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RESEARCH PAPER

Towards Developing a Toolkit for Community-Driven Climate Adaptation:

A Realist and Implementation Science Analysis of Urban Informal Settlements in Nairobi, Kenya

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Acronyms and Key Terms

Acronyms

AACJ	African Activists for Climate Justice
C-S-M-O	Context-Strategy-Mechanism-Outcome is the central analytical configuration used to explain causal pathways in the study.
CBA	Community-Based Adaptation is a paradigm that established adaptation as a participatory process.
CBO	Community-Based Organization
CCA	Community-Driven Climate Adaptation refers to the highest level of community agency where an intervention is originated and implemented by residents to address urgent needs.
CFIR	Consolidated Framework for Implementation Research used to analyze contextual factors.
CR	Critical Realism - the philosophical grounding of the study.
DIT	Diffusion of Innovation Theory
ERIC	Expert Recommendations on Implementing Change is an implementation science taxonomy that was used to categorize community strategies.
FGD	Focus Group Discussion.
GCA	Global Center on Adaptation
GDPC	Global Disaster Preparedness Center
IFRC	International Federation of Red Cross and Red Crescent Societies.
IRB	Institutional Review Board (implied by mandates for ethical refinements and consent procedures).
IS	Implementation Science
KII	Key Informant Interview
LLA	Locally Led Adaptation; paradigm prioritizing local agency and devolving decision-making power.

M&E	Monitoring and Evaluation
NABREP	Nairobi Rivers Basin Regeneration Programs—a multi-agency state team acting as a coordination mechanism for adaptation.
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
RE	Realist Evaluation - the qualitative methodology employed to retrodict generative mechanisms.
RE-AIM	Reach, Effectiveness, Adoption, Implementation, and Maintenance; an implementation science framework used to evaluate adaptation outcomes with an equity lens.
RRREIC	Resolution, Redescription, Retrodiction, Elimination, Identification, and Correction - the specific realist analytical cycle followed in the study.
SPA	Special Planning Area; a formal policy designation for urban settlements (e.g., Mukuru in 2017) that enables state-community collaboration.
WASH	Water, Sanitation, and Hygiene

Key Terms

Chama: An indigenous social structure or savings group used for mutual support and financial safety nets.

Context (C): The specific setting or circumstances (CFIR domains) that determine which mechanisms can be activated.

Ecology of Exclusion: A context defined by decades of systemic state neglect and infrastructure collapse, as seen in Mathare.

Ecology of Formalized Collaboration: A context defined by formal state partnership and policy windows, as seen in Mukuru.

Mathare Futurism: A philosophy that frames climate adaptation as a symbolic, decolonial act to build intergenerational hope.

Mechanism (M): The underlying causal pathways or "active ingredients" triggered by strategies within a specific context to produce outcomes.

Outcome (O): The result produced by the interaction of context, strategy, and mechanism, evaluated via RE-AIM.

Primacy of Need: A mechanism where acute survival crises (e.g., hunger, health) act as a foundational barrier to participation in adaptation efforts.

Primacy of Payment: A facilitator mechanism where reliable income from a project makes it a viable economic competitor to crime or other survival activities.

Retrodiction: The analytical process of inferring underlying generative mechanisms from observed strategies and outcomes.

Strategy (S): The specific community-led interventions or implementation tactics (ERIC domains).

Whose Agent?: An informal barrier manifesting as community suspicion that organizing youth are working for gangs or politicians.

Whose Letter?: A formal barrier characterized by bureaucratic threats or a lack of official authorization that paralyzes community action.

Abstract

The convergence of rapid urbanization and climate change threatens one billion people in urban informal settlements. Communities are developing solutions (Community-Driven Climate Adaptations, or CCA), but the factors underpinning their success or failure are poorly understood, hindering scalability. This study identifies the causal pathways for successful CCA. We conducted a comparative, realist-informed case study in Nairobi's Mathare and Mukuru settlements. Using a novel qualitative methodology combining Realist Evaluation (Context-Strategy-Mechanism-Outcome) C-S-M-O with Implementation Science frameworks (CFIR, ERIC, RE-AIM), we analyzed desk, qualitative and spatial data to retrodict the generative mechanisms of success and failure.

Our cross-case analysis revealed two core, divergent findings. First, “Economic & Survival Primacy” is a dual mechanism: in Mukuru, a context of relative stability, a 'Primacy of Payment' (reliable income) was a key facilitator; in Mathare, a context of acute health crisis, a 'Primacy of Need' (basic survival) was a profound barrier. Second, “Agency” is a constructed mechanism: in Mukuru, success was *activated* by 'Legitimized & Trusted Agency' (state partnership + non-sectarian leaders); in Mathare, it was *paralyzed* by formal state hostility ("Whose Letter?") and informal community suspicion ("Whose Agent?").

The identified C-S-M-O configurations form a refined program theory and provide the evidence base for a v1.0 prototype toolkit suite, translating causal logic into actionable guidance for both practitioners and community innovators.

Keywords: Chama, Context (C), Ecology of Exclusion, Ecology of Formalized Collaboration, Mathare Futurism, Mechanism (M), Outcome (O), Primacy of Need, Primacy of Payment, Retrodiction, Strategy (S), Whose Agent?, Whose Letter?

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Section A: Research Report

1. Introduction

The 21st century is defined by the twin challenges of rapid urbanization and accelerating climate change, a convergence acutely felt in the urban informal settlements of the Global South. These communities are disproportionately vulnerable to climate hazards due to their location in fragile areas and a systemic lack of risk-reducing infrastructure. While a paradigm shift towards community-centric adaptation has occurred, a critical "translatability gap" persists. The literature is dominated by descriptive accounts (Muchiri & Opiyo, 2022; Sandberg, 2025) that document *what* interventions are being implemented but fail to explain *how* and *why* they produce their effects in specific contexts. This descriptive bias limits the development of evidence-based guidance for scaling successful adaptations.

This study addresses a critical research gap in climate change adaptation by adopting a case study approach using Critical Realist philosophy (Easton, 2010; Fuchs & Robinson, 2024), realist evaluation methodology (Renmans & Castellano Pleguezuelo, 2023) and Implementation Science frameworks (Damschroder et al., 2022; Glasgow et al., 2022; Powell et al., 2015; Yapa & Bärnighausen, 2018). We move beyond simple description to causal explanation by conducting a comparative case study of CCA initiatives in the Mathare and Mukuru settlements of Nairobi. This approach aims to identify the underlying Context-Success Mechanism-Outcome (C-S-M-O) configurations (De Weger et al., 2020; Mukumbang & Wong, 2025) that drive effective adaptation, with the goal of translating these causal findings into a practical, evidence-based implementation toolkit for practitioners, policymakers, and communities.

2. Study Objectives

- Identify contextual factors and mechanisms driving success/failure of CCA.
- Develop empirically grounded C-S-M-O program theories.
- Translate findings into a practitioner toolkit

3. Literature Review

The approach to climate adaptation in vulnerable communities has evolved significantly over the past two decades, tracing a conceptual spectrum from external "involvement" to genuine community "ownership." This evolution is captured in three key paradigms: *Community-Based Adaptation (CBA)*, which established adaptation as a participatory

process but was often critiqued for being externally driven (Ensor & Berger, 2009; Forsyth, 2017; Lee, 2013; Reid et al., 2009); *Locally Led Adaptation (LLA)*, which emerged to address this by prioritizing local agency and devolving decision-making power (Coger et al., 2022; Global Center on Adaptation, 2022; Rahman et al., 2023; Soanes et al., 2021); and finally, *Community-Driven Climate Adaptation (CCA)*. For this study, we use the term CCA to synthesize these concepts, representing the highest level of community agency where an intervention is primarily originated, designed, and implemented by people in at-risk localities to address their urgent needs. Despite the richness of CCA initiatives in Nairobi's settlements, their outcomes are highly variable. This study builds on existing descriptive work by introducing an analytical framework capable of explaining this variability.

4. Methodology

This qualitative study is philosophically grounded in Critical Realism (CR) (Easton, 2010; Fuchs & Robinson, 2024) and employs a Realist Evaluation (RE) methodology (Renmans & Castellano Pleguezuelo, 2023), structured as a comparative multiple case study embedded with analysis using Implementation Science (IS) frameworks Consolidated Framework for Implementation Research (CFIR) , the Expert Recommendations on Implementing Change (ERIC) and the Reach Effectiveness-Adaption Implementation, Maintenance (RE-AIM) frameworks. This approach was chosen for its strength in explaining causation in complex, open social systems like informal settlements (Fletcher, 2017; Fuchs & Robinson, 2024; Mukumbang & Wong, 2025).

4.1 Conceptual Framework: The C-S-M-O Configuration

The central analytical tool is the Context-Strategy-Mechanism-Outcome (C-S-M-O) configuration. This posits that community Strategies (S) are shaped by a given Context (C); these strategies activate underlying generative Mechanisms (M) which produce the observed Outcomes (O) (Mukumbang & Wong, 2025). To add analytical rigor, each component is mapped to a corresponding IS framework: 1) *Context (C)* analyzed using CFIR; 2) *Strategy (S):* categorized using ERIC framework; 3) *Mechanism (M)* inferred through realist analysis of causal pathways and 4) Outcome (O) evaluated using RE-AIM, with a focus on equity.

4.2 Study Sites and Sampling

The study was conducted in two deliberately chosen sites within the Nairobi River Basin: Mukuru (Hazina) and Mathare (Mabatini) informal settlements, adjacent to the Mukuru and Mathare Rivers, respectively.

Mukuru was declared a Special Planning Area (SPA) in 2017, enabling formal state collaboration (Karamallis et al., 2022). In contrast, Mathare's SPA status is an emergent,

consortium-led advocacy process (post-2020) that is not yet fully formalised (Koyaro, 2025). This formalization gap provides the primary comparative axis for the study.

Participants for Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) were recruited using stratified purposive and snowball sampling.

4.3 Data Collection

This study followed a phased, mixed-methods approach to data collection, integrating a systematic desk review with in-depth qualitative fieldwork. *Phase 1: Systematic Desk Review* involved a review of existing literature to develop foundational case study profiles of the two study sites and formulate the initial program theory (Shearn et al., 2017), framed as plausible C-S-M-O configurations. Following a Google Scholar search using the following terms: “climate change”, “Climate change adaptation”, in various combination with “Community-based”, “Innovation”, “Barrier”, “Success”, “lessons” “resilience”, “vulnerability” and “Mukuru”, “Mathare”, “Nairobi”, “Kenya”, “Urban” and “Informal Settlement”, the review analysed a range of academic literature, policy documents, and grey literature, including reports from community-based organizations like the Muungano Alliance and international bodies like UN-Habitat. This process aimed to identify documented causal pathways, contextual factors, and outcomes from past and ongoing CCA initiatives with a focus on Mukuru and Mathare. This was supplemented with cross-review of CCA initiatives in similar urban informal settlements.

Phase 2: Primary Qualitative Data Collection took place between September 2025 and early November 2025 to enrich, validate, and refine the initial program theories. This phase employed multiple qualitative methods: 1) KIIs: 14 In-depth KIIs were conducted with community leaders (n=2), CCA innovators (n=8) , national and county government officials (n=2), and youth leaders (n=2); 2) *FGDs:* A total of four FGDs (two per site) were conducted, with each site hosting separate discussions for women and men women with youth (ages 18-35) alongside populations marginalized in community decision making such as the elderly incorporated into each session to ensure group homogeneity as well as platform marginalized voices; 3) *Non-participant qualitative observatio*n was conducted concurrently throughout the fieldwork to systematically document social interactions, environmental conditions, and the functioning of CCA projects, serving to triangulate interview data; 4*) Participatory mapping exercises* (Two in Mukuru and one in Mathare) helped understand spatial risks and community resources.

KIIs, FGDs and participatory mapping exercises lasted approximately 60-90 minutes, 90-120 minutes and 60 to 120 minutes respectively. Sessions were conducted face-to-face or virtually (KIIs) in Kiswahili, English, or Sheng/Vernacular as appropriate, following semi-structured guides. These guides are explicitly informed by the study's integrated theoretical framework, with questions designed to probe for Contexts (CFIR), Strategies

(ERIC), Mechanisms, and Outcomes (RE-AIM). All sessions were audio-recorded with participant consent, with concurrent field notes maintained. In line with qualitative research principles (Baxter & Jack, 2015; Fletcher, 2017; Gaikwad, 2017), the data collection instruments were iteratively refined in response to emerging themes and contextual realities.

The study process also included participatory mapping and non-participant observation, where researchers and community-based researchers used mobile phones to photograph key environmental features and adaptations. Verbal consent for all activities, including photography, was obtained as per IRB-approved informed consent procedures. All data was handled ethically to ensure privacy and confidentiality, stored securely on encrypted drives, and anonymized where applicable.

4.4 Data Analysis

This study's analysis was guided by a Critical Realist (CR) epistemology (Easton, 2010; Fuchs & Robinson, 2024) , a theoretical lens used to systematically explain how and why complex social interventions, like CCA, produce outcomes in specific settings. This was operationalized using a realist analytical process structured around the Resolution, Redescription, Retrodiction, Elimination, Identification, Correction (RRREIC) methodology (Armstrong, 2018) . Analysis followed the Realist RRREIC cycle, moving from thematic coding to retrodicting causal mechanisms and, following the work of Bonell et al., (2024), refining the initial program theory to develop a "middle-range realist programme theory" (Mukumbang & Wong, 2025) of *what works (CCA) for whom (equity considerations) in which context*. Developed following Pawson's and Tiley's (1997) and Pawson's (2024) work on realist evaluation, this process was conducted in two iterative steps:

Stage 1: Thematic Analysis and Redescription: Initial analysis of the desk review, KIIs, and FGD transcripts (including participatory mapping discussions) involved systematic thematic analysis (Fryer, 2022). Using a hybrid deductive-inductive approach, emergent themes and sub-themes were identified. These themes were then "Redescribed" using established theoretical frameworks: Contexts were categorized using CFIR, Strategies with ERIC taxonomy, and implementation outcomes were considered against the RE-AIM framework. This stage allowed for the "Resolution" of complex, raw data into manageable, theoretically informed components (C-S-M-O elements).

Stage 1 produced site-specific themes; Stage 2 compared them to refine cross-case program theories.

Stage 2: Cross-Case C-S-M-O Configuration and Program Theory Refinement: Following site-specific thematic analysis, a cross-case comparative approach was employed. The C-S-M-O elements identified in each case study (Mukuru and Mathare) were then configured

into explicit program theories. This involved Retrodiction which is inferring the underlying generative Mechanisms (M) that were activated or inhibited by specific Strategies (S) within certain Contexts (C) to produce observed Outcomes (O). Through this comparative process, common "demi-regularities" (recurrent C-S-M-O patterns) were "Identified", and initial assumptions or draft program theories (e.g., from the desk review) were "Eliminated" or "Corrected" based on empirical evidence. The refined transfactual, meaning reusable or portable, (Hawkins, 2016) C-S-M-O configurations representing our validated program theories directly inform the toolkit components.

The final methodology described herein was refined from the initial proposal to enhance analytical rigor and to integrate formal IRB feedback. A full justification for these modifications, including the pivot from Diffusion of Innovation Theory (DIT) to Implementation Science frameworks and the refinements to the sampling protocol, is provided in Appendix D: Methodological Evolution and Justification, *as required by the funder*.

5. Results and Findings

This section presents the synthesized findings from the cross-case analysis of Mathare and Mukuru. This analysis identifies recurrent C-S-M-O configurations, which constitute the refined program theories explaining how and why specific CCA initiatives succeed or fail in these informal settlements. The findings are structured around key causal insights, directly derived from our thematic analysis and refined through the RRREIC methodology.

5.1 Comparative Context: Ecologies of Exclusion vs. Formalized Collaboration

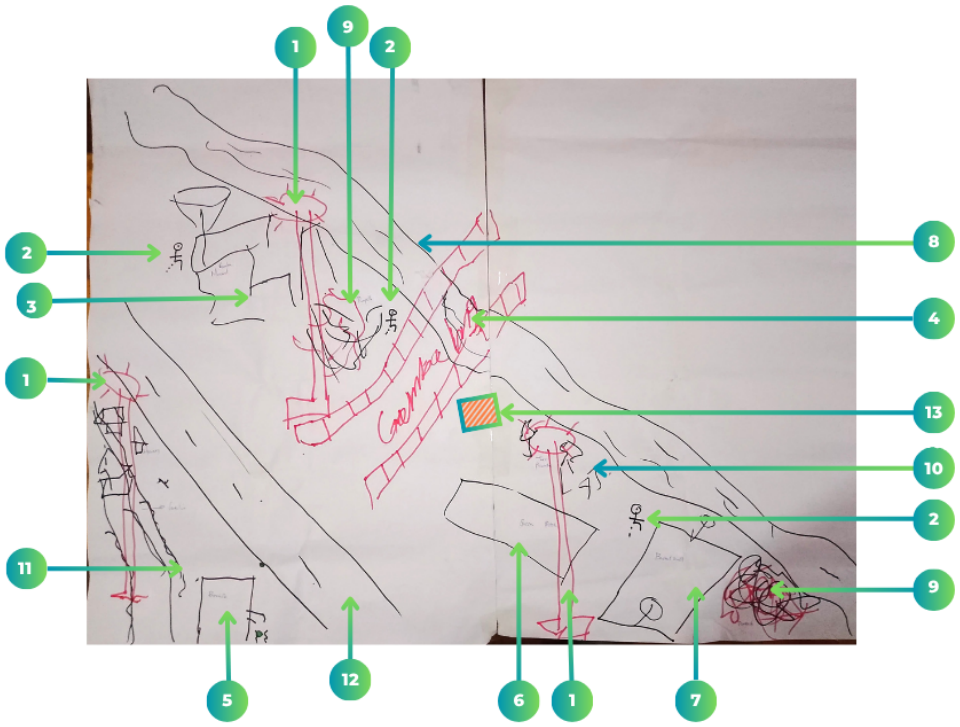
Our analysis reveals two distinct implementation contexts, which determine which mechanisms can be activated.

5.1.1. Mathare: “The Ecology of Exclusion”

The context in Mathare is defined by decades of systemic state neglect, creating an "ecology of exclusion" (Kimari, 2021; Sandberg, 2025) that manifests as a complete foundational health crisis: the effects of climate change are perceived in terms of the health risk it precipitates. As our fieldwork revealed, this is not an abstract concept but a lived reality: 1) *Water Sanitation and Hygiene (WASH) Infrastructure Collapse:* During participatory mapping (Figure 1) participants described a total breakdown of sanitation, with water pipes passing directly through sewer lines which often spill over during floods; *2) Visceral Health Risk Arising from the State of the Built Environment:* During the participatory mapping, participants graphically illustrated this by directing the mapper to draw sewer lines (which often experience blockages and spillage during floods) running inside their homes, stating, "The sewage just stinks while you are eating"; 3) *Active*

Hostility: Community agency is met with both formal and informal barriers, a core feature of the "Ecology of Exclusion."(Kimari, 2021; Sandberg, 2025) This includes the "Whose Letter?" paralysis (bureaucratic threats) and "Whose Agent?" suspicion (community fear that youth are being used by politicians or gangs). *4) Adaptive Governance for Systemic Gaps:* This "ecology of exclusion" is, at its core, a systemic coordination gap between different stakeholders. A meso-level KII confirmed that core climate-related functions (like solid waste management) are devolved responsibilities. The implementation barriers identified in our fieldwork (e.g., the "garbage truck not coming") are symptomatic of these coordination challenges. In a significant adaptive response, a key governance innovation has emerged: a KII (a National Government official) confirmed state support to communities was coordinated through a "multi-agency team": *The Nairobi Rivers Basin Regeneration Programs* (NABREP). This body acts as a positive, ad-hoc mechanism to bridge the gap and streamline climate change adaptation along the Nairobi River Basin. Grey literature affirms the coordination role of NABREP as part of wider multi-level multi-stakeholder engagement by the state (Adyang, 2025; *Nairobi Rivers Basin Regeneration Programs (NABREP) | Nairobi Rivers Commission*, n.d.) This suggests the service delivery failures we encountered during non-participatory observatory visits are not a permanent state but a temporal, solvable barrier now being actively addressed by this new coordination structure.

Figure 1: Participatory Map of Climate Risks, Resources, Asset Gap and CCA Drawn by Mathare, Mabatini Area Residents



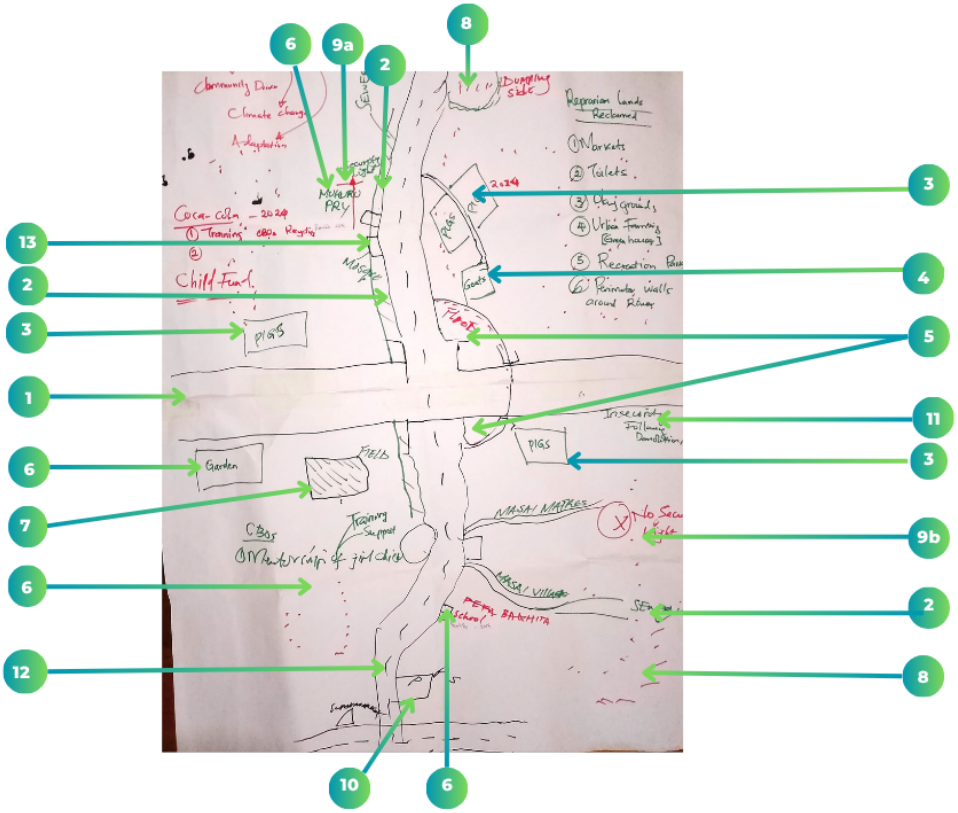
Risks	*Enabling Assets*	*CCA*
2 Open defecations due to lack of sanitary facilities *4 Flood prone area (footbridge)* *8 Swelling of river Mathare* *9 Uncontrolled dumpsites* *11 Sewer Line in built up areas* *12 Paved major road (surface runoff)*	*1 Security flood lights (Wishlist meaning not currently there or in working condition)* *3 Formal market with strained physical and WASH infrastructure* *5 Borehole with "green looking" water only good for washing* *10 Tree nursery with seedbed for seedlings* *12 Paved major road*	*6 Football field* *7 Basketball field (Wishlist meaning not currently there or in working condition)* *10 Tree planting* *13 formal market area on reclaimed riparian land (Wishlist meaning not currently there or in working condition)*

5.1.2 Mukuru: The "Ecology of Formalized Collaboration"

In contrast, Mukuru's context is defined by its 2017 designation as a Special Planning Area (SPA). While still a context of high vulnerability, this formal policy window created an

"ecology of formalized collaboration": 1) *State Partnership:* This context *legitimized* community-driven action. State enabled strategies like Climate WorX were implemented in partnership with existing, trusted community groups; 2) *Legitimized Agency:* The SPA framework shifted the power dynamic, creating a space where community-led data collection could be "tabled" with the state, enabling large-scale, co-produced infrastructure projects; 3) *Different Foundational Risk:* The primary risks identified by residents were flooding and surface waste, not the systemic, life-threatening WASH collapse seen in Mathare.

Figure 2: Participatory Map of Climate Risks, Resources, Asset Gap and CCA Drawn by Mukuru, Hazina Area Residents



Risks	*Enabling Assets*	*CCA*
1 Ngong River (prone to flooding) *2 Storm drainage (liable to blocking and spillage of sewage)* *11 Insecurity prone area (limits meaningful CCA activity)* *12 Paved Road (risk for surface runoff)*	*5 Footbridge (flood prone area)* *6 State drilled boreholes that commenced operations in 2018 (closed due to community conflicts and/or breakdown of f pump)*	*3 Urban farming (Pig rearing with pigs fed in partly from food waste)* *4 Urban farming (Goats) and manure being used for urban vegetable farming.* *7 Football field*

	8 Dumping site (unfenced and unmanned, close to living areas) *9a Security flood light mast (working, has enabled night patrols to reduce waste dumping into rivers)* *9b Security flood light mast (wish list-what the community identified as a need)* *10 Chief, DO offices and police station for governance and enabling asset support.* *13 Religious institutions (social support and refuge during floods)*	

5.2 Key Causal Findings: Identifying Convergent and Divergent Mechanisms (M)

By comparing these two contexts, we can now retrodict the causal mechanisms that explain why similar strategies produced vastly different outcomes.

5.2.1 Finding 1: The Primacy of Need: Economic & Survival Needs as a Dual Mechanism (Facilitator and Barrier)

This analysis reveals a "demi-regularity" as our most significant finding: In contexts of high vulnerability, a CCA's success and sustainability is contingent on its relationship to the foundational economic and survival needs of the community. Our cross-case analysis shows this mechanism has two distinct, context-dependent sides:

1*)The Facilitator: "Primacy of Payment" (Mukuru):* In both sites, the most successful innovations were those that activated a mechanism of "Economic Self-Reliance" or "Primacy of Payment". In Mukuru, the Climate WorX project succeeded because it provided a reliable, paid stipend to youth. The C-S-M-O configuration is as follows: *Context (C)*: High youth unemployment within an "Ecology of Formalized Collaboration" (the SPA). The foundational risk was flooding and surface waste. *Strategy (S):* The Climate WorX project, implemented in partnership with a trusted CBO, providing a reliable, paid stipend to youth. *Mechanism (M)*: "Primacy of Payment." The reliable financial incentive was a viable economic competitor to crime. It "pulled" youth into the project, creating sustained engagement and social recognition. *Outcome (O):* High project success, cleaner river, and reduced crime.

While the 'Primacy of Payment' mechanism proved potent in Mukuru by driving youth engagement in waste collection, the long-term sustainability and equitable distribution of value are critically dependent on the broader waste-to-value chain. Our non-participant observation revealed a common operational model:

Figure 3: Segregated plastic recyclables awaiting collection by a middleman in Mukuru

As shown in Figure 3 above, segregated plastic waste, bundled into large sacks, is routinely stored on the roadside outside informal middleman shops. This visual evidence of temporary, exposed aggregation points illustrates the challenges in achieving robust 'Market & System Integration' mechanism (Dalkin et al., 2015). The reliance on these informal intermediaries, while facilitating collection, often means primary waste collectors receive disproportionately lower returns. It highlights a critical barrier where the 'Primacy of Payment' mechanism, effective at the collection level, is constrained by a fragmented and informal downstream market, limiting the potential for truly self-reliant economic ecosystems within the informal settlement.

2)The Barrier: "Primacy of Need" (Mathare): The constrained success of the informal urban farms on reclaimed riparian land provides a powerful counter-explanation. *Context (C):* High unemployment within an "Ecology of Exclusion," compounded by a foundational

health crisis (cholera, "sewage in the house") amid stretched WASH facilities. *Strategy (S):* "Higher-level" CCA, such as voluntary greening projects (PTiM) (Sandberg, 2025) or enterprise (Urban vegetable farms) (Figure 4 below). *Mechanism (M)*: "Primacy of Need." The lack of basic survival needs (food, health) acted as a powerful barrier. It "pushed" people away from unpaid projects. This was articulated perfectly by a female participant echoing community voices, stating: "You've visited me, have you brought me flour? If there's anything else... don't tell me." *Outcome (O):* Gendered exclusion from unpaid initiatives (as mothers could not afford the "luxury" of volunteering) and market failure for the urban vegetable farms (due to the related "Fear of Contamination" mechanism).

5.2.2. Finding 2: The Mechanisms of Agency: Formal Legitimization vs. Informal Trust

This analysis corrects a simplistic view that "community agency" is a uniform good. We identified that for agency to be effective; it must overcome both formal and informal barriers.

In Mukuru ("Legitimized & Trusted Agency"): The arrangement where CBO (South B Finest) works as the recycling partner to Climate WorX is successful because it activated two mechanisms simultaneously: 1) *"Legitimized Agency"*: This partnership was formally sanctioned and supported by the local administration (DO, Chief). 2) *"Trusted Agency":* The community explicitly noted that the CBO leader was non-partisan and did not favor his own ethnic group, building essential community trust.

In Mathare ("Paralyzed Agency"): Community agency was systematically deactivated by two negative mechanisms triggered by the "ecology of exclusion" (C): 1) *"Formal Barrier":* The *"Whose Letter?"* paralysis, where state actors actively threaten and block "insurgent" community action. 2) "Informal Suspicion": The *"Whose Agent?"* suspicion, where the community itself distrusts self-organizing youth, assuming they are fronts for gangs or politicians.

5.3 Synthesized Cross-Case C-S-M-O Configurations (Identification & Correction)

Based on the retrodictive analysis above, we identified the following "demi-regularities" and "divergences" as the core theoretical output of this study.

Table 1: Cross-Case C-S-M-O Configurations

Context (C)	*Strategy (S)*	*Mechanism (M)*	*Outcome (O)*

SHARED CONTEXT (C1): High youth unemployment; environmental degradation.	Strategy (S1): Waste-to-value enterprises with a direct, reliable payment (e.g., Climate WorX in Mukuru.	Mechanism (M1): Economic Incentive / "Primacy of Payment". The direct, reliable financial benefit sustains engagement, overriding apathy or competing priorities.	Outcome (O1): Sustained maintenance of public spaces (Sandberg, 2025); reported reductions in crime and anti-social behavior (Sandberg, 2025).
DIVERGENT CONTEXT (C2): Mukuru: Formal SPA partnership; trusted CBO leadership. Mathare: "Ecology of Exclusion"; uncoordinated systems.	Strategy (S2): Waste collection and aggregation (e.g., Climate WorX in both sites).	Mechanism (M2) - DIVERGENCE: Mukuru: "Trusted & Legitimized Agency". The CBO is seen as a fair and formal employer, activating community pride . Mathare: "Countervailing Economic Incentive". The strategy is undermined by waste pickers who are not integrated, leading to a "system coordination failure".	Outcome (O2) - DIVERGENCE: Mukuru: High project success, clean river. Mathare: Project failure; "back to square one" every day.
SHARED CONTEXT (C3): Youth stigmatization; neglected/unsafe public spaces.	Strategy (S3): "Insurgent Greening" / Youth-led CBOs (e.g., PTiM in Mathare; Key Informant (CCA Innovator), female urban vegetable famer in Mukuru.	Mechanism (M3): Symbolic Rescripting / Identity Shift: Visibly transforming a space re-writes the narrative of the area *and* the youth, fostering ownership, hope, and new, positive social identities (Sandberg, 2025).	Outcome (O3): Improved social cohesion; reduced crime; new "safe spaces" created; youth perceived as "contributors" not "criminals".
CONTEXT (C4): Acute, systemic WASH failure (e.g., sewage in homes in Mathare .	Strategy (S4): Riparian-based food production (e.g., Vegetable Farms in Mathare).	Mechanism (M4): "Fear of Contamination" (see Figure 4 below) + "Primacy of Need". The foundational health crisis triggers rational fear in consumers and forces residents to prioritize survival (flour, clean water) over all other projects.	Outcome (O4): Market failure for farm produce; gendered exclusion from non-survival-related projects.

5. Discussion

Our findings demonstrate that the success of CCA hinges on activating the right mechanisms in response to specific contextual realities. The C-S-M-O configurations provide a powerful analytical lens to understand these pathways.

6.1 The "Primacy of Need" as a Foundational Barrier

Our finding of a "Primacy of Need" mechanism, viscerally captured by the Mathare participant's statement, "Have you brought me flour? If there's anything else... don't tell me", provides a critical correction to the climate adaptation and community engagement literature.

This finding empirically grounds theoretical concepts like Maslow's hierarchy, demonstrating that in contexts of acute, systemic crisis (e.g., an active cholera outbreak, sewage in the home), "higher-level" interventions focused on abstract goals (like "climate resilience") or psychosocial benefits (like "identity") are non-starters. This challenges a wide body of literature that promotes "identity-driven" or "psychosocial" interventions like those identified in the desk review as primary drivers, suggesting instead that they are contingent upon a foundation of basic health and safety.

Furthermore, this finding highlights a critical gendered dimension. The "Primacy of Need" was most forcefully articulated by women, whose calculus for participation is intrinsically linked to household survival. This supports feminist critiques of development projects that treat "the community" as a homogenous (and often implicitly male) actor, thereby failing to account for the gender-specific barriers that prevent women from engaging in unpaid, voluntary projects.

Finally, the "Fear of Contamination" mechanism identified in Mathare, which led to the market failure of the urban vegetable farms, corrects "deficit-model" thinking. The community was not "uneducated" about the benefits of urban farming; they were rational actors responding to a visible health crisis (sewage in the river) that made the project's outputs (food) unsafe. This finding that a foundational health crisis (C) triggers a "Fear of Contamination" mechanism (M) that defeats market-based strategies (S) (See Figure 4 below), is not just a local perception. It is strongly validated by our KII with a national government official, which confirmed that "pollution of urban rivers" is a primary national-level concern which contributes to the “health concerns” that urban communities link to climate change. The community's focus on foundational health (WASH) is, therefore, not a 'distraction' from climate goals, but a scientifically accurate identification of the core linked environmental-health-climate problem derived from local knowledge.

Figure 4 A urban vegetable farm, by the roadside in Mabatini Mathare. This innovative, "insurgent" strategy (S) allows residents to grow produce on available land, no matter the size

Urban Vegetable farming shown in this image, this strategy (S) represents a resourceful innovation "bricolage" (Sandberg, 2025) for food security. However, as our analysis revealed, this strategy was largely unsuccessful. It was defeated by a powerful, context-driven counter-mechanism (M): "Fear of Contamination." As documented in the participatory mapping, the foundational "WASH Infrastructure Collapse" (C), with sewer lines or industrial waste discharged into the river or through storm drains triggered a rational community-wide fear of eating food grown with local water. This led to a total market failure (O), providing a stark C-S-M-O example of how a foundational health crisis (C) can neutralize an otherwise brilliant adaptation (S)."

This highlights the critical need for formal mechanisms that bridge this information and coordination gap. The national-level Kenya Climate Change Knowledge Porta (KCCKP) (*Kenya Climate Change Knowledge Portal – Climate Change Knowledge Management Portal*, n.d.), identified in a KII, is a key, yet currently under-leveraged, meso-level resource designed for this exact purpose. It provides a formal platform to enhance coordination, facilitate peer-to-peer learning, and reduce the duplication of efforts that currently challenges the fragmented implementation landscape.

6.2 Providing Mechanisms for Scaling Participatory Agency

Our second finding on the divergence of agency provides contributes to a gap in participatory governance theory. Literature has challenged traditional "community engagement" models, arguing for a "rethink" that moves beyond seeing participation as a single, government-led process. Instead, scholars call for recognizing it as a "juxtaposition

of different ways of governing" (Eversole, 2011) one driven by top-down "engagement" and the other by indigenous "community agency".

The "Ecology of Exclusion" in Mathare is a clear example of the "failure" of top-down engagement. We identified the precise mechanisms of this failure: the "Whose Letter?" (Formal Barrier) and the "Whose Agent?" (Informal Suspicion) mechanisms are the active barriers that "disrupt" and "co-opt" indigenous "community agency," just as the literature warns.

The Mukuru case, in contrast, provides the C-S-M-O model for the "new ways of working" that scholars are calling for. This is best understood by mapping our findings onto the "enabling conditions" for scaling participation identified by Horn (2021):

Horn's 1st Condition ("Using political opportunities"): We identified this as the "Formal Legitimization" mechanism, triggered by the SPA (Context).

Horn's 2nd Condition ("Qualitative changes in how stakeholders see themselves"): We identified this as the "Identity Shift" mechanism (M) in Mathare, proving this change can happen even without a formal political opportunity.

Horn's 3rd Condition ("Capacity to manage conflict and prevent co-optation"): Our findings reveal the specific mechanism for this. The "capacity to manage conflict" is not an abstract skill; it is produced by the "Trusted, Non-Sectarian Leadership" (M). This trusted leadership is the "active ingredient" that prevents the "pitfalls" of co-optation that Ouma (2023) critically identifies within the Mukuru SPA.

This leads to our final, plausible correction of social capital theory: community agency is an outcome, not an input. It is the fragile product of an alignment between formal state sanction (Horn's "political opportunity") and perceived social trust (our "mechanism to manage conflict"). Our work thus provides the field with the specific, on-the-ground mechanisms required to bridge the "juxtaposition" and create the "enabling conditions" for genuine participation.

6.3 The "Temporality of Formalization": Policy Windows are a Process, Not an Event

A critical finding from our cross-case analysis is the correction of a simple assumption that formal policy designation (like an SPA) automatically creates a positive implementation context. Both Mathare and Mukuru were designated as SPAs, but they exist in profoundly different realities. This reveals that a formal "policy window" (C) is not a simple 'on/off' switch but a process moderated by time, resources, and implementation fidelity.

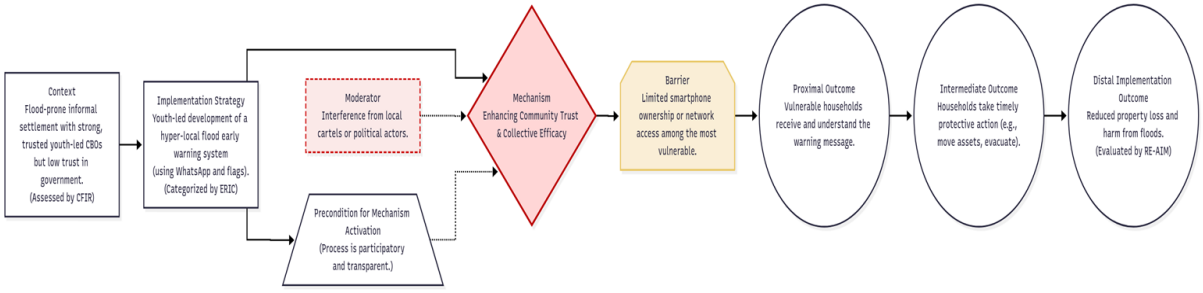
Temporal Lag: Mukuru's 2017 SPA designation has had years to mature, fostering a genuine "ecology of formalized collaboration" and building the institutional trust necessary for projects like Climate WorX to succeed. Mathare's more recent designation has not yet had the time or resources to overcome the deep-seated "ecology of exclusion". This implies a critical "temporal lag" before the *mechanisms* of formalization (e.g., "Legitimized Agency," "State Partnership") can be activated.

Fragmented Implementation: Furthermore, the Mukuru data itself shows that the benefits of the SPA are not "enjoyed uniformly." Participants in the Mukuru FGD described a stark "divide" between their area and neighbouring villages, suggesting a "fragmented upgrading" highlighting how context within context influences outcomes.

6.4 Synthesizing the Program Theory: How Mechanisms Interact

A key contribution of this study is the final step of the RRREIC process: the Correction and refinement of our initial, simplistic program theory (Figure 5 below). This initial, assumed program theory is linear: a "good" strategy (S) in a "vulnerable" context (C) will be adopted by the community (M) and lead to a good outcome (O). For example, we tested the assumption that in a decentralized governance system (C), a state-funded strategy (S) like Climate WorX would inherently be "community-driven" and activate a 'Community Agency' mechanism (M).

Figure 5: Conceptual diagram how C-S-M-O configurations lead to toolkit components



Our cross-case analysis corrects this linear, simplistic assumption. We found that mechanisms do not activate in isolation; they interact in complex, non-linear ways. Success is not guaranteed by a good strategy but is contingent on specific preconditions being met that allow mechanisms to potentiate each other in a virtuous cycle. Our refined program theory is a dynamic model with three core processes:

1). Preconditions as Causal Triggers: We found that the high-level Context (C) (e.g., the SPA) is only necessary but insufficient condition. For a mechanism to fire, a specific, micro-level Precondition must be met. Mukuru Example: The Context (C) of the "Formalized SPA" did not automatically trigger trust. The specific precondition that activated the "Trusted

Agency" mechanism (M) was the presence of a known, non-sectarian local leader (the youth group leader/CBO head/Chief). Without this precondition, the SPA context would have been inert, likely triggering the same "internal divide" and "suspicion" seen in Mathare.

2). Potentiation & Virtuous Cycles (How Mechanisms Trigger Each Other): Once a primary mechanism is triggered, it can potentiate (amplify) a secondary mechanism, creating a virtuous feedback loop. Mukuru Example: The "Trusted Agency" (M1), once triggered by its precondition, directly potentiated the "Primacy of Payment" (M2). Because the leadership (M1) was trusted, the community perceived the payments (S) as equitable and non-partisan. This amplified the power of the economic incentive (M2). This created a powerful, self-sustaining feedback loop:(S) Climate WorX → (Precondition Met: Trusted Leader) → (M1) "Trusted Agency" → (M2) "Primacy of Payment" (seen as fair) → (O) High Engagement/Clean River → (Feedback) Further strengthens "Trusted Agency" (M1)

3). Counter-Mechanisms & Impediments (How Mechanisms Compete): Conversely, a negative context can trigger a competing mechanism that impedes or defeats the intended program theory. Mathare Example 1 (Competing C-M-O): The "Vertical Farms" (S) were intended to trigger an "Economic Incentive" (M). However, the Context (C) of "Ecology of Exclusion" (specifically, sewage in the river) triggered a far more powerful counter-mechanism: "Fear of Contamination" (M1). This competing mechanism impeded and overpowered the intended economic one, leading directly to the Outcome (O) of market failure. Mathare Example 2 (Impeding a Precondition): The Context (C) of "Ecology of Exclusion" actively prevents the precondition for "Trusted Agency" from being met. The pervasive "Whose Agent?" mechanism (M) directly impedes any leader from being seen as "non-sectarian," meaning the virtuous cycle of trust seen in Mukuru can never begin.

4) Governance Coordination as a Precondition for Implementation: Our final refined theory, informed by qualitative insights, identifies that systemic Implementation Barriers (e.g., the "garbage truck not coming") are often symptomatic of coordination challenges within a complex, multi-level governance system. A KII confirmed that core functions like waste management are devolved responsibilities, creating an implementation landscape that requires a high degree of coordination. In this context, implementation gaps or "teething challenges" between national and county bodies (C) can act as a critical precondition that impedes the success of a strategy (S) like Climate WorX, leading to suboptimal outcomes (O). This suggests that for community-level strategies to thrive, a precondition of established, coordinated governance must be in place. Encouragingly, our fieldwork identified an adaptive innovation designed to bridge this very gap: the “multi-agency team" in Mathare. This body, coordinated by the National Government, represents a proactive mechanism to streamline devolved functions and overcome these implementation challenges, suggesting these barriers are temporal and solvable.

Our refined nonlinear program theory (see below) is a dynamic model that argues that for a strategy to be successful, practitioners must first ensure the preconditions for positive mechanisms (like trust) are met, which will then potentiate other mechanisms (like economic incentives) in a virtuous cycle, while simultaneously mitigating the counter-mechanisms (like fear or suspicion) that are actively competing to defeat the intervention.

6. Implications and Practitioner Toolkit

7.1 Dual-Prototype Approach

The most significant practical implication of this research is the development of a Practitioner Toolkit (Section B). This toolkit translates our validated C-S-M-O configurations into actionable guidance. However, our research identified at least two distinct user groups with different needs:

Intermediaries: CBO leaders, NGO program managers, and urban planners who need a "high-level," rigorous tool to guide strategic planning, funding proposals, and Monitoring and Evaluation (M&E).

Community Innovators: Grassroots leaders and youth groups who need a simpler, more direct, and action-oriented tool.

Therefore, we are presenting two v1.0 Prototypes of the toolkit. Both are grounded in the same C-S-M-O logic, but they are "translated" for these different audiences. Both versions are considered drafts and will be the foundation for the iterative validation and co-refinement process outlined in our Future Roadmap. The toolkit is structured to guide users through the same causal pathway our research identified:

- Context (C) Informs Assessment: First, you must diagnose your specific community context.
- Strategy (S) Informs Selection: Based on your context, you can select a proven strategy.
- Mechanism (M) Informs Action: This is the how-to guide. It provides the "operational tactics" needed to trigger the "active ingredient" (the mechanism) for your strategy to work.
- Outcome (O) Informs Evaluation: Finally, it helps you measure what matters.

7.2 Toolkit Summary: A Four-Step C-S-M-O Process

The toolkit suite is organized into four main components that mirror the C-S-M-O logic. This core structure is the foundation for both the Intermediary Toolkit (1a) and the Community Innovator's Action Guide (1b).

Tool 1: The Foundational Context Diagnostic ('C') This tool guides users through a diagnostic of their foundational context. It provides instruments to map the "Ecology of Trust" (e.g., "Formalized Collaboration" vs. "Ecology of Exclusion"), the "Primacy" of community needs (e.g., "Primacy of Payment" vs. "Primacy of Need"), and the specific, often gendered, "Enabling Assets Gap."

Tool 2: The Social & Political Contract Strategy Guide ('C' & 'M') This tool provides operational tactics for navigating the specific socio-political context identified in Tool 1. It details how to build and leverage agency, explaining the tactics for "Anchoring in Trusted Governance" (as in Mukuru) or the "Insurgent Agency" tactics (as in Mathare) needed to overcome formal and informal barriers.

Tool 3: The Mechanism Activation Manual ('S' & 'M') This is the core "how-to" guide of the toolkits. It provides a menu of specific, evidence-based operational tactics (e.g., "Flexible Team Design," "Market & System Integration," "Identity-Based Stewardship") that are designed to trigger the correct causal mechanisms (e.g., "Inclusion," "Economic Self-Reliance," "Identity Shift") required for a strategy to succeed.

Tool 4: The RE-AIM Evaluation Guide ('O') This tool provides a simple, RE-AIM-based evaluation framework. It moves beyond measuring simple outputs (e.g., "number of trees planted") and prompts users to measure what matters: Reach to vulnerable groups, Effectiveness in solving the core problem, Adoption by other community members, Implementation of the core mechanisms, and Maintenance via "system-failure-proofing."

7.3 Accessing the Toolkit Prototypes

The full, operational v1.0 prototypes of both toolkits are available as appendices to this report: 1) *Toolkit 1a:* The C-S-M-O Intermediary Toolkit (v1.0). This "high-level" toolkit preserves the full analytical rigor of the C-S-M-O configurations. It is designed for program managers and planners. It uses matrices, logic models, and the full RE-AIM framework. 2) *Toolkit 1b:* The Community Innovator's Action Guide (v1.0). This is a "draft translation" of the Intermediary Toolkit. It is designed to be more accessible, using a question-and-answer format and "operational tactics." It is intended to be the starting point for the co-refinement workshops with community members.

8. Limitations

This study, while rigorous in its qualitative and realist methodology, has several limitations that provide a clear roadmap for future research and toolkit refinement.

First, the study's findings, while theoretically transferable, are context-bound. The analysis is specific to two large, established urban informal settlements in Nairobi. The C-S-M-O configurations (particularly those related to formal policies like the SPA or the specific "Ecology of Exclusion" in Mathare) may not be directly applicable to peri-urban, rural, or non-Kenyan contexts, which have different governance and social structures.

Second, the sampling strategy, while demographically equitable (purposively including women, youth, and elder adults across the FGDs), was heavily weighted towards individuals with existing social capital. Our purposive sampling primarily engaged with organized CBOs, their leaders, and formal leadership (e.g.., the Area Chief). Consequently, the voices of the most marginalized, those who are unorganized, isolated, or disconnected from these formal and informal community structures, may be underrepresented. This is a critical equity consideration, as the "community-driven" solutions we identified are, by definition, from those who already have the social capital to organize.

Third, the study is cross-sectional. It provides a "snapshot" of these interventions but cannot draw firm conclusions about their long-term maintenance or distal outcomes (a key component of the RE-AIM framework).

These analytical limitations lead directly to the limitations of the study's primary output, the Practitioner Toolkit (v1.0). We are presenting a "dual-prototype" approach (see Section B), which is an intentional part of our iterative research plan with: an Intermediary Toolkit (1a) which has high scientific fidelity to our findings but, as a result, has low accessibility for a non-technical audience; and the Community Action Guide (1b) has higher accessibility but is an *unvalidated*, *draft translation*. 1b has not yet been co-designed or culturally adapted *with* community innovators.

Therefore, the Future Roadmap for this research is a necessary Phase 2 focused on validating and refining this v1.0 toolkit. This process must involve:

- Track 1 (Alpha Testing): Piloting the Intermediary Toolkit (1b) with its target audience (CBOs, NGOs, planners) to gather feedback on its strategic utility and rigor.
- Track 2 (Co-Refinement): Using the Community Action Guide (1b) as the *starting point* for "translation workshops" with diverse community innovators (including those *not* in formal CBOs) to co-design a culturally relevant, linguistically accessible, and validated v2.0.
- Synthesis: Merging the learnings from both tracks into a final, multi-level toolkit suite that is both scientifically robust and practically accessible to all stakeholders.
- Longitudinal Study: A follow-up, longitudinal study is required to test the toolkit's implementation and to assess the long-term *maintenance* (RE-AIM) of the CCA it helps develop.

9. Conclusion

This research confirms that communities in Nairobi's informal settlements are not waiting for solutions but are actively creating them. By uncovering the causal pathways that underpin successful adaptations, this study provides both theoretical understanding and the practical tools needed to support and scale these vital local efforts. The shift from funding isolated projects to investing in the underlying mechanisms of community agency, economic self-reliance, and social cohesion is critical for building genuine, lasting climate resilience in the world's most vulnerable urban communities.

Section B: Toolkits

Toolkit 1a. Practitioner Toolkit for Implementing and Supporting Community-Driven Climate Adaptations

Introduction: A Tool for Strategic Realist Planning

Purpose: This toolkit is a planning, M&E, and proposal-writing tool for intermediaries (CBOs, NGOs, planners) working on Community-Driven Climate Adaptations (CCA). It translates the C-S-M-O "program theories" from our research into a rigorous, step-by-step analytical process.

Audience: Program managers, CBO leaders, M&E officers, and urban planners.

The C-S-M-O Logic: Our research shows that successful interventions are not just about a good Strategy (S), but about whether that strategy activates the right Mechanism (M) for a specific Context (C) to produce a sustainable Outcome (O). This toolkit guides you through this 4-step logic.

Tool 1: The Foundational Context Diagnostic (C)

Purpose: To conduct a rigorous "realist diagnostic" of your implementation context. Use this tool in your planning phase to identify the foundational barriers and enablers that will determine which strategies are viable.

Instructions: Use this checklist with your planning team. The "Context Archetypes" (based on our case studies) are provided to make the abstract concepts concrete.

Table 2: Practitioner Toolkit- Context Archetype Tool

Diagnostic Domain	*Key Diagnostic Question*	*Context Archetype A: "Ecology of Exclusion" (e.g., Mathare)*	*Context Archetype B: "Ecology of Formalized Collaboration" (e.g., Mukuru)*	*Your Context Assessment & Notes*
1. Foundational Context	What is the *primary felt need* that defines this context?	"*Primacy of Need*" (Survival Crisis). Community is battling acute health (cholera, hunger) or safety (house fires) Crisis	*"Primacy of Payment"* (Relative Stability). The community is battling chronic economic/environmental issues (unemployment, flooding).	*[Your Assessment Here]*
*2. Socio-Political Contex***t**	What is the "Ecology of Trust" with formal systems and between residents?	*"Paralyzed Agency."* *Formal:* State is absent or hostile ("Whose Letter?" paralysis). *Informal:* High "Whose Agent?" suspicion (fear of political/gang co-option).	*"Legitimized Agency."* *Formal:* State is an active partner (e.g., SPA). *Informal:* Trust is "anchored" in neutral, non-sectarian leaders (Chief, DO, CBOs).	*[Your Assessment Here]*
3. *Foundational Asset Gap*	What critical asset is *missing*, preventing action?	*"Human Survival Assets."* (e.g., Clean water, working sewers, public toilets, safe housing).	*"Enabling Assets."* *Communal:* Security lights, perimeter walls. *Occupational:* Gloves, boots, tools.	*[Your Assessment Here]*

Tool 2: The Context-Strategy Selection Menu (S)

Purpose: To select an evidence-based *Strategy* (S) that directly addresses the *Context* (C) you identified in Tool 1.

Instructions: Use your answers from Tool 1 to identify your primary barriers. This table provides proven strategies (many drawn from the ERIC framework) to overcome them.

Table 3: Practitioner Toolkit -The Context-Strategy Selection Menu Tool

If Your Contextual Barrier (C) is...	*Consider This Evidence-Based Strategy (S)...*	*Rationale / Case Study Example*
"Primacy of Need" (Survival Crisis)	*Integrate with Basic Services.* (Do not design a standalone "climate" project).	A project must first address the "flour" or "cholera" problem. A greening project will fail if the community is in survival mode (Mathare).
"Primacy of Payment" (Economic Need)	*Develop a Waste-to-Value or similar Livelihood Model.* (Ensure it has a reliable payment structure).	A reliable stipend is a viable economic competitor to crime and the key to sustained youth engagement (Mukuru Climate WorX).
"Paralyzed Agency" ("Whose Letter?" / "Whose Agent?")	*"Insurgent Greening" + "Provide Top-Down Cover."* (Support existing "insurgent" CBOs and use your NGO status as their shield).	CBOs in Mathare must build "Visible Neutrality" to fight suspicion. They need an external partner to handle the formal/political threats.
"Legitimized Agency" (Formal Partnership)	*"Anchor in Trusted Governance" + "Adopt a Consortia Model."*	Leverage the formal SPA structure, but ensure implementation is "anchored" in trusted, non-sectarian local leaders to ensure equity (Mukuru).
Gendered Time/Safety Gaps (Women Excluded)	*"Tailor Interventions: Flexible & Inclusive Design."*	Use small teams and flexible schedules to accommodate women's time-poverty and domestic responsibilities (Mukuru Climate WorX).
Systemic Failure (e.g., No waste collection)	*"Design for Systemic Failure" + "Market Integration."*	*Assume* no state support. Your strategy *must* account for all actors (like waste pickers) and have its own *formal* market linkage (Mukuru vs. Mathare).

Knowledge/Capacity Gaps	*"Develop a knowledge-to-Livelihood Pipeline."*	CBOs have ideas but lack the "how-to." Your strategy must include a "resource map" or mentorship to link them to expert support (Mukuru).
"Implementation Gaps", "Duplication of Efforts", "Knowledge Gaps"	*"Leverage National Coordination & Learning Platforms."*	The NEMA KII identified the Kenya Climate Change Directory as a key meso-level resource to reduce duplication, identify potential partners, and enable peer-to-peer learning among actors.

Tool 3: The Mechanism (M) Activation Manual

Purpose: To guide implementation. This is the "how-to" for your proposal, explaining *how* your Strategy (S) will activate the "active ingredient," or *Mechanism* (M), for success.

Instructions: For your chosen strategy, identify the key mechanism you need to activate. These are the tactics that funders want to see.

Table 4: The Mechanism (M) Activation Manual

To Activate This Mechanism (M)...	*Use These Operational Tactics (The "How-To")...*
M1: "Primacy of Payment" (Economic Incentive)	Design a *reliable, predictable, and transparent payment structure* (e.g., "every 10 days"). *The payment must be a **viable economic competitor** to alternative incomes (e.g., crime).*
M2: "Identity Shift" / "Affective Stewardship"(Foster, 2017; Mathevet et al., 2018) (Psychosocial Incentive)	Design the project around *identity transformation* (e.g., "reformed youth as champions"). *Create "emotional encounters" (e.g., giving each participant personal responsibility for 5 specific trees) to build ownership and hope.*
M3: "Trusted & Legitimized Agency" (Socio-Political Incentive)	*Tactic 1 (Formal):* Formally embed the project with local administration (Chief, DO) to *"Anchor in Trusted Governance."* *Tactic 2 (Informal):* Ensure the CBO leader or project manager is a ***respected, non-sectarian*** figure to prevent "internal divides."
M4: "Visible Neutrality" (Countering Suspicion)	*Tactic 1 (Show, Don't Tell):* Use highly visible, undeniably "good" and *non-political* acts (e.g., planting, cleaning a public space) to *prove* neutrality *before* scaling. *Tactic 2 (Shielding):* Use your (NGO/funder) status to act as a "shield," handling the political ("Whose Letter?") side so the CBO can work.

M5: "Flexibility & Inclusion" (Gender Equity)	*Tactic 1 (Operations)*: Design project work in *small, independent teams* (not large groups). *Tactic 2 (Scheduling)*: Use *flexible schedules* (not rigid 9-to-5s) to accommodate women's time poverty and domestic duties.
M6: "Market & System Integration" (Sustainability)	*Tactic 1 (Market):* Secure a *formal, direct-to-buyer market linkage* (e.g., Coca-Cola, large compost buyer) *before* launching the project. *Tactic 2 (System): Assume* systemic failure. Your design *must* have a plan for *all* actors (e.g., integrate informal waste pickers as sorters).

Tool 4: The RE-AIM Evaluation Framework (O)

Purpose: To provide a comprehensive M&E and planning framework. This tool has two parts: *1) RE-AIM Outcome Tracker:* For monitoring the implementation and outcomes of your project in real-time. *2) Sustainability Scaffold Planner:* For strategically planning the long-term governance, financial, and capacity structures needed for your project to last.

Instructions: Use this table to build your project's M&E plan. It guides you to measure what matters: the mechanisms, the reach, and the effectiveness, not just the outputs.

Table 5: Practitioner Toolkit RE-AIM Outcome Tracker

RE-AIM Dimension	*Outcome Pathway*	*Key M&E Question for Your Project*	*Example Indicators (Based on Research Findings)*
R - Reach	*Proximal*	Are we *really* reaching the intended vulnerable populations (e.g., women, isolated youth, ethnic minorities)?	% of female vs. male participants in paid vs. unpaid activities. % of participants from different villages/ethnic groups (to track "internal divides"). Qualitative reports of *who* is being left out (e.g., "Political aid isn't reaching us").

E - Effectiveness	*Intermediate*	Is the intervention *actually* solving the core problem (C) and activating the core *mechanism* (M)?	*Negative Indicator:* Market failure of outputs (e.g., "Fear of Contamination" for Mathare farms). *Negative Indicator*: "Back to square one" problem (e.g)., the waste picker in Mathare). *Positive Indicator:* Reports of increased trust/hope (M).
A - Adoption	*Intermediate*	Are other community members, CBOs, or leaders *independently* copying this idea?	# of new, "insurgent" greening sites emerging (e.g., PTiM model in Mathare). # of households asking to join the waste-collection scheme.
I - Implementation	*Proximal*	Are we implementing the "Operational Tactics" (Tool 3) with fidelity? Are we *really* activating the mechanism?	*Tactic Check*: Are payments *actually* reliable? (e.g., 95% of payments made on time). *Mechanism Check:* Qualitative reports of "research fatigue" or "suspicion" (M is *not* being activated).
M - Maintenance	*Distal*	Is this project "system-failure-proof?" What is its long-term viability?	% of project costs covered by its *own* revenue (e.g., sales of compost). *Risk Indicator:* of critical dependencies on failed systems (e.g., "Our project fails if the county truck doesn't come").

Sustainability Scaffold Planner (Planning Tool)

Purpose: Planning Tool

Instructions: A successful project needs a strong scaffold to support it over time. Use this checklist during your planning phase to build the three core pillars of long-term maintenance.

Table 6: Practitioner Toolkit - Sustainability Scaffold Planner

Pillar	*Key Actions & Ideas*	*Our Plan (For proposal/workplan)*
1. Capacity Building	- Train community members in financial management. - Create a learning collaborative to share knowledge with other CBOs. - Embed advocacy training (e.g., on land tenure, policy) into project workshops.- Develop a "Knowledge-to-Livelihood" mentorship plan (Tool 3). - Utilize the Kenya Climate Change Directory to identify potential partners, create a formal learning collaborative with other CBOs/NGOs, and ensure new project efforts are not being duplicated.	*[Your Plan Here]*
2.Economic Instruments	-Develop a formal business plan for selling project outputs (e.g., compost, seedlings, recyclables).- Secure *formal market linkages* (Tool 3).- Reinvest a defined % of revenue back into the project. Explore future funding (e.g., waste-to-value bonds, grants). - Leverage national-level financial instruments. Investigate and apply for new national regulations (e.g., the Carbon Markets Regulations) that can monetize processes like waste diversion, creating a formal, non-physical revenue stream.	*[Your Plan Here]*
3. Governance	- Establish a clear, community-led governance committee for the project. - *Anchor* the project in *trusted*, *non-sectarian* leadership (Tool 3).- Develop resource-sharing agreements with other CBOs/NGOs. - Embed local leaders (Chief, elders) into M&E systems to report progress and ensure accountability.	*[Your Plan Here]*

Toolkit 1b: The Community Innovator's Action Guide (v1.0 - DRAFT)

Introduction: A How-To Guide for Community Changemakers

This guide is for you: the community leaders, CBO members, youth group organizers, and innovators who are already working to build a stronger, safer, and healthier community.

This guide is a v1.0 DRAFT. It is a *starting point* for discussion. Our research with leaders in Mathare and Mukuru showed that the most successful projects follow a clear, 4-step logic. We have translated our findings into this guide to help you plan your next successful project.

We want your feedback in our workshops: Is this useful? Is the language right? What did we miss?

The 4-Step Logic: How Change Really Happens

Our research found that successful projects aren't just about a "good idea." They follow a 4-step logic:

Step 1: Know Your Starting Point (Your CONTEXT): You must be honest about the *real* challenges and resources you have.

Step 2: Choose Your Project (Your STRATEGY): You choose *what* you are going to do (e.g., plant trees, start a waste business).

Step 3: Find the "Active Ingredient" (Your MECHANISM): This is the *most important step*. It's the "how-to" that makes people join and stay. It's the *human reason* your project works (e.g., it provides hope, a job, or trust).

Step 4: Check If It's Working (Your OUTCOME): You must check if your project is *really* solving the problem and helping everyone.

This guide will walk you through these four steps.

Step 1: Know Your Starting Point (Your Context)

Before you plan, you must diagnose your community's starting point. A project that works in one place can fail in another if the context is different. Use this checklist to have an honest discussion with your team.

Table 7: Community Toolkit - Checklist 1: What Is Our "Primary Need"?

Question	*Our Context is like... MUKURU (Relative Stability)*	*Our Context is like... MATHARE (Survival Crisis)*
What is our community's most urgent problem today?	The main problem is economics. People need jobs and a cleaner, safer environment. (We call this "Primacy of Payment").	The main problem is survival. We are facing an *active crisis* (e.g., cholera, no water, no food). (We call this "Primacy of Need").
Our First Move:	Our project *must* have a strong, reliable economic engine (a real payment or business model) to get people involved.	Our project *must* be integrated with basic survival. We cannot ask people to volunteer for a "climate" project if they need "flour" or "clean water" first.

Table 8: Community Toolkit - Checklist 2: What Is Our "Ecology Of Trust"?

Question	*Our Context is like... MUKURU (Formal Collaboration)*	*Our Context is like... MATHARE (Ecology of Exclusion)*
What is our relationship with the government / state and leaders?	The context is "Formalized." The government/ state (SPA, Chief) is an *active partner*. We can (mostly) work with them.	The context is "Exclusion." The government is absent (no services) or hostile ("Whose Letter?" paralysis).
How do community members see us?	Our CBO is seen as a "Trusted, Non-Sectarian" partner. Our leader is known for being fair.	Our community is "suspicious." People may think we are "agents" for a politician or a gang ("Whose Agent?").

What Is Our "Assets Gap"?

Question: What basic things are we missing that stop our projects from working?

Asset Gap 1 (Mukuru Women): We are missing Communal Safety Assets. (e.g., We need security lights to keep women safe and stop illegal dumping at night. We need perimeter walls to protect children.)

Asset Gap 2 (Mukuru Men): We are missing Occupational Assets. (e.g., We need proper gloves, boots, and wheelbarrows to do the Climate WorX job safely and with dignity.)

Asset Gap 3 (Mathare): We are missing Human Survival Assets. (e.g., We need clean water that doesn't "taste like sewage," working toilets, and safe housing that won't burn down.)

Step 2: Choose Your Project (Your Strategy)

Now that you know your Context (from Step 1), you can choose the right Strategy (your project idea). A good strategy is one that is a direct answer to your context.

Use this checklist to test your project idea. A strong idea should get a "Yes" on all three questions.

Strategy Selection Checklist

1. Does our project idea solve our "Primacy" problem?

( ) YES / ( ) NO

This is the most important question.

If your problem is "Primacy of Need" (like Mathare): Does your project *directly* provide food, health, or clean water? If not, can it be *integrated* with a project that does? Consider partnering with enterprises that address a proven high community need e.g, public sanitation enterprise.

If your problem is "Primacy of Payment" (like Mukuru): Does your project *directly* provide a reliable, paid job that can compete with crime (or livelihood)?

2. Does our project idea fit our "Ecology of Trust"?

( ) YES / ( ) NO

If your context is "Ecology of Exclusion" (like Mathare)**:** Is this an "insurgent" project (like greening a dump site) that you can start *yourselves*? (This helps build trust by showing "visible neutrality").

If your context is "Formal Collaboration" (like Mukuru)**:** Is this a project you can *partner* with the government, SPA, or a large CBO on?

3. *Does our project idea have a plan for our "Assets Gap"?*

( ) YES / ( ) NO

If your gap is "Human Survival" (like Mathare**):** Does your project *fix* the asset gap? (e.g., A plan to *fix* the sewer before you clean storm drains).

If your gap is "Communal" or "Occupational" (like Mukuru): Does your project budget *include* these assets? (e.g., a line item for security lights, or a line item for gloves and boots).|

Project Inspiration (Examples of Strategies):

Waste-to-Value: Starting a business that collects waste and recycles it (like the Climate WorX project or the Coca-Cola partnership).

"Insurgent" Greening: Finding a dump site or "no-man's land" and transforming it into a green park, a field, or a community space (like the PTiM project).

Urban Farming: Growing food for sale or for the community (like Vertical Farms or pig/poultry farming).

Social Support: Creating a program that also builds the community (like the football club that mentors youth, or the CBOs that teach hygiene).

Information: Using your skills or personal assets such as social media reach to help (like Mathare FM, which sends out flood alerts on the radio).

Public Sanitation Enterprise: Building and managing community toilets. Our research in Mathare and Mukuru confirmed this as top health priority, with key informants identifying it as a viable, community-run enterprise model.

Step 3: Make It Work (Find Your "Active Ingredient")

This is the most important part. A "Strategy" is just an idea. "The Mechanism" (the "Active Ingredient") is the how-to tactic that makes it successful.

Table 9: Community Toolkit - Finding your 'active ingredient' tool

If Your Goal Is...	*The "Active Ingredient" (Mechanism) You Must Activate*	*The "Operational Tactic" (The How-To)*
To Get Youth to Join & Stay (Paid Project)	*"Primacy of Payment"*	***Tactic:*** Don't just promise "profit." You must design a *reliable, predictable payment* (e.g., "every 10 days"). It must be a real, dignified job.
To Get Youth to Join & Stay (Unpaid Project)	*"Identity Shift" / "Hope"*	**Tactic:** Your project *must* be about more than the task. It must build *identity*. Use "reformed youth as champions." Give each person *personal responsibility* for a specific part (e.g., "This is *your* 5 trees to water") to build ownership and pride.

To Make Sure Women Can Participate	*"Flexibility & Inclusion"*	*Tactic:* Don't use a rigid 9-to-5 schedule. Design the project with *small, independent teams* and *flexible schedules and deadlines*. This allows women to join while managing their other household duties. Also provides an opportunity for those in informal work to participate as it anticipates the unpredictability of informal work. Anchor community solidarity networks to foster teamwork.
To Prevent Conflict (including fights) & Build Trust (in a Stable Context)	*"Trusted, Non-Sectarian Leadership"*	*Tactic (mukuru model):* Formally include a *trusted, neutral leader* (like a Chief, DO, or respected CBO head) as your project's main conflict resolver. This *proves* the project is fair and not just for one tribe or political group. This is essential for stopping the "internal divide."
To Build Trust from Zero (In a Hostile Context)	*"Visible Neutrality"*	*Tactic (Mathare Model):* Your project *must* prove it is *not* a "political agent." Start with highly visible, simple, "good" acts (planting, cleaning a public space). This *shows* the community your neutrality *before* you ask for anything.
To Protect Your Project from Harassment	*"Top-Down Cover"*	*Tactic (Mathare Model):* To fight "Whose Letter?" paralysis, partner with an "outsider" who has formal power (like a large, registered NGO, a church, or a university). They can act as your "shield" and answer the "whose letter" question for you.
To Start a Real, Sustainable Business	*"Market & System Integration"*	*Tactic 1 (Market):* Find your *buyer first*. Get a formal contract (like the Coca-Cola model). Do *not* rely on informal middlemen who will pay you pennies. *Tactic 2 (System): Assume* the system is broken. Your plan *must* include *all* actors both in the formal and informal systems. The Climate WorX in Mathare faced challenges because of waste pickers. *Tactic 3* (KII insight): During scaleup ask your NGO or CBO partner to research new national-level funding, like the Carbon Credits regulations. This can create a formal, new source of income.
To Start a New Kind of Project	*"Knowledge-to-Livelihood"*	*Tactic:* Don't guess. You need a *how-to guide*. Find an expert or another CBO that has done it. Ask them for a *step-by-step* plan. (This toolkit will help you find them).

Step 4: Check If It's Really Working (Your Outcomes)

Finally, you must be honest. Is your project really working? his step is not a "pass/fail" test. It's a "check-and-fix" guide. Ask the question, and if the answer is "No," use the tactic to get back on track.

Table 10: Community Toolkit - Check and Fix Tool

The Question to Ask...	*Example from Our Research...*	*The "Fix-It" Tactic (If the Answer is "No")*
1. Reach: Are we really reaching the most vulnerable? (e.g., women, isolated youth)	*In Mathare, we found that political aid was not reaching women.*	*If "No," your design is not inclusive. Tactic: Go back to Step 3. You must add the "Flexibility & Inclusion" tactic to your project.*
2. Effectiveness: Did we actually solve the core problem?	*Climate WorX in Mathare had sub-optimal outcomes. The waste picker problem meant it was "back to square one" every day.*	*If "No," your project has a major design flaw. Tactic: Go back to Step 3. You must add the "Market & System Integration" tactic. You have to make a plan for the part of the system you ignored (like the waste pickers).*
***3. Adoption:** Is our idea so good that other people are copying it?*	*The "Insurgent Greening" in Mathare was high on adoption. It inspired hope.*	***If "Yes,"** this is a great sign! **Tactic:** Your role is now also to be a mentor. Use the **"Knowledge-to-Livelihood"** tactic to share your "how-to" guide with other groups. If "No," **Tactic:** Revisit step 2*
***4.** Implementation: Are we really activating our "Active Ingredient" from Step 3?*	*Are we really building trust, or just causing meeting fatigue? Is our payment really reliable?*	***If "No,"** your team has lost focus. **Tactic: You must pause and re-read Step 3.** Are you really being non-partisan? Have your payments been late? You must fix the core tactic.*
***5.** Maintenance: Is our project "system-failure-proof?"*	*Does your project die if the county truck doesn't come? (The Mathare answer was "Yes," which is a big risk).*	*If "**No,**" your project is too dependent**.** **Tactic:** You must **design a backup plan**. (e.g., "If the truck doesn't come, we will use our own compost pit." or "We will partner with a private company as a backup buyer.")*

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Appendix

Appendix 1: Case Study: Evaluation of Community-Driven Climate Change Adaptations for Translatability in Mathare

Methodological Brief & Data Sources

This case study is a thick description (Crowe et al., 2011; Easton, 2010) built from a triangulation of four distinct data sources as detailed above in the 'Methodology' section: *1) Desk Review:* A comprehensive desk review of community-driven adaptations in Mathare. 2) *Key Informant Interview (KII):* seven semi-structured interviews were conducted with community members including local administration (n=1), Community leader (n=1), Youth leader (n=1) and CCA innovators (n=4). *3) Focus Group Discussion (FGD):* Two FGDs (n=13) conducted with male and female residents (lived more than two years) of Hazina village in Mukuru Kayaba. The group included seven women and six men, with an approximate age range of 20-50. Each FGD included two members each of populations traditionally marginalized in community decision: two youth (male) and one youth and widow (female FGD). *4) Participatory Mapping:* The FGD concluded with a participatory mapping exercise with community researchers serving as the mappers. The detailed transcription of this mapping discussion was analyzed as a core data source to understand the community's spatial "mental model" of their risks, assets, and priorities as seen in Figure 1 above. *5) Non-Participant Observation:* The primary researcher and community researcher's field notes, memory, and photographs from site visits are used as a final layer of triangulation to provide objective visual evidence and to capture the sensory and atmospheric context of the findings.

Contextual Backdrop

Mathare, Nairobi's second-largest informal settlement, is defined by what research terms an ecology resulting from decades of systemic state neglect (Kimari, 2021). This context is characterized by severe climate vulnerabilities, chief among them seasonal flooding from the polluted Mathare River. A 2024 flood, for instance, displaced 15,000 residents and destroyed 400 homes (Briefing Note: Kenya Heavy Rainfall and Floods, 2024) This vulnerability is compounded by a high youth population, high unemployment rate, and insecure land tenure under (Sandberg, 2025).

The qualitative fieldwork provides a thick, visceral description of this "exclusion" as a daily, multi-system failure. Participants describe a critical infrastructure collapse that poses an immediate threat to life: *1) Public Health Crisis:* The most urgent issue is the complete breakdown of Water and Sanitation (WASH) infrastructure (Sandberg, 2025). FGD

participants describe this reality: a sewer line has been "troubled... for almost a whole year" , with water pipes passing directly through it. The result is that tap water "tastes like sewage". This is compounded by a cholera outbreak during the study period that participants noted had "killed five people"; *2) Water Scarcity:* Despite the cholera outbreak, clean water is supplied "only on Friday". A local borehole is unusable for consumption, as the water "looks green (like algae)" and is "only for washing clothes"; 3) *Constant Risk*: Participants describe "flying toilets" (*uhuru bags*) and sewage pipes that flow "direct into the river" or "right into the houses". This is coupled with the constant threat of fire, with "no year... without an incident of fire" due to *mabati* (iron sheet) housing and poor wiring.

Figure 6: Containers awaiting water at a communal point in Mathare

Figure 6 visually captures the daily logistical burden of securing water, highlighting how informal infrastructure necessitates significant household labor and time allocation to address a basic human survival need

The Community Worldview: Reframing 'Climate' as 'Health, Hunger, and Hope'

A salient finding from the fieldwork is the gap between the academic "climate" frame and the community's lived worldview. The problem of climate change is framed in terms of immediate, tangible crises: health, safety, and survival.1) *"Climate" as Health & Hygiene:* The community's primary concern is health. During participatory mapping, participants placed priority in mapping areas with poor sanitation from open defecation which they identified as, in part, a cause of cholera, as flies from human waste on waste picker-scattered garbage land on food. The problem is "sewage" , "cholera" , "diarrhoea", and "garbage"; 2) *"Adaptation" as Insurgent Hope:* In this context of "hopelessness" , the desk review identifies a powerful community philosophy of "Mathare Futurism", which frames projects

as a "decolonial act of creating a better future". Qualitative inquiry provides the voice for this. One youth group, upon seeing a demolished space, said, "this space can't just be left like this... before they [the government] come, they should find that we have already... started". This "insurgent greening" is an act of "self-drive," a tangible expression of hope against a backdrop of neglect.

Descriptive Narrative

The Governance-Community Agency Nexus ("A Seat at the Table")

The Governance-Community Agency relationship in Mathare is fundamentally one of uneasy co-existence. What the desk review termed "ecology of exclusion" is experienced by residents as "state abandonment" punctuated by hostile interference. This creates a two-pronged paralysis for community-driven action: 1) *The Formal Barrier* ("Whose Letter?"): The FGD participants identified that when residents organize, "someone emerges to ask a question, 'Do you have a letter from so-and-so?'". This bureaucratic threat, backed by the fear of "sleeping inside [jail]," causes residents to "get tired" and abandon their own initiatives; 2) *The Informal Barrier* ("Whose Agent?"): The fieldwork also revealed a powerful *social* barrier. Self-organizing youth are not just blocked by the state; they are actively undermined by suspicion from their own community. They are perceived as being "used" or as "agents of 'people' (a term taken to mean devious characters, gangs, or politicians). Their "insurgent" good work is thus re-framed as a front for a hidden, threatening agenda.

However, key informants provide a formal (Governance) counter-narrative. Local administrators (n=1) and community leaders (n=2) reference the state's involvement through a "multi-agency team" to clear the riparian land. They described his strategy as a mix of "force" ("it forced some people to move") and "negotiation," but ultimately one where the multi-agency team must "be firm" because "that riparian land is public land under the custody of the government". This creates a clear tension between the state's top-down (and funded) agency and the community's bottom-up (and criminalized) "insurgent" agency.

The Livelihood-Climate Competition: "The Gendered 'Primacy of Need'"

A critical finding from the fieldwork is the "Primacy of Need", which acts as a profound, gendered barrier to participation. The desk review and key informants, local youth leader (n=1), highlight that the most celebrated community projects (like PTiM) (Sandberg, 2025) are voluntary, termed as *"kujituma"* [self-diligence and personal drive] and driven by psychosocial mechanisms like "identity transformation" (Sandberg, 2025).

However, this approach grounded in volunteerism represents a key vulnerability, as highlighted in the FGDs. A quote from a female participant vividly illustrates this: "a mother who tells you, 'You've visited me, have you brought me flour? If there's anything else... don't tell me.'" This statement powerfully conveys the urgency of household survival. This gendered reality, where women predominantly manage household resources, forces a different calculus: they cannot prioritize the "luxury" of engaging in voluntary, long-term identity projects when immediate food security for their children is at stake. This stands in stark contrast to the often male-led "insurgent greening" projects, which are frequently motivated by future-oriented, aspirational goals.

Moreover, this creates a central tension: the most celebrated community projects are often "voluntary," yet the community's most pressing need is income. This conflict is clearly exemplified by participants in both male and female FGDs, who consistently expressed a desire for capital over training. The support they truly need is for "small businesses," with one male participant articulating this desire: "if only he [a young man in the community] could get even 20 shillings, to start their businesses. That's the support I would ask for."

Enabling Sustainability: Market Barriers, System Coordination Gaps and The Layered "Assets Gap"

While the desk review identifies several innovations, the qualitative data reveals critical, on-the-ground sustainability challenges related to markets, systemic coordination, and access to basic assets.

Market Barriers and System Coordination Gaps

(1) *Market Barrier:* “The Perception of Contamination” The desk review notes successful market linkages for the Teenage Mother Vertical Farms (Adhiambo et al., 2025). However, the qualitative data from female FGD participants reveals a significant market barrier. The pervasive WASH infrastructure collapse described, in part, as sewage flowing directly into the river and water tasting "like sewage", creates a strong public perception of contamination. FGD participants noted people are "afraid of the safety of the food" grown on riparian land. This fear is a major barrier to sales, with one female participant stating that even when they do sell, "it is because of problems... the persons buying have no alternative." This indicates a fragile market of last resort, not a thriving, sustainable one. (2) *System Gap:* “Uncoordinated Economies”: A similar implementation gap is seen with the 'Climate WorX' project. FGDs revealed that while community youth collect garbage, their efforts are immediately undermined by waste pickers who "start scattering it" to find recyclables. This is not a malicious act but a system coordination failure. The waste pickers have an established, informal market for their "bricolage" (plastics, paper). The core issue is that this informal recycling economy is not integrated with the government-enabled

Nairobi River cleanup and rehabilitation project. This lack of coordination between the two parallel economies creates a "back to square one" inefficiency, undermining the project's sustainability.

The Layered "Assets Gap"

The data reveals two distinct layers of "asset gaps" that constrain community resilience.

1) The Foundational "Human Assets" Gap: This is a view strongly held by the community highlighted in both FGDs which identified the most fundamental gap as the lack of basic human survival infrastructure. Community priorities are systemic; a finding powerfully visualized in the participatory mapping exercise. The community drew their desired assets directly onto their map, including public toilets, solar-powered streetlights for "black spots" , and "vibanda" (kiosks) along new roads and on reclaimed riparian land to create safe economic spaces. This spatial representation confirms their verbal priorities: livelihood, clean water, working sewers, and safe housing “not *Mabati* [iron sheets]”to prevent fires.

2) The Project-Level "Greening Assets" Gap: The gap identified through desk review highlights specific asset deficiencies for greening initiatives, including toxic, plastic-layered soil, a lack of necessary seedlings, and insufficient water for irrigation. However, key informants (a community leader, a youth leader, and a local administration representative) confirmed that the state is actively working to bridge this gap. They noted that the state multi-agency team is actively "providing soil and seedlings" to support the tree-planting efforts. This demonstrates a formal, targeted response to the project-level asset gap, even as state and non-state (CBOs and NGOs) efforts to address the more foundational human-level asset gap (WASH) continue to lag.

Systemic Failures and Emergent Community-driven Responses

Systemic Failures

As noted with “Asset Gaps” in the previous section, systemic failures impending the success of CCA are layered. The qualitative data provides thick, visceral evidence of the systemic failures that define the "ecology of exclusion." These are not abstract barriers but daily, lived realities, as visualized in the community's participatory map: *1) Infrastructure Collapse*: The participatory map (Figure 1 above) graphically illustrates the health crisis. Participants drew water pipes passing through sewers , and sewer lines running "inside the houses" , corroborating reports of water "tasting like sewage" and the active cholera outbreak; *2) State Abandonment*: The mapping discussion confirmed the lack of formal systems: No county truck for garbage, no designated dump site, and water supplied only once a week; *3)"Whose Letter?" Paralysis and “Whose agent” Suspicion*: Community self-

starters are actively blocked by bureaucratic threats (*"Mko na barua ya nani?"* [whose letter (of authority) do you have]) and undermined by community suspicion that they are "agents" for politicians or gangs. This particularly marginalizes young men limiting their participation; 4) *Insecure Land Tenure:* The desk review notes this as an overriding threat; 5) Implementation Failure: The multistakeholder initiative to mitigate climate change 'Climate WorX' model has sub-optimal outcomes by a failure to manage the "waste picker" subsystem. Moreover, past NGO projects have also failed due to a lack of long-term maintenance ("two weeks [river cleaning] ... it's right back there" [garbage after NGO-supported river cleaning exercise ended]); 6) *Fragmented & Politicized Aid:* The fieldwork reveals that while CBOs are seen as helpful, aid is fragmented. More importantly, women participants described a gendered political exclusion, stating that aid from politicians rarely reaches them. One woman noted, "It's better for it to be brought by the Red Cross... The one from the politicians, we don't get it," as "it's the men who are benefiting.";*6) Gendered Barriers to Participation:* The desk review identifies that gendered time constraints and the "PAR Resource Paradox" exclude young mothers. Moreover, the acute need for basic survival ("Have you brought me flour?") is a primary, gendered barrier to participating in unpaid projects.

Emergent CCA Innovations Based on Solidarity

In response to this context, residents are not passive. The desk review and qualitative data show the emergence of new, "indigenous" social structures and "insurgent" enterprises designed to create safety nets and claim a stake in the community's future. *1) Emergence of New Solidarity and Aid Structures:* Residents have developed their own formal and informal networks to manage crises and fill the gaps left by the state. The desk review, including news reports, identifies a strong *Chamaa/Harambee* culture within Mathare that manifests as "Crisis-Driven Mutual Aid," with grassroots groups like Mathare Social Justice Centre (MSJC) and Muungano wa Wanavijiji: coordinating the response during various crises. This is reinforced by community resources that foster social inclusion such as the innovative online community radio Mathare FM (Ndirangu et al., 2024). FGD participants reported CBOs partnering with the government to provide essential health education and flood relief (soap, jerrycans). *2) Spontaneous & "Insurgent" Enterprise:* Community members demonstrate spontaneous, adaptive entrepreneurship in the face of resource scarcity. This is seen in informal livelihoods, where residents adapt to the failed waste system by keeping pigs (which eat food scraps) or planting precarious vegetable gardens. The flagship example of this is "Insurgent Greening" (Sandberg, 2025). The PTiM youth group's decision to "clear the space" and plant 120 trees *before* the government arrived is a powerful act of "auto construction" and "self-drive," demonstrating a bottom-up response that is both practical and deeply symbolic (Sandberg, 2025).

Table T1 below provides a comprehensive, triangulated list of all identified CCA innovations in Mathare.

Community's Spatial Narrative (The Participatory Community Mapping Exercise)

The participatory mapping exercise provides the single clearest piece of evidence for the "ecology of exclusion." When invited to draw their community, participants created a "map of systemic failure" consisting of a spatial inventory of risks overlaid on a few precarious assets.

The Landscape of Risk

The community first anchored their map with the river but immediately populated it with risks. They drew flood hotspots, garbage dumps , and the community borehole with "dirty" water that looks "like leaves". Most viscerally, they made the mapping exercise a graphic testament to the WASH crisis. Rather than just drawing an abstract "sanitation problem," they directed the mapper to draw the crisis at the household level, stating, "Draw a house there and put it inside. Sewer line... You find a house, the sewer line is right here... The sewage just stinks while you are eating". This act of mapping the sewer *inside* the house is a powerful visualization of the health crisis, which they also linked to the nearby "dirty" borehole and the active cholera outbreak. At the community level, they directed the mapper to draw caricatures of open defecation by children highlighting the WASH infrastructure deficit collapse by drawing sewer lines running inside their homes. One participant instructed the artist, "Draw a house there and put it inside. Sewer line... You find a house; the sewer line is right here... The sewage just stinks while you are eating".

The Landscape of Agency

The community then overlaid their "insurgent" assets onto this map, drawing the "field" they are creating and the "trees" they have planted.

The Landscape of Solutions

Finally, the map became a tool for advocacy. Participants explicitly drew their desired solutions, placing streetlights on the "black spots" to improve security and drawing "vibanda" (kiosks) along the new road to create safe spaces for business. The mapping process itself transformed into a planning session, with the moderator noting, "research is finding where the problem is and the solutions. And we already have solutions... Waweke uwanja, waweke miti, waweke vibanda, waweke streetlight"

Analytical Summary

Table 11: Community-Driven Climate Change Adaptations (CCA) in Mathare

Innovation	**Source**	**Description & Key Citations**
River Rehabilitation Squads	Desk Review	Youth-led teams (e.g., Mathare 4B River Adoption Group) cleaning riparian zones and creating parks (Sandberg, 2025).
Teenage Mother Vertical Farms	Desk Review	Sack gardens on riverbanks producing vegetables for income, with sales to neighboring areas (Sandberg, 2025).
Radio-Coordinated Early Warnings	Desk Review	Mathare FM (reaching 88% of residents) facilitates cross-ward flood alerts and evacuation plans (Ndirangu et al., 2024)
Post-Flood Mutual Aid	Desk Review, Fieldwork	Grassroots networks (*Chamaa*) and CBOs (MSJC, Muungano wa Vijiji, Ghetto Foundation) mobilizing cash transfers and shelters (Sandberg, 2025).
Planting Trees in Mathare (PTiM)	Desk Review, Fieldwork	A youth CBO (Future Leaders +254) transforming dumping sites (Sandberg, 2025). The male FGD confirms this is "insurgent": "before they [govt] come... we've already started".
'Climate WorX' Project	Fieldwork	An ongoing government-enabled Nairobi River cleanup and rehabilitation project. Collected garbage is immediately scattered by waste pickers.
Urban Farming (Informal)	Fieldwork	Residents keep pigs, feeding them from garbage dumps (See Figure 1: Participatory map). Others plant vegetable gardens, which are vulnerable to destruction.
CBO-led Health Interventions	Fieldwork	CBOs partner with the government to provide health education and flood relief (soap, jerrycans).

Table 12: Mathare Key Contextual Factors (CFIR) and Strategies (ERIC)

Framework	**Domain**	**Key Findings (Triangulated)**

Context (CFIR)	C-Outer Setting	*State Neglect ("Ecology of Exclusion"):* No county garbage trucks, no dump sites, water only on Fridays. *Bureaucratic Paralysis:* The "Whose Letter?" barrier; community action is blocked by political threats. *Insecure Land Tenure*: Overriding threat of forced evictions.
	C-Inner Setting	Infrastructure Collapse: Water pipes run through sewers; sewage flows into houses. Constant Shocks: Pervasive risk of "fire" and floods ("people being swept away"). Social/Economic: 40% unemployment. Strong *Chamaa* culture. Conflict between community efforts and waste pickers. Suspicion of Youth Agency: Community perceives self-organizing youth as "agents" for politicians or gangs. Physical: Toxic, plastic-layered soil.
	C-Individuals	Worldview: "Climate" is framed as immediate crises: "cholera," "sewage," "diarrhoea". Gendered "Primacy of Need": Basic survival (hunger, income) is the main barrier to (unpaid) participation. ("Have you brought me flour?"). "Mathare Futurism": A counter-mechanism of hope and "self-drive".
	C-Process	Implementation Failure: 'Climate WorX' model fails to account for waste pickers. Past NGO projects lack maintenance.
Strategy (ERIC)	S-Stakeholder	Top-Down (Govt): Use multi-agency teams and "force/negotiation" to clear riparian land. Bottom-Up (CBO): "Insurgent Greening" includes starting projects without permission. Identify Champions: Use reformed youth as "tree caregivers" (Sandberg, 2025).
	S-Financial	Crisis-Driven Mutual Aid: Mobilize cash transfers post-flood. (Planned): Use revenue from nurseries/compost for self-sufficiency (Sandberg, 2025)
	S-Education	Affective Stewardship: Foster emotional bonds with plantsi Govt-led: Key informants as well as FGD participants reports getting enabling assets from Nairobi Regeneration Team, who also provide technical "how-to-plant" training.
	S-Restructuring	"Insurgent Greening": Transform dumping sites into green spaces. "Safe-Space Hybridization": Integrate green zones with mentorship hubs

	S-Implementation	Iterative Design: Adapt by selecting flood-resilient species. Tailor Interventions (Gendered): Offer alternate times for working mothers as stated by female FGD participants. Create market-linked food/income-based models based on guarantee of healthy food to avoid pitfalls faced by 'insurgent' urban vegetable farms.

Table 13: C-S-M-O Causal Configurations Identified in Mathare

Context (C)	Strategy (S)	Mechanism (M)	Outcome (O)	Source
"Primacy of Need" (Gendered): Mothers face time *and* resource poverty ("Have you brought me flour?").	Teenage Mother Vertical Farms (Gender-specific, food/income-based model).	Economic & Food Security: The project directly addresses the "flour" problem, making participation viable and desirable.	Income generated; food security improved; mothers engaged.	Desk Review & Fieldwork
Recurring Climate Shocks (flooding) + Fragmented/Politicized Formal Aid (which excludes women).	Crisis-Driven Mutual Aid (Leveraging trusted *Chamaa* culture).	Communal Loss → Reliance on Trusted Networks: Shared trauma + mistrust in formal aid strengthens reliance on indigenous, non-political solidarity networks.	Coordinated aid; local resources (e.g Mathare FM) used for alerts; more equitable informal distribution.	Desk Review & Fieldwork
Ecology of Exclusion (state abandonment, youth stigmatization)	"Insurgent Greening" (Youth-led "autoconstruction" of green spaces)	Visible Impact → Collective Efficacy: Transforming dump sites provides tangible proof of change, shifting mindset from fatalism to agency.	New peer networks form; community joins in maintenance.	Desk Review

Social Fragmentation (distrust, anxiety about youth)	"Affective Stewardship Model" (Assigning youth "tree caregivers" for daily rituals).	Emotional Encounter → Ownership: Daily nurturing fosters personal bonds and protective responsibility for the trees.	Green spaces created; acceptable tree survival rate.	Desk Review
Insecurity & Police Brutality (hostile environment for young men) (Sandberg, 2025) + Community Suspicion (youth seen as “agents” for gangs/politicians).	"Safe-Space Hybridization" (Integrating visible green zones with mentorship hubs) (Sandberg, 2025).	Spatial Legitimization → Demonstrated Neutrality and Trust: Public, visible, “neutral” work (planting trees) creates a new, non-threatening social identity, disapproving the suspicion of then being “agents”. Identity Shift: Positive use of space shifts perception of youth from "threat" to "contributor".	Police participate in planting events; community trust is rebuilt; youth feel safer.	Desk Review and Fieldwork
Hopelessness (narratives of Mathare as "outlaw space")	"Mathare Futurism" Philosophy (Framing planting as a symbolic, decolonial act)	Symbolic Rescripting → Intergenerational Hope: Planting becomes an investment in an alternative, positive future.	Children adopt pro-environmental behaviours (Sandberg, 2025).	Desk Review
Recurring Climate Shocks (severe flooding)	Crisis-Driven Mutual Aid (Leveraging *Chamaa* culture).	Communal Loss → Knowledge Sharing: Shared trauma breaks down divisions and	Coordinated aid; community radio (Mathare FM) used for alerts.	Desk Review

		creates new norms of cooperation.		
State Neglect & "Whose Letter?" Paralysis	"Insurgent" Self-Starting ("Before they [govt] come... we've already started").	Agency & "Self-Drive": A refusal to wait for a failed state; finding motivation in proactive, visible change.	120 trees planted (key Informant, youth leader); space cleared *before* any formal support arrives.	Fieldwork
Riparian "Hideouts" & Crime.	Top-Down State Action (Multi-agency team clearing riparian land).	Force & Firm Negotiation: Use of state power (including military) to enforce "government land" mandate.	River cleaned; crime reduced; people "forced... to move"	Fieldwork
Implementation w/o System Integration	'Climate WorX' Collection (Gathering waste in piles)	Countervailing Economic Incentive: Waste pickers' need for plastic (income) is greater than the project's ability to secure the waste.	Waste pickers "mess up" the work; project fails; "back to square one".	Fieldwork

Appendix 2: Case Study: Realist Evaluation of Community-Driven Climate Change Adaptations for Translatability in Mukuru

Methodological Brief & Data Sources

This case study is a thick description (Crowe et al., 2011; Easton, 2010) built from a triangulation of four distinct data sources as detailed above in the 'Methodology' section: 1) *Desk Review:* A foundational desk review of the Mukuru Special Planning Area (SPA) and its associated interventions. 2) *Key Informant Interview (KII):* six semi-structured interviews were conducted with community members: Community leader (n=1), Youth leader (n=1) and CCA innovators (n=4). 3)*Focus Group Discussions (FGDs):* Two gender-disaggregated FGDs were conducted with Mukuru residents in Hazina. The female FGD comprised six female participants among whom were two participants (one youth and one single mother) from populations marginalized in climate change adaptation, with an approximate age range of 20-45. They all described themselves as "hustlers", meaning informal workers, like participants in the Male FGD. The Male FGD comprised seven male participants among whom were two participants (two youth) from populations marginalized in climate change adaptation, with an approximate age range of 18-55. All FGD participants. 4) *Participatory Mapping*: Each FGD concluded with a participatory mapping exercise under the guidance of community researchers who served as the mappers. The detailed transcriptions of these mapping discussions were analyzed as a core data source to understand the community's spatial "mental model" of their risks, assets, and priorities as seen in Figure 2 above. *5) Non-Participant Observation:* The primary researcher and community researcher's field notes, memory, and photographs from site visits are used as a final layer of triangulation to provide objective visual evidence and to capture the sensory and atmospheric context of the findings.

Contextual Backdrop

Mukuru, one of Kenya's largest informal settlements, is defined by significant environmental and health risks, including severe flooding (Horn, 2021; Karamallis et al., 2022) and industrial pollution **(**FGD participants Male-only FGD) the adjacent Ngong River. Organic waste is a primary contributor, blocking an estimated 60% of drains. Participants in our study confirmed this is their lived reality, describing how companies "drain their waste into the river", poisoning water sources and how residents have "experienced different things like floods, and house demolitions."

This context of risk is compounded by a socioeconomic profile of high unemployment and tenancy; 94% of residents are tenants (Karamallis et al., 2022), which our desk review

identifies as a key barrier to infrastructure development. The single most "game-changing" macro-contextual factor identified by the desk review was Mukuru's designation as a Special Planning Area (SPA) in 2017 (Karamallis et al., 2022). This formal government recognition provided a legal framework for a co-planning process with over 5,000 residents, creating Africa's largest informal settlement upgrading program (Global Center on Adaptation, 2022; Horn, 2021; Karamallis et al., 2022; Marano, 2022; Ouma, 2023). However, this formal, top-down "enabling" action exists in direct contradiction with the lived experience of trauma. Participants in the women's FGD revealed that a recent government facilitated demolition of structures on riparian land "hasn't gone [in their minds]". Participants stated, "We were all demolished", creating a deep and unresolved psychological trauma that coexists with the government's role as a partner in mitigating against climate change effects, with both male and female participants acknowledging that demolition of structures on riparian areas and construction of storm drains had resulted in less flooding.

The Community Worldview: Reframing 'Climate' as 'Health, Livelihoods, and Hope'

A critical finding from the fieldwork is the gap between the academic "climate" frame and the community's lived worldview. The term "climate change adaptation" is not the language of the participants. Instead, their worldview intrinsically links environmental issues to immediate, tangible, and social-moral concerns*: 1)"Climate" as Health & Hygiene:* The problem of pollution is framed as a direct health threat. The men's waste management group was formed "to see if we [can clean the environment] and push diseases far away". The women noted that company waste in the river "affects the children, they get sick" . Solutions, therefore, are valued in these terms. The "Climate WorX" project is praised because "the air has become clean"; 2*) "Adaptation" as Hope & Agency:* In this context of "grave adversity", poverty, high unemployment, high crime, the trauma of demolitions, generational trauma "because these things [adversarial nature of communities lived reality] have now moved from the youths, they have gone to the old people" and become a "family thing"; these adaptation projects are not merely functional. They are powerful generators of hope and social change. The women's group explained that the project provided more than money; it took at-risk youth, once "thieves," and turned them into "disciplined... good role models" . This "hope/future orientation" is a core generative mechanism. This worldview is the "voice of the ground" and informs a critical outlook: to be successful, stakeholders must align with these community-defined priorities of health, safety, income, and dignity, not abstract environmentalism. As a participant in the male-only FGD expressed " I would request if it were possible, once you leave here, in case you go and talk to others and so on, try to tell them even if they come to a place like this, at least they should find out the things that are there."

Descriptive Narrative

This section provides a thick description of the implementation of the Mukuru CCA portfolio using the study's integrated frameworks.

The Governance-Community Agency Nexus ("A Seat at the Table")

The desk review identifies the SPA as a pivotal success, shifting the power dynamic by formally "legitimizing the residents' knowledge and data". This S/ICMO configuration (SPA → Co-Planning → Legitimized Agency → Integrated Plan) frames the community as a "credible, expert partner".

Our qualitative findings reveal that this "dignity of engagement" is a critical, and often unfulfilled, need at the grassroots level: 1) *The Desire for agency:* The men's group expressed a deep desire for this exact mechanism. They feel leaders and external actors "try to handle a problem without listening to the person who has that problem". They argued that if leaders would "come and listen to these youths," the youth would "feel like he is being recognized," a powerful motivator in itself; 2) *The Fatigue of Extraction:* The women's group articulated the trauma of this mechanism's failure. They suffer from "research fatigue," describing how "every researcher comes... They ask you questions. Then from there, we don't see them again". This cycle of extractive, non-reciprocal engagement creates cynicism and disempowerment. While the SPA provides a formal "seat at the table" at the macro-level, the lived experience is still one of fighting for recognition and being wary of extractive partners.

The Livelihood-Climate Competition ("The Primacy of Payment")

The desk review highlights youth-run Black Soldier Fly (BSF) units as a key "waste-as-resource" innovation, where economic incentives (regular monthly income) drive a 70% reduction in organic waste (*A Circular Economy Model for Sustainable Waste Management in Mukuru - Akiba Mashinani Trust*, n.d.; *Turning Waste into Wealth through Climate Adaptation - Global Center on Adaptation*, n.d.; *Waste to Wealth with Black Soldier Flies*, n.d.). Our fieldwork confirms that this economic incentive is the single most important mechanism for the success and sustainability of any climate adaptation project. In the context of extreme poverty, these projects are in direct economic competition with crime: 1) *When It Works:* The women's group discussed the "Climate WorX" project, a similar government-enabled initiative. Its success is singular: "every 10 days, a person waits for that money. They plan themselves". This reliable payment is the reason "the youth who used to steal, now many have stopped because they are busy"; 2) *The Implementation Design for Equity:* The design of this project is also a key factor in its success and equitable reach. The work is structured into "small groups working independently" . This is coordinated by the government (NYS) and features active oversight from local administration (the DO and chief), who resolve conflicts and provide leadership as well as coordinate government and stakeholder financing of community-driven climate adaptation through provision of inputs

such as seedlings and arable soil. This flexible, small-group structure is critical for inclusion, as it allows women and minorities to participate by accommodating their schedules; 2*) When It Fails:* The men's group described self-initiating a football program to engage at-risk youth. This program is failing because it offers no pay. A young man sees "a friend of mine who went somewhere, did a small job [crime] and was given something," while he "hasn't been given anything" for playing football, so he "leaves that thing".

The community's conclusion is unambiguous. When asked if the climate projects would continue without pay, the women's group stated definitively, "It can't". For any intervention to be sustainable, it must first provide a reliable, competitive *payment* that can out-compete the immediate economic incentives of crime.

Enabling Sustainability: Market Linkages & The "Assets Gap"

While the desk review identifies "waste-as-resource" models, our fieldwork revealed two critical, practical factors that determine their viability: market linkages and enabling assets.

The Market Linkage Barrier (and Solution)

The success of any recycling or waste-to-value project hinges on access to a fair and reliable market. *The Problem:* The men's group, running their own waste management initiative, identified their key barrier as having "no market". They are forced to sell to exploitative "middlemen" , where "the dirt he has handled and the money you have given him, it doesn't match," which leads to youth giving up. *The Solution Model:* The women's group described a successful Coca-Cola recycling project. This model worked because it solved the market linkage: "they brought us these machines nearby, and then... Coca-Cola usually comes weekly, collects". This formal, direct-to-company linkage eliminates the broker and ensures reliable, fair payment.

The Gendered "Enabling Assets" Gap

The desk review identifies a gap in formal assets (e.g., land tenure, financing). However, the qualitative fieldwork reveals a more fundamental, gendered "enabling assets gap." This finding was powerfully visualized in the female participatory mapping exercise.

While the men's group focused on "occupational" assets for their waste management work (e.g., gloves, gumboots), the women's group prioritized communal safety and economic assets. Their map and discussion were dominated by the lack of security lights. They explained this is not a minor convenience but a core security and economic failure, as young men hide in the dark, demolished areas to rob "market women" of their goods and "school children" of their money.

This infrastructure failure directly undermines climate adaptation projects. As the women noted, the darkness allows residents to dump garbage at night, reversing the gains of the 'Climate WorX' project. The solutions proposed during their mapping exercise were all enabling assets: security lights, perimeter walls to protect children from the river, and markets to create safe economic spaces.

Systemic Failures and Emergent Community-driven Responses

The desk review identifies formal consortia (*A Circular Economy Model for Sustainable Waste Management in Mukuru - Akiba Mashinani Trust*, n.d.; Karamallis et al., 2022; Ouma, 2023) involved in stakeholder-led climate change adaptation projects. However, qualitative data reveals a more granular ecosystem of community-led initiatives operating despite, and in direct response to, several deep systemic failures. These systemic failures are not abstract barriers but daily, lived realities, as visualized in both the men's and women's participatory map.

Systemic Failures

These failures are critical contextual differentiators that shape the very nature of any intervention. Our analysis categorises these systemic failures as formal (institutions), and informal (community) barriers.

Formal Barriers: 1) **"**Infrastructure Collapse": The men's map graphically shows sewer lines running "inside the houses", creating a constant health hazard. The river itself is described as "poison" , as companies and residents direct sewage into it.; 2) "Landowner Resistance" The desk review identifies a significant barrier from "resistance from landowners to infrastructure upgrades, fearing it would affect their rental properties" (Horn, 2021; Karamallis et al., 2022; Marano, 2022); 3) *Bureaucratic Delays:* Formal progress is also hampered by "bureaucratic delays" in the implementation process (Karamallis et al., 2022; Marano, 2022). *4) "Fragmented Upgrading & "A-la-Carte" Development"*: The SPA is not experienced uniformly. Participants perceive a stark inequity between their area and neighboring areas like Kwa Reuben. They see that in Ruben, "roads have been built, they have been built well," "hospitals are nearby," and they have innovative "water facilities" like water ATMs. This creates deep resentment and confusion, with one participant noting, "You can even say they are at least closer to town than us and we are the ones closer to town than them". This highlights a core systemic failure: the upgrading process is experienced as fragmented and inequitable, creating new internal divisions and perceptions of being "left behind" within the same settlement; *5) "Failed Security & Corrupt Governance":* There is a profound breakdown in state-provided security. The men's group described security personnel as ineffective and corrupt: "they are also just passers-by; as long as you give them 50 shillings, they pretend they haven't seen anything". However, government-funded infrastructure projects, see participatory map Figure 2**,** such as high

mast security lights are cited to be helpful such as facilitating night patrols by community members to curb nighttime river dumping. As noted by the women FGD, security light[s] are needed to protect themselves from "young men hiding" to rob them.

*Informal Barriers:*1) “Pervasive Poverty and Unemployment”: This is the primary driver of instability. The men's group highlighted a critical mismatch between the "many youths" and the "few jobs". One participant noted that for a single job needing 20 people, "up to three hundred might show up," which "creates another conflict". This economic desperation is the main competitor to any climate initiative; 2) “Erosion of Social Structures”: The stress of poverty is fraying the traditional family unit, turning social breakdown into a "family thing". One participant explained, "violence in the home has contributed to even the youths themselves becoming notorious because he sees his mother and father fighting daily. So, this child, there is nothing you will tell him"; 3) “Knowledge and Capacity Gaps”: While residents are innovative, they face critical knowledge gaps that block their progress. The women's group, for example, has clear ideas for new livelihood projects like greenhouses and poultry but stated, "we don't have that enough knowledge" and need "people to train us".

Emergent CCA Innovations Based on Solidarity and Community-Driven Indigenous Responses

In response to this context of systemic failure, residents are not passive. The qualitative data shows the emergence of new, "indigenous" social structures and spontaneous enterprises designed to create safety nets and opportunities where none exist: 1*) Emergence of New Social Structures:* Residents have created their own formal and informal groups for mutual support. For example, The "South B Finest Football Club" is not just a sports team; it's a peer-to-peer mentorship program ("we... talk to them through sport") and a financial safety net, with its own self-funded chama (savings group) to cover player injuries. Further, the women's groups have formed CBOs that respond directly to social gaps, running "mentorship... For girls" on "Hygiene... [and] SRH [Sexual and Reproductive Health]"; *2) Spontaneous Bottom-Up Enterprise:* Community members demonstrate spontaneous, adaptive entrepreneurship. The women's group noted that after the "Climate WorX" project began aggregating waste, local youth saw an opportunity and "decided to rear... pigs" to consume the food scraps, creating a new livelihood from a waste stream Table 14shows innovations identified through triangulation of data sources, identifying which innovations were found in the desk review versus the qualitative fieldwork.

The Community's Spatial Narrative (The Participatory Maps)

The mapping exercises conducted with the male and female FGDs are the clearest articulation of the community's lived reality. Mapping occurred sequentially with the

gendered groups with all mapping taking place on the same paper. The men were given the first go, then the women followed by joint mapping of solutions. For the full map, see Figure 2 above. The following are the key insights:

The Men's Map: A "Map of Systemic Failure"

The male FGD's mapping process was a spatial inventory of systemic infrastructure collapse. When asked to draw their village, their primary landmarks were risks. They centred their map on the river and then immediately shaded the bridge in red, identifying it as the main flooding hotspot. Their map spatially connects sewer lines as running directly "inside the houses", with one participant noting, "The sewage just stinks while you are eating". Their map shows dump sites and "Mabase" (local drug dens) spots directly adjacent to community assets. The few assets they drew, like the "football field" and "trees", were community-created, precarious, and situated within this landscape of risk.

The Women's Map: A "Map of Gendered Insecurity"

The female FGD's mapping process was dominated by a different set of priorities, focusing on the link between safety and infrastructure. Their primary "risk" was not a flood, but the lack of security lights. They spatially mapped the "dark spots" where there are "no lights" and explained *why* this was a critical failure: "That's where you find young men hiding somewhere, looking for the market women". They explicitly link this *infrastructure gap* to *gender-based economic risk* ("They snatch their goods") and *crime* (robbing school children). This "assets gap," they note, also undermines climate projects, as people "dumping that garbage at night" in the dark areas.

The Community's Advocacy: A "Map of Solutions"

When prompted to state what they would do "if they had the means," both groups articulated a clear, infrastructure-based vision for the future, but with distinct, gendered priorities:

1) The Women's "Infrastructure-for-Safety" Model: The women's solution directly mirrors the risks they mapped. Their advocacy centres on capital investment for communal safety and health. They prioritized "security lights" to prevent crime, "perimeter walls" to protect children from falling into the polluted river, and formal "markets" to create safe, structured economic spaces.

2) The Men's "Livelihood-through-Infrastructure" Model: The men's solution was a sophisticated social-enterprise model. They advocated for the government to build foundational assets like public toilets, but with a critical addition: that the government give the youth groups the formal, paid responsibility for their long-term care. As one

participant stated, "If they do that and say, 'Ah, you youths... take care of that thing... The maintenance is yours.' ...he will never lack anything." .

In essence, both groups see large-scale capital investment in public works as the primary solution, but the women prioritize assets that enable safe community life, while the men prioritize assets that generate sustainable community livelihoods.

Analytical Summary

Table 14: Community Driven Climate Change Adaptations (CCA) in Mukuru

Innovation	Source	Description & Key Citations
Waste-to-Value (Formal)	Desk Review	*Black Soldier Fly (BSF) Units:* 12 youth-run units converting organic waste into animal feed (*A Circular Economy Model for Sustainable Waste Management in Mukuru - Akiba Mashinani Trust*, n.d.; *Turning Waste into Wealth through Climate Adaptation - Global Center on Adaptation*, n.d.; *Waste to Wealth with Black Soldier Flies*, n.d.).
Infrastructure (Formal)	Desk Review and Fieldwork (participatory mapping)	*Government funded infrastructure pilots:* Co-designed sewer (1.44km) and water (1.6km) pipe installation (Karamallis et al., 2022), See Figure 2 Mukuru participatory map).
Housing (Formal)	Desk Review	*Climate-Resilient Housing* (Global Center on Adaptation, 2022; Karamallis et al., 2022)
Waste-to-Value (Govt.)	Fieldwork (both interviews and mapping)	*'Climate WorX' Project:* A government-enabled community cleanup and river-cleaning project providing regular payment (Key Informant Youth Leader).
Waste-to-Value (Informal)	Fieldwork (both interviews and mapping)	*Waste Recycling:* Informal and CBO-led collection and sorting of plastics and paper for sale (Key Informant CCA Innovator).
Urban Farming	Fieldwork (both interviews and mapping)	*Animal Husbandry:* Rearing pigs and chicken, often using food waste from garbage collection (see participatory map Figure 2 above). Plant cultivation (vegetable gardens) on reclaimed riparian land (See Figure 4 above).

Peer-to-Peer Engagement	Fieldwork (both interviews and mapping)	*Sports Program:* A men's football club ("South B Finest") used to engage and mentor at-risk youth (Male FGD and Key Informant, Youth Leader).
Social Enterprise	Fieldwork (both interviews and mapping)	*Liquid Soap Manufacturing*: A business run by women displaced by demolitions (Key Informant CCA Innovator).
Indigenous Social Structures	Fieldwork (both interviews and mapping)	*Self-Help Chamas*: An informal savings group run by the men's football team to cover player injuries (Male FGD). *Mentorship CBOs:* Women's groups running formal mentorship for girls on hygiene and SRH (Key Informant, CCA Innovator). Notably, *local entrepreneurs facilitate skill acquisition and social support* through apprenticeships; for example, a salon owner employs teenage mothers displaced by demolitions.

Table 15: Mukuru Key Contextual Factors (CFIR) and Strategies (ERIC)

Framework	Domain	Key Findings from Qualitative Data
Context (CFIR)	C-Outer Setting	*Facilitator (Political):* SPA policy window created an "authorizing environment" while “Climate WorX” (Key Informant, Community Leader) formalized government-facilitated stakeholder engagement with communities. *Barrier (Political):* Perceived inequity in SPA rollout leading to fragmented upgrading creating a "divide" between areas that get benefits (e.g., Kwa Reuben) and those that do not. *Barrier (Relational):* "Research fatigue" from extractive partners and "perpetrator" (demolitions). *Barrier (Security):* Failed and corrupt security (e.g., "50-shilling" bribe).
	C-Inner Setting	*Barrier (Formal):* Resistance from landowners. Barrier (Formal): Bureaucratic delays. *Barrier (Economic):* Extreme poverty and high youth unemployment. *Barrier (Physical):* Lack of "enabling assets" (clean portable water, lights, toilets, walls). *Barrier (Social):* Erosion of family structures ("a family thing”), and trauma from demolitions.

	C-Individuals	*"Worldview":* Framing "climate" in terms of "health," "hygiene," and "hope". *Knowledge Gaps:* Eagerness to start new projects such as farming but lacking technical knowledge (FGD Participant, Marginalized population).
	C-Process	*Facilitator (Stakeholder Engagement):* Establishment of 8 thematic consortia to prevent fragmented solutions (Karamallis et al., 2022). Facilitator (Operational): Flexible, small-group structure ("Climate WorX") with admin-led conflict resolution.
Strategy (ERIC)	S-Financial	*Formal (Develop Resource Sharing Agreements)* (e.g., Muungano Alliance pooling GCA/AfDB funds) (Karamallis et al., 2022; Steinbach et al., 2022); *Informal (Direct Payment):* Regular, predictable payment from 'Climate WorX'. *Informal (Self-Funding):* Use of *chamas* (savings groups) to create safety nets. *Informal (Service Fees):* Fee-for-service waste collection (30 shillings/household/week)
	S-Stakeholder	*Informal (Peer Engagement):* Using sports and mentorship to engage youth/girls. *Informal (Peer learning):* Learning urban farming of chicken from peers. *Formal (Market Linkage):* Successful model of direct corporate pickup (Coca-Cola). *Informal (Market Linkage):* Unsuccessful model of selling to exploitative middlemen.
	S-Implementation	*Informal (Adapt work design):* Use of small, independent teams with flexible schedules to enable equitable participation for women and minorities.

The table below presents the core of our realist analysis, integrating the S/ICMOs from the desk review with new configurations identified from the fieldwork.

Table 16: C-S-M-O Causal Configurations Identified in Mukuru

Context (C)	Strategy (S)	Mechanism (M)	Outcome (O)	Source
Governance Opportunity (SPA designation) and government-community cooperation.	Data-Driven Advocacy by community federations	Legal Recognition → Legitimized Agency: Community shifted from "complainant" to "expert partner."	Mukuru Integrated Development Plan adopted; infrastructure installed	Desk Review and Fieldwork

Environmental & Economic Crisis (blocked drains, high unemployment)	Circular Economy Enterprise (BSF Units)	Economic Incentive: Reliable monthly income → sustained engagement.	Reduction in organic waste; sustained youth livelihoods.	Desk Review and Fieldwork
Extreme Youth Unemployment & competition from crime.	Provide Regular, Paid, Low-Barrier Work (e.g., 'Climate WorX'.	*Primacy of Payment (M1)*: Reliable pay is a viable competitor to crime. *Hope/Social Recognition (M2)*: Youth transform from "thieves" to "role models".	Youth "have stopped" stealing; the project is sustained; the environment is cleaner.	Fieldwork
Dominance of Exploitative Middlemen who pay too little for recyclables.	Create Direct, Formal Market Linkages (e.g., Coca-Cola model) .	*Perceived Fairness and Reliability*: Direct linkage ensures economic viability and trust.	Sustainable income; continued participation in recycling (vs. giving up).	Fieldwork
Systemic Failures (security, health, social gaps)	Form Indigenous Social Structures (chamas, CBOs, mentorship groups)	Social Cohesion and Mutual Support: Groups create their own safety nets	Emergency funds for injuries; health/hygiene knowledge shared; youth mentored.	Desk Review and Fieldwork
Perceived Inequity & Fragmented Upgrading (e.g., "Kwa Reuben has roads, we don't")	(Implementation Strategy): A-la-carte / Politicized Rollout of SPA benefits.	*Resentment, Mistrust, & Demotivation* among residents in neglected areas. A sense of "being left behind." that is described by participants to be the lived reality of young men.	Fragmented Social Cohesion (O1) (intra-settlement "divide"). Loss of community faith/buy-in (O2) in the formal SPA process.	Desk Review and Fieldwork

Gaps in "Enabling Assets" (lack of tools, safety, light).	(Implied Strategy): Provide small-scale capital investment in assets.	*Dignity & Safety*: Proper tools (gloves) and lights (safety) make the work dignified and possible	(Implied Outcome): Higher retention; safer community; 24-hour work is possible.	Fieldwork
Need for flexible, paid work for diverse groups (incl. women with time constraints and other marginalised groups), in a context of low social trust and potential for conflict.	Implement projects using small, independent groups with flexible scheduling, coordinated by trusted local administration and community leadership.	*Flexibility & Inclusion (M1):* Flexible scheduling accommodates women's time, enabling their participation. *Trusted, Inclusive CCA Leadership (M2):* Admin and community leadership oversight is seen as a fair, non-sectarian arbiter (as you said, "devoid of sectarianism"). This "good communication" and mentorship resolve conflicts before they grow, builds trust, and ensures inclusivity.	Equitable Reach (O1): Women and minorities can participate. High Project Success (O2): Project runs smoothly with minimal internal conflict. High Project Stability (O2): The project runs smoothly with high social cohesion and minimal internal conflict.	Fieldwork

Appendix D: Methodological Evolution and Justification

This appendix provides a clear explanation for the modifications made to the study's methodology and sampling, as required by the GDPC. These refinements were made to increase the study's scientific rigor and to ensure the highest ethical standards.

D.1: Methodological Refinement (From DIT to Implementation Science)

As communicated in our Mid-Term Progress Report, the methodological framework was refined to enhance analytical rigor.

- Initial Proposal: Combined Critical Realism (CR) with Diffusion of Innovation Theory (DIT).
- Revised Approach: Replaced DIT with Implementation Science (IS) frameworks (CFIR, ERIC, RE-AIM) integrated with Realist Evaluation (RRREIC).

Justification: This approach, as detailed in our Mid-Term Report, was specifically adapted for community-driven innovations, which are often catalyzed by context. It posits a generic causal pathway: a given Context (C) shapes the choice of Strategies (S) available to a community; these strategies, in turn, activate underlying generative Mechanisms (M) to produce Outcomes (O). This C-S-M-O framework is more rigorous than DIT as it moves beyond simply mapping *adoption* to *diagnosing how and why* adaptations succeed or fail in complex, resource-constrained contexts. The choice of CFIR, ERIC, RE-AIM implementation science frameworks was informed by the usefulness in similarly complex domains such as global health and qualitative research.

This methodological recalibration was essential to generate the transferable, practical insights required for the toolkit.

D.2: Ethical Refinements and Protocol Modifications

In response to thorough feedback from the MTRH/MU-ISERC (Protocol IREC-1291-2025), the protocol was further strengthened to ensure robust ethical safeguards.
Justification: These changes were made to ensure the protocol was ethically robust and practically feasible. Key actions taken included:

- Refining Sampling: The sampling strategy was refined to enhance ethical protection.
- Correcting Citations: The correct citation for the RRREIC framework was added.
- Correcting Consent Forms: The Informed Consent Form (ICF) was corrected to remove an erroneous reference to "health information."
- Correcting Terminology: The Kiswahili plural for "barazas" was corrected to "mabaraza."

These IRB-mandated changes represent a meticulous refinement of the study protocol, ensuring all procedures met the highest ethical standards.

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