	0.03	0.06	-0.05	-0.3***	0.35****	0.49****	0.87****	0.52****	0.41****	0.52****	-0.26**	0.32***	0.09	-0.01
Social Capital & Institutional Support	**X.v3.5**	2.94	0.61	0.78	0.27	0.15	-0.1	-0.01	0	-0.11	0.6****	0.52****	0.78****	0.69****	0.45****	0.49****	0.12	0.42****	0.45****	-0.27**
Natural Capital	**X.v3.6**	2.21	0.62	0.79	0.36	0.11	0.02	0.05	0.06	0.04	0.27**	0.29***	0.31***	0.48****	0.1	0.18*	0.25**	0.17*	0.12	0.01
Governance																				
Levels of Trust, Networks	**X.v4.1**	2.51	1.35	1.16	0.46	0.24**	-0.05	0.03	-0.06	-0.32***	0.27***	0.33****	0.57****	0.8****	0.1	0.37****	0.2*	0.28***	0.02	0.04
Gender & Race Relations	**X.v4.2**	1.54	1.05	1.02	0.67	0.2*	-0.13	0.18*	-0.07	0.1	0.24**	0.17*	0.2*	0.49****	0.02	0.13	0.26**	0.12	0.28**	-0.05
	X.v4.3	2.2	1.16	1.08	0.49	0.19*	-0.03	-0.03	-0.06	-0.32***	0.21*	0.22**	0.48****	0.83****	0.07	0.29***	0.19*	0.27**	0	0.06
Levels of Participation & quality decision making																				
Planning Capacity	**X.v4.4**	2.45	1.28	1.13	0.46	0.22**	-0.08	-0.06	0.02	-0.29***	0.3***	0.29****	0.52****	0.83****	0.1	0.3***	0.18*	0.31***	0.12	0.02
Presence of local Environemental Institutions & Social Norms	**X.v4.5**	2.45	0.53	0.73	0.3	0.2*	-0.09	0.07	0.08	-0.03	0.64****	0.66****	0.64****	0.76****	0.45****	0.45****	0.29***	0.34****	0.46****	-0.21*
Quality of Governance and Leadership in	**X.v4.6**	2.18	1.09	1.04	0.48	0.26**	0.02	0.11	-0.06	0.04	0.55****	0.43****	0.55****	0.79****	0.32****	0.43****	0.35****	0.23**	0.45****	-0.19*
Active Risk Management and Adaptive Governance Processes	**X.v4.7**	2.2	0.99	0.99	0.45	0.19*	-0.03	-0.02	0.04	-0.2*	0.3***	0.32****	0.51****	0.9****	0.05	0.33****	0.32***	0.28***	0.13	-0.01
Dependent Variables																				
Action to Increase AC	**Y1**	3.1	0.22	0.46	0.15	0.12	0.08	-0.03	0.09	-0.12	0.52****	0.5****	0.61****	0.34****	0.49****	0.39****	-0.09	0.27**	0.31***	-0.11
Interaction with Networks	**Y2**	2.32	0.41	0.64	0.28	0.16	-0.01	0.02	-0.02	0	0.65****	0.75****	0.67****	0.61****	0.46****	0.38****	0.31***	0.28***	0.37****	-0.18*
Interaction with Governance & Institutions	**Y3**	2.65	0.39	0.63	0.24	0.03	-0.05	0.05	0.02	0.19*	0.64****	0.57****	0.51****	0.45****	0.43****	0.26**	0.2*	0.26**	0.61****	-0.38****

****. Correlation is significant at the 0.0001 level (2-tailed).
***. Correlation is significant at the 0.001 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N = 141; V= Variance; SD = Standard Deviation; CV= Coefficient Variance

Code	X.v1.7	X.v2.1	X.v2.2	X.v2.3	X.v2.4	X.v2.5	X.v2.6	X.v3.1	X.v3.2	X.v3.3	X.v3.4	X.v3.5	X.v3.6	X.v4.1	X.v4.2	X.v4.3	X.v4.4	X.v4.5	X.v4.6	X.v4.7	Y1	Y2	Y3
X.v2.1	0.3***																						
X.v2.2	0.26**	0.25**																					
X.v2.3	-0.03	-0.22**	-0.1																				
X.v2.4	0.29***	0.8****	0.3***	-0.28***																			
X.v2.5	0.53****	0.24**	0.29***	-0.14	0.25**																		
X.v2.6	0.23**	0.12	0.21*	-0.29***	0.17*	0.45****																	
X.v3.1	0.26**	0.22**	0.03	-0.2*	0.24**	0.35****	0.47****																
X.v3.2	0.28***	0.31***	0.22**	-0.12	0.36****	0.29***	0.43****	0.3***															
X.v3.3	0.26**	0.37****	0.29***	0.28***	0.36****	0.19*	-0.05	-0.04	0.28***														
X.v3.4	0.24**	0.32***	0.15	-0.3***	0.45****	0.4****	0.59****	0.69****	0.44****	0.11													
X.v3.5	0.38****	0.18*	0.35****	-0.26**	0.21*	0.58****	0.67****	0.44****	0.43****	0.07	0.55****												
X.v3.6	0.14	0.21*	0.41****	-0.03	0.22**	0.13	-0.04	0.13	-0.05	0.17*	0.13	0.13											
X.v4.1	0.08	0.23**	0.36****	-0.57****	0.25**	0.34****	0.51****	0.39****	0.27**	-0.16	0.54****	0.56****	0.32****										
X.v4.2	0.07	0.07	0.2*	-0.09	0.01	0.18*	0.15	-0.02	0.05	0.07	0.16	0.24**	0.3***	0.34****									
X.v4.3	0.02	0.17*	0.32***	-0.51****	0.19*	0.19*	0.37****	0.36****	0.13	-0.17*	0.4****	0.54****	0.4****	0.74****	0.33****								
X.v4.4	0.13	0.19*	0.33****	-0.46****	0.24**	0.3***	0.38****	0.41****	0.21*	-0.18*	0.4****	0.59****	0.33****	0.69****	0.29***	0.83****							
X.v4.5	0.33****	0.33****	0.6****	-0.17*	0.4****	0.45****	0.51****	0.27**	0.42****	0.23**	0.46****	0.7****	0.3***	0.52****	0.31***	0.43****	0.49****						
X.v4.6	0.24**	0.2*	0.52****	-0.1	0.18*	0.19*	0.35****	0.25**	0.3***	0.28***	0.35****	0.56****	0.39****	0.44****	0.42****	0.48****	0.54****	0.67****					
X.v4.7	0.05	0.19*	0.47****	-0.4****	0.2*	0.2*	0.38****	0.29***	0.06	-0.05	0.45****	0.5****	0.52****	0.67****	0.4****	0.77****	0.7****	0.57****	0.63****				
Y1	0.44****	0.21*	0.23**	-0.03	0.28***	0.57****	0.39****	0.47****	0.43****	0.3***	0.45****	0.47****	0.19*	0.29***	0.17*	0.21*	0.3***	0.44****	0.29***	0.16			
Y2	0.44****	0.63****	0.57****	-0.16	0.65****	0.43****	0.28***	0.28***	0.39****	0.5****	0.46****	0.5****	0.45****	0.41****	0.29***	0.4****	0.44****	0.66****	0.53****	0.51****	0.48****		
Y3	0.51****	0.22**	0.47****	0.04	0.24**	0.57****	0.28***	0.22**	0.25**	0.34****	0.24**	0.62****	0.31***	0.23**	0.23**	0.25**	0.38****	0.58****	0.45****	0.28***	0.5****	0.62****	

****. Correlation is significant at the 0.0001 level (2-tailed).

***. Correlation is significant at the 0.001 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

N = 141; V= Variance; SD = Standard Deviation; CV= Coefficient Variance

A.3.4.12 Variance Inflation Factor Test

The high correlation and significance of each independent variable the dependent variables requires that each variable is required to avoid an upward omitted variable bias on the total effects on Y_1, Y_2, and Y_3. A variance inflation factor test was conducted to ensure no multicollinearity exists between independent variables with the following results:

X1	X2	X3	X4
2.11	2.37	2.51	1.80

Results of VIF of Independent Sub-variables

X.v1.1	X.v1.2	X.v1.3	X.v1.4	X.v1.5	X.v1.6	X.v1.7
2.89	2.60	2.32	1.77	2.547	1.46	1.88
X.v2.1	X.v2.2	X.v2.3	X.v2.4	X.v2.5	X.v2.6	
3.38	2.42	2.50	4.27	2.70	2.50	
X.v3.1	X.v3.2	X.v3.3	X.v3.4	X.v3.5	X.v3.6	
2.66	1.74	2.37	5.34	4.80	1.96	
X.v4.1	X.v4.2	X.v4.3	X.v4.4	X.v4.5	X.v4.6	X.v4.7
4.20	1.61	5.85	4.87	3.89	3.88	5.56

A.3.4.13 Sub-Variable Regression outputs

```
Call:
lm(formula = Y1 ~ X.v1.1 + X.v1.2 + X.v1.3 + X.v1.4 + X.v1.5 +
    X.v1.6 + X.v1.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.24439 -0.17606  0.02655  0.23923  0.90611

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.916021   0.332358   2.756 0.006670 **
X.v1.1       0.249929   0.065725   3.803 0.000217 ***
X.v1.2       0.079914   0.053028   1.507 0.134176
X.v1.3      -0.069252   0.040099  -1.727 0.086484 .
X.v1.4       0.007077   0.041031   0.172 0.863325
X.v1.5       0.037399   0.033773   1.107 0.270130
X.v1.6       0.070200   0.067253   1.044 0.298464
X.v1.7       0.346973   0.079890   4.343 2.76e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3694 on 133 degrees of freedom
Multiple R-squared:  0.3975,    Adjusted R-squared:  0.3657
F-statistic: 12.53 on 7 and 133 DF,  p-value: 2.854e-12
```

```
Call:
lm(formula = Y2 ~ X.v1.1 + X.v1.2 + X.v1.3 + X.v1.4 + X.v1.5 +
    X.v1.6 + X.v1.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.13666 -0.40599 -0.00121  0.32156  1.17971

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.065779   0.444381  -2.398   0.0179 *
X.v1.1       0.357856   0.087877   4.072 7.95e-05 ***
X.v1.2       0.038246   0.070901   0.539   0.5905
X.v1.3       0.235155   0.053614   4.386 2.33e-05 ***
X.v1.4       0.073644   0.054860   1.342   0.1818
X.v1.5      -0.001524   0.045156  -0.034   0.9731
X.v1.6       0.030218   0.089921   0.336   0.7374
X.v1.7       0.490588   0.106817   4.593 1.00e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4939 on 133 degrees of freedom
Multiple R-squared:  0.438,     Adjusted R-squared:  0.4085
F-statistic: 14.81 on 7 and 133 DF,  p-value: 3.498e-14
```

```
Call:
lm(formula = Y3 ~ X.v1.1 + X.v1.2 + X.v1.3 + X.v1.4 + X.v1.5 +
    X.v1.6 + X.v1.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.55144 -0.23555  0.04942  0.28163  1.01572

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.04489    0.39752   0.113  0.91025
X.v1.1       0.25122    0.07861   3.196  0.00174 **
X.v1.2      -0.06593    0.06342  -1.039  0.30048
X.v1.3       0.07335    0.04796   1.529  0.12852
X.v1.4       0.03116    0.04907   0.635  0.52658
X.v1.5       0.16981    0.04039   4.204 4.78e-05 ***
X.v1.6      -0.12570    0.08044  -1.563  0.12051
X.v1.7       0.47152    0.09555   4.935 2.36e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4418 on 133 degrees of freedom
Multiple R-squared:  0.527,     Adjusted R-squared:  0.5021
F-statistic: 21.16 on 7 and 133 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = Y1 ~ X.v2.1 + X.v2.2 + X.v2.3 + X.v2.4 + X.v2.5 +
    X.v2.6, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.37254 -0.20026  0.02456  0.22712  0.89097

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.71028    0.29409   2.415   0.0171 *
X.v2.1      -0.03759    0.04422  -0.850   0.3968
X.v2.2       0.01069    0.03086   0.346   0.7296
X.v2.3       0.08599    0.04664   1.844   0.0674 .
X.v2.4       0.12350    0.05896   2.094   0.0381 *
X.v2.5       0.46298    0.08052   5.750 5.77e-08 ***
X.v2.6       0.08697    0.03668   2.371   0.0191 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3728 on 134 degrees of freedom
Multiple R-squared:  0.3817,    Adjusted R-squared:  0.354
F-statistic: 13.79 on 6 and 134 DF,  p-value: 3.678e-12
```

```
Call:
lm(formula = Y2 ~ X.v2.1 + X.v2.2 + X.v2.3 + X.v2.4 + X.v2.5 +
    X.v2.6, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.20971 -0.24961  0.01385  0.23253  0.92605

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.18088    0.31119  -0.581  0.56204
X.v2.1       0.14526    0.04679   3.104  0.00233 **
X.v2.2       0.20747    0.03265   6.354 3.04e-09 ***
X.v2.3       0.05480    0.04935   1.111  0.26877
X.v2.4       0.20616    0.06239   3.304  0.00122 **
X.v2.5       0.23165    0.08520   2.719  0.00742 **
X.v2.6       0.04111    0.03881   1.059  0.29135
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3945 on 134 degrees of freedom
Multiple R-squared:  0.6388,    Adjusted R-squared:  0.6227
F-statistic:  39.5 on 6 and 134 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = Y3 ~ X.v2.1 + X.v2.2 + X.v2.3 + X.v2.4 + X.v2.5 +
    X.v2.6, data = mathare.data)

Residuals:
    Min      1Q  Median      3Q     Max
-1.3561 -0.2666  0.0268  0.2900  1.0521

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.636725   0.372441  -1.710   0.0897 .
X.v2.1       0.005364   0.056001   0.096   0.9238
X.v2.2       0.182025   0.039079   4.658 7.60e-06 ***
X.v2.3       0.149278   0.059065   2.527   0.0127 *
X.v2.4       0.044000   0.074673   0.589   0.5567
X.v2.5       0.636221   0.101975   6.239 5.38e-09 ***
X.v2.6       0.029124   0.046445   0.627   0.5317
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4721 on 134 degrees of freedom
Multiple R-squared:  0.4558,    Adjusted R-squared:  0.4314
F-statistic:  18.7 on 6 and 134 DF,  p-value: 1e-15
```

```
Call:
lm(formula = Y1 ~ X.v3.1 + X.v3.2 + X.v3.3 + X.v3.4 + X.v3.5 +
    X.v3.6, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.98820 -0.20513  0.00624  0.25108  0.79997

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.496446   0.185404   8.071 3.51e-13 ***
X.v3.1       0.216121   0.064416   3.355 0.001032 **
X.v3.2       0.082589   0.040928   2.018 0.045597 *
X.v3.3       0.094356   0.025991   3.630 0.000402 ***
X.v3.4      -0.004463   0.057764  -0.077 0.938526
X.v3.5       0.165208   0.047479   3.480 0.000678 ***
X.v3.6       0.037160   0.039997   0.929 0.354527
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3636 on 134 degrees of freedom
Multiple R-squared:  0.4118,    Adjusted R-squared:  0.3855
F-statistic: 15.64 on 6 and 134 DF,  p-value: 1.496e-13
```

```
Call:
lm(formula = Y2 ~ X.v3.1 + X.v3.2 + X.v3.3 + X.v3.4 + X.v3.5 +
    X.v3.6, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.26162 -0.24952  0.05215  0.25306  1.00437

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.03464    0.20579  -0.168  0.86658
X.v3.1      -0.04619    0.07150  -0.646  0.51940
X.v3.2       0.13578    0.04543   2.989  0.00333 **
X.v3.3       0.18792    0.02885   6.514 1.36e-09 ***
X.v3.4       0.13222    0.06412   2.062  0.04112 *
X.v3.5       0.26985    0.05270   5.121 1.04e-06 ***
X.v3.6       0.25816    0.04440   5.815 4.23e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4036 on 134 degrees of freedom
Multiple R-squared:  0.6219,    Adjusted R-squared:  0.605
F-statistic: 36.74 on 6 and 134 DF,  p-value: < 2.2e-16
```

```
Call:
lm(formula = Y3 ~ X.v3.1 + X.v3.2 + X.v3.3 + X.v3.4 + X.v3.5 +
    X.v3.6, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.35608 -0.26005 -0.00382  0.29865  1.15700

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.74079    0.22080   3.355  0.00103 **
X.v3.1       0.06265    0.07672   0.817  0.41554
X.v3.2      -0.05858    0.04874  -1.202  0.23155
X.v3.3       0.15239    0.03095   4.923 2.46e-06 ***
X.v3.4      -0.15128    0.06879  -2.199  0.02959 *
X.v3.5       0.53718    0.05654   9.500  < 2e-16 ***
X.v3.6       0.15383    0.04763   3.229  0.00156 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.433 on 134 degrees of freedom
Multiple R-squared:  0.5422,    Adjusted R-squared:  0.5217
F-statistic: 26.45 on 6 and 134 DF,  p-value: < 2.2e-16
```

Other useful codes for multiple regression:

```
Call:
lm(formula = Y1 ~ X.v4.1 + X.v4.2 + X.v4.3 + X.v4.4 + X.v4.5 +
    X.v4.6 + X.v4.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.62206 -0.19365  0.01136  0.26722  0.81120

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.384279   0.126431  18.858  < 2e-16 ***
X.v4.1       0.051261   0.048319   1.061 0.290664
X.v4.2       0.027145   0.038509   0.705 0.482099
X.v4.3      -0.002655   0.071015  -0.037 0.970234
X.v4.4       0.091812   0.058739   1.563 0.120419
X.v4.5       0.273351   0.069558   3.930 0.000136 ***
X.v4.6       0.016243   0.051629   0.315 0.753547
X.v4.7      -0.171291   0.064330  -2.663 0.008708 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4111 on 133 degrees of freedom
Multiple R-squared:  0.2536,    Adjusted R-squared:  0.2143
F-statistic: 6.454 on 7 and 133 DF,  p-value: 1.5e-06
```

```
Call:
lm(formula = Y2 ~ X.v4.1 + X.v4.2 + X.v4.3 + X.v4.4 + X.v4.5 +
    X.v4.6 + X.v4.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.08692 -0.34363  0.00209  0.35065  1.05164

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.846016   0.147559   5.733 6.31e-08 ***
X.v4.1      -0.023174   0.056394  -0.411    0.682
X.v4.2       0.026003   0.044945   0.579    0.564
X.v4.3      -0.003352   0.082883  -0.040    0.968
X.v4.4       0.046353   0.068555   0.676    0.500
X.v4.5       0.447255   0.081182   5.509 1.80e-07 ***
X.v4.6       0.040737   0.060257   0.676    0.500
X.v4.7       0.091104   0.075080   1.213    0.227
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4799 on 133 degrees of freedom
Multiple R-squared:  0.4695,    Adjusted R-squared:  0.4416
F-statistic: 16.82 on 7 and 133 DF,  p-value: 8.925e-16
```

```
Call:
lm(formula = Y3 ~ X.v4.1 + X.v4.2 + X.v4.3 + X.v4.4 + X.v4.5 +
    X.v4.6 + X.v4.7, data = mathare.data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.20722 -0.32919 -0.01608  0.35486  1.12039

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.40121    0.15220   9.206 6.31e-16 ***
X.v4.1      -0.11335    0.05817  -1.949  0.05343 .
X.v4.2       0.05207    0.04636   1.123  0.26341
X.v4.3      -0.03328    0.08549  -0.389  0.69772
X.v4.4       0.18741    0.07071   2.650  0.00902 **
X.v4.5       0.48725    0.08374   5.819 4.20e-08 ***
X.v4.6       0.05556    0.06215   0.894  0.37294
X.v4.7      -0.11314    0.07744  -1.461  0.14639
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4949 on 133 degrees of freedom
Multiple R-squared:  0.4063,    Adjusted R-squared:  0.3751
F-statistic:    13 on 7 and 133 DF,  p-value: 1.124e-12
```

A.3.4.14 Structural Equation Model Estimate Outputs

Warning: lavaan some estimated lv variances are negative
lavaan 0.6-12 ended normally after 39 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	19
Number of observations	141

Model Test User Model:

	Standard	Robust
Test Statistic	36.209	36.590
Degrees of freedom	30	30
P-value (Chi-square)	0.201	0.189
Scaling correction factor		0.990
Yuan-Bentler correction (Mplus variant)		

Model Test Baseline Model:

Test statistic	363.420	352.000
Degrees of freedom	42	42
P-value	0.000	0.000
Scaling correction factor		1.032

User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.981	0.979
Tucker-Lewis Index (TLI)	0.973	0.970
Robust Comparative Fit Index (CFI)		0.980

Robust Tucker-Lewis Index (TLI)		0.971

Loglikelihood and Information Criteria:

Loglikelihood user model (H0)	-755.549	-755.549
Scaling correction factor for the MLR correction		1.000
Loglikelihood unrestricted model (H1)	-737.444	-737.444
Scaling correction factor for the MLR correction		0.994
Akaike (AIC)	1549.097	1549.097
Bayesian (BIC)	1605.124	1605.124
Sample-size adjusted Bayesian (BIC)	1545.008	1545.008

Root Mean Square Error of Approximation:

RMSEA	0.038	0.039
90 Percent confidence interval - lower	0.000	0.000
90 Percent confidence interval - upper	0.078	0.079
P-value RMSEA <= 0.05	0.643	0.627
Robust RMSEA		0.039
90 Percent confidence interval - lower		0.000
90 Percent confidence interval - upper		0.078

Standardized Root Mean Square Residual:

SRMR	0.042	0.042

Parameter Estimates:

Standard errors	Sandwich
Information bread	Observed
Observed information based on	Hessian

Latent Variables:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
adapt.cap =~						
X3	1.000				0.434	0.694
X2	0.737	0.090	8.156	0.000	0.320	0.618
X1	0.856	0.107	8.029	0.000	0.371	0.692
X4	0.980	0.150	6.521	0.000	0.425	0.573
res.act =~						
Y2	1.000				0.444	0.673
Y1	0.685	0.127	5.386	0.000	0.304	0.557
Y3	1.066	0.124	8.566	0.000	0.473	0.666
highcap.agent =~						
adapt.cap	1.000				0.971	0.971
res.act	0.451	0.361	1.248	0.212	0.428	0.428

Composites:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
adapt.cap <~						
SD.1	0.069	0.029	2.403	0.016	0.158	0.234
SD.2	-0.050	0.076	-0.661	0.508	-0.115	-0.073
SD.4	0.020	0.144	0.142	0.887	0.047	0.022

Regressions:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
res.act ~						

adapt.cap	0.728	0.360	2.021	0.043	0.712	0.712

Variances:

	Estimate	Std.Err	z-value	P(>|z|)	Std.lv	Std.all
.X3	0.203	0.029	6.995	0.000	0.203	0.519
.X2	0.166	0.017	9.727	0.000	0.166	0.618
.X1	0.150	0.019	7.994	0.000	0.150	0.522
.X4	0.371	0.045	8.283	0.000	0.371	0.672
.Y2	0.238	0.032	7.382	0.000	0.238	0.547
.Y1	0.205	0.020	10.270	0.000	0.205	0.689
.Y3	0.280	0.037	7.526	0.000	0.280	0.556
.adapt.cap	0.000			0.000	0.000	
.res.act	-0.056	0.018	-3.095	0.002	-0.282	-0.282
highcap.agent	0.177	0.040	4.468	0.000	1.000	1.000

R-Square:

	Estimate
X3	0.481
X2	0.382
X1	0.478
X4	0.328
Y2	0.453
Y1	0.311
Y3	0.444
adapt.cap	1.000
res.act	NA

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