IMPERIAL COLLEGE LONDON

Faculty of Natural Sciences

Centre for Environmental Policy

Rooted in inequality? An Environmental Justice assessment of Freetown's urban reforestation campaign

By

Maxwell A. Ryding

A report submitted in partial fulfilment of the requirements for the MSc and/or the DIC.

24th September 2025

“They use us to boost donor reports but don’t reward us properly. We’re the ones in the mud and the mangroves.”

DECLARATION OF OWN WORK

I declare that this thesis *Rooted in inequality? An Environmental Justice assessment of Freetown's urban reforestation campaign*

is entirely my own work and that where any material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgement given.

Signature: Maxwell Ryding

Name of student (Please print): Maxwell A. Ryding

Name of supervisor/s: Dr. Jessica Thorn and Dr. Elia Apostolopoulou

AUTHORISATION TO HOLD ELECTRONIC COPY OF MSc THESIS

Thesis title: *Rooted in inequality? An Environmental Justice assessment of Freetown's urban reforestation campaign*

Author: Maxwell A. Ryding

I hereby assign to Imperial College London, Centre of Environmental Policy the right to hold an electronic copy of the thesis identified above and any supplemental tables, illustrations, appendices or other information submitted therewith (the "thesis") in all forms and media, effective when and if the thesis is accepted by the College. This authorisation includes the right to adapt the presentation of the thesis abstract for use in conjunction with computer systems and programs, including reproduction or publication in machine-readable form and incorporation in electronic retrieval systems. Access to the thesis will be limited to ET MSc teaching staff and students and this can be extended to other College staff and students by permission of the ET MSc Course Directors/Examiners Board.

Signed: 

Name printed: Maxwell A. Ryding

Date: 24/09/2025

Abstract

Urban reforestation is increasingly promoted as a nature-based solution (NbS) for climate adaptation in African cities, yet its equity outcomes remain contested. This thesis presents the first justice-centred evaluation of FreetownTheTreetown (FTT), Sierra Leone's flagship reforestation campaign, examining how its benefits and burdens are distributed, how governance structures participation, and whose ecological knowledge is legitimised. Anchored in Urban Political Ecology and Fraser's three-dimensional justice framework, the study integrates spatial equity analysis, 102 stratified household surveys, 24 semi-structured interviews, participatory valuation of ecosystem services, and Power–Influence–Inclusion mapping of institutional arrangements.

Findings reveal systemic inequities. Spatial analysis revealed that planting followed feasibility and donor visibility rather than vulnerability, concentrating trees in uplands, while flood-prone settlements, such as Kolleh Town, remained underserved (Gini 0.52). Household and interview data demonstrate a burden–benefit paradox: poorer households, tenants, women, and youth contributed disproportionate labour but gained the least durable benefits. Cultural and livelihood species, including mango and tamarind, were consistently excluded in favour of donor-prioritised trees such as mangroves and teak, exemplifying epistemic misrecognition. Governance mapping confirmed vertical concentration of power among donors and municipal elites, while community actors were confined to brokerage or labour, with no grassroots group achieving parity in decision-making.

This research advances a diagnostic framework combining spatial, distributive, procedural, and recognitional dimensions of NbS justice. It argues that without vulnerability-weighted siting, recognition of local species preferences, and institutional reforms embedding marginalised voices in agenda-setting, NbS risk reproducing climate apartheid rather than fostering resilience. Beyond Freetown, the framework contributes transferable insights for designing justice-oriented NbS in rapidly urbanising African contexts.

Word count: 9,996 /10,000

Acknowledgements

This thesis has been produced with the financial assistance of the European Union (Grant no. DCI-PANAF/2020/420-028), through the African Research Initiative for Scientific Excellence (ARISE), pilot programme. ARISE is implemented by the African Academy of Sciences with support from the European Commission and the African Union Commission.

I would like to express my deepest gratitude to all those who supported this research.

First, I am profoundly grateful to my supervisor, Dr. Jessica Thorn, for her invaluable guidance, encouragement, and thoughtful feedback throughout this project. This project was facilitated under an interdisciplinary research programme titled “Future Landscape Optimisation for peri-Urban Resilience and Ecosystem Health in Africa” (FLOURISH). I also extend my sincere thanks to Dr. Elia Apostolopoulou, whose advice and support were instrumental in shaping both my methodology and analysis.

I am thankful to the Sierra Leone Urban Research Centre (SLURC), in particular Dr. Joseph Macarthy, Braima Koroma and Andrea Klingel, whose expertise, generosity, and logistical support were vital in shaping and delivering this research. I also appreciatively acknowledge the African Futures Natures Lab and my research assistant, Andrew Saffa, whose insight, collaboration and commitment were central throughout the fieldwork.

This study would not have been possible without the time, trust, and knowledge of the residents of Dwarzark, Tree Planting, Kolleh Town and other communities. I am deeply appreciative of their willingness to share experiences and insights.

I am also grateful to the staff of the Freetown City Council (FCC) and to members of community-based organisations, particularly FEDURP and CODASAPA, for their collaboration, openness, and commitment to supporting this research.

Finally, I would like to acknowledge the many unnamed individuals who assisted with introductions, translations, and fieldwork logistics, often going above and beyond to ensure that this project could succeed. To all of you — thank you.

Executive summary

Rooted in inequality? An environmental justice assessment of Freetown's urban reforestation campaign

Maxwell A. Ryding

Imperial College London, Centre for Environmental Policy

Academic year: 2024–2025

Supervisors: Dr. Jessica Thorn and Dr. Elia Apostolopoulou

Date: 24 September 2025

Objectives

This thesis examines the FreetownTheTreetown (FTT) campaign to assess whether its benefits and trade-offs are equitably distributed, governed, and experienced in informal settlements. It aims to:

- analyse how tree-planting aligns with population density, vulnerability, and access;
- explore how different social groups perceive and experience benefits and burdens;
- evaluate governance structures and decision-making processes; and
- assess the inclusion of local knowledge, values, and species preferences.

These objectives directly support the research question and provide a foundation for informing a more just and inclusive FTT Phase III.

Introduction

Urban reforestation is gaining traction across African cities as a low-cost strategy to address climate risks and socio-economic vulnerability. In Freetown, the FTT campaign — part of the Transform Freetown Agenda — aims to expand tree cover, improve health, and create green jobs. However, without community input, such initiatives risk deepening existing inequities.

This thesis approaches FTT as a political as well as ecological process. Using Environmental Justice and Urban Political Ecology frameworks, it assesses who benefits, who decides, and whose knowledge is recognised. By focusing on distributive, procedural, and recognitional justice, the study provides a timely analysis as the city prepares for FTT Phase III. — a critical opportunity for more inclusive, just, and context-sensitive implementation.

Methodology

To operationalise these justice-oriented objectives, the research adopted a mixed-methods design across three informal settlements with contrasting geographies and vulnerabilities: Dwarzark, Kolleh Town, and Tree Planting Community. The methodological approach combined spatial analysis, household surveys, qualitative interviews, and participatory fieldwork.

Spatially, the study mapped 2023 FTT tree locations using GIS, overlaying them with WorldPop density data and hazard risk layers to assess proximity-based access and distributional equity. Quantitatively, 102 household surveys were conducted using a purposive-stratified sampling strategy, capturing perceived benefits and burdens by tenure, gender, ethnicity, age, and income. Qualitatively, 24 semi-structured interviews with residents, local leaders, city officials, and NGO representatives were conducted, supported by five transect walks to contextualise ecological and infrastructural dynamics.

Institutionally, the research developed a Power–Influence–Inclusion (PII) matrix and a Social Network Analysis to map the governance architecture of FTT, identifying formal and informal actors and their relative roles in shaping outcomes. The methodology was designed to be inclusive and reflexive, drawing on participatory design principles and co-facilitation with local partners to mitigate power asymmetries and enhance validity.

Findings

Spatial analysis revealed stark inequalities in the geographic distribution of tree planting. Despite claims that the campaign targeted climate-vulnerable zones, trees were predominantly planted in upland areas with low population density and logistical ease, rather than in dense, hazard-prone informal settlements. A proximity-based Gini index of 0.52 confirmed the concentration of ecological benefits in relatively privileged areas. In Kolleh Town, for example, none of the surveyed households had tree access within a 300-metre radius.

FTT's governance structure was hierarchical and technocratic, with decision-making concentrated among donors, city officials, and programme managers. Community actors, including chiefs, community-based organisations, and youth groups, were involved mainly as labour providers and mobilisers rather than decision-makers. While participatory language was present in policy documents, interviews and network analysis revealed that local input rarely influenced site selection, species choice, or programme metrics.

Cultural and ecological knowledge held by residents, particularly women, elders, and ethnic minorities, was systematically undervalued. Preferred species such as mango, coconut, and tamarind — valued for their food, ritual, and shade functions — were largely excluded in favour of donor-favoured trees like neem and red mangrove. Residents' narratives indicated a deep sense of disempowerment, with some even

reporting the uprooting of trees seen as ecologically inappropriate or socially illegitimate.

The survey findings demonstrated that the groups most active in planting and maintenance — women, youth, poor households, and tenants — received the fewest long-term benefits. Meanwhile, landowners and wealthier residents captured more durable gains through property-based access and proximity to planted zones. This asymmetry reflects a structural injustice where labour and participation do not translate into voice or value.

Discussion, conclusions and implications

The findings suggest that FTT, despite its ecological intentions and participatory branding, falls short of delivering environmental justice. Distributively, planting was guided by feasibility rather than need. Procedurally, participation was instrumental rather than empowering. Recognitionally, local knowledge was treated as anecdotal rather than actionable. These patterns are not coincidental but embedded in the design logics of NbS that privilege visibility, measurability, and donor accountability over social legitimacy.

For municipal actors, this calls for reorienting planting strategies based on hazard overlays, vulnerability indices, and community priorities rather than terrain convenience. For donors, it necessitates expanding KPIs to include indicators of participation quality, cultural recognition, and benefit equity. For community groups, the study highlights the importance of building coalition-based advocacy to demand co-design and co-governance of greening efforts. More broadly, the case of FTT offers transferable insights for other rapidly urbanising African cities grappling with how to implement just, effective, and legitimate NbS.

Limitations

The study is limited to the 2023 planting cohort and does not assess long-term ecological outcomes such as tree survival, growth, or ecosystem service delivery. It also relies on 2015 census data, which may not fully capture contemporary urban dynamics. While reflexivity and local facilitation were integral to the research design, the positionality of the researcher as a foreign academic remains a potential source of bias.

Remaining gaps and future research

While this thesis provides the first systematic, justice-focused evaluation of the FTT campaign, it also reveals critical gaps that future research must address to deepen and extend its contributions. First, the findings are temporally bound to the 2023 planting cohort and therefore cannot assess how tree survival, maintenance, or ecological performance evolves over time. Longitudinal studies are needed to evaluate how

access to ecosystem services — such as shade, flood protection, and fruit — changes in both material and symbolic terms, and whether these benefits are equitably maintained across different social groups.

Second, while this research integrated resident perspectives through surveys, interviews, and participatory mapping, it did not fully quantify or monetise cultural ecosystem services, nor did it model trade-offs between donor-mandated metrics (e.g., carbon, erosion control) and community-valued functions (e.g., ritual species, shade trees). There is thus a need for justice-aware valuation frameworks that centre co-produced knowledge and recognise plural ecological rationalities, particularly those embedded in informal settlements.

Third, although acts of contestation and local discontent emerged during interviews — such as resistance to non-preferred species and strategic tree uprooting — these dynamics remain underexplored. Future studies should systematically document community-led greening alternatives and resistance practices as not merely reactive but generative: as sources of political imagination and design inspiration for bottom-up, culturally legitimate NbS.

Lastly, while this thesis focused on intra-urban inequalities across settlements and social groups, future research could expand horizontally to include inter-urban comparisons across African cities implementing similar NbS frameworks. Doing so would enable the development of transferable justice indicators and governance typologies that move beyond technocratic delivery to embed inclusive, place-based resilience strategies at scale.

Together, these directions can build on this thesis's contribution to recasting urban reforestation from a technocratic solution to a socially negotiated, culturally embedded, and politically accountable form of environmental governance.

This thesis provides a comprehensive and multi-dimensional assessment of environmental justice in Freetown’s reforestation campaign. It shows that greening is not neutral and that the success of urban NbS depends not just on how many trees are planted, but on how fairly, inclusively, and meaningfully they are integrated into the lived fabric of urban life.

Table of Contents

List of figures and tables

List of abbreviations

CBO – Community-Based Organisation

CBDRM – Community-Based Disaster Risk Management

CICES – Common International Classification of Ecosystem Services

CODASAPA – Centre of Dialogue on Human Settlement and Poverty Alleviation

ES – Ecosystem Services

FCC – Freetown City Council

FEDURP – Federation of the Urban and Rural Poor

FTT – FreetownTheTreetown

KPI – Key Performance Indicator

NbS – Nature-based Solutions

RUSLP – Resilient Urban Sierra Leone Project

SLURC – Sierra Leone Urban Research Centre

SNA – Social Network Analysis

SSA – Sub-Saharan Africa

UNDP – United Nations Development Programme

UNDRR – United Nations Office for Disaster Risk Reduction

1. Introduction

1.1 Background

Urban reforestation is advocated as a nature-based solution (NbS) for African climate adaptation, promising shade, flood mitigation, and livelihoods (Dupar et al., 2023). Yet when siting, participation, and valuation are not grounded in local social-ecological systems, greening can reproduce uneven exposure and access (Anguelovski & Corbera, 2022; Shackleton, 2023). In Freetown, rapid urbanisation, high informality, and overlapping hazards concentrate risk in low-income lowlands, where tree shortages worsen heat and flood exposure (World Bank, 2018; FCC, 2024; UNDP, 2025; Lian et al., 2025). Meanwhile, transnational NbS programmes often import managerial key performance indicators that constrain participation and priorities.

Grounded in urban political ecology and environmental justice, this thesis treats reforestation as a power-laden socio-ecological process and answers calls for equity-sensitive diagnostics that move beyond planting totals to who benefits, who decides, and whose knowledge is recognised (Calderón-Argelich et al., 2021; Kato-Huerta & Geneletti, 2022). Within this context, FTT — the flagship programme under the Transform Freetown Agenda (Pillars 3: Healthy City; 4: Resilient Urban Planning) — pairs municipal delivery and community mobilisation with digital verification via TreeTracker (FCC, 2024). Phase II consolidated scale under planting/survival KPIs, but, as the literature cautions, such logics can privilege technically feasible sites and easily measured outputs over vulnerability, participation, and recognition (Rochell et al., 2024a; Sekulova et al., 2021).

As Freetown prepares Phase III, there is an opportunity to align reforestation with distributive, procedural, and recognitional justice. This thesis provides the equity-centred evidence base for that shift by delivering the first systematic, justice-centred assessment to inform Phase III and wider African NbS debates.

1.2 Aims and research question

This thesis evaluates how the FTT campaign affects distributional, procedural, and recognitional justice in three informal settlements, with the explicit aim of informing FTT Phase III design and delivery under the Transform Freetown Agenda (Pillars 3 and 4).

Research question: *How are FTT's benefits and trade-offs distributed, governed, and experienced in these settlements, and what does this reveal about distributive, procedural, and recognitional justice?*

1.3 Objectives:

1. Analyse FTT's spatial distribution relative to access, environmental vulnerability and population density.

2. Examine how residents across tenure, gender, ethnicity, income, and age perceive and experience benefits/burdens.

3. Investigate governance and decision-making to understand how power, participation, and institutional roles shape procedural equity.

4. Explore how marginalised groups' knowledge and cultural values are acknowledged or excluded in practice.

1.4 Scope and structure

The study is tightly delimited to: (i) three informal settlements with contrasting hazard exposure and socio-economic/demographic profiles; (ii) the 2023 planting cohort and contemporaneous governance records; and (iii) justice outcomes — who benefits/decides/is recognised. Biophysical growth, survival, and formal cost–benefit analysis are excluded due to timeframe and data limits. Chapters 2–6 cover literature, methods, results, discussion, and conclusion with policy implications for FTT Phase III and the thesis's contributions to African NbS scholarship.

2. Literature review

2.1 Introduction

Urban greening is increasingly promoted in Global South cities as a response to climate risks, environmental degradation, and socio-economic precarity (Shackleton, 2023; UNDRR, 2024). FTT, launched in 2019, is a local government-led restoration scheme that aims to restore canopy cover, mitigate climate hazards, and generate green jobs, with future expansion tied to carbon-offset financing (FCC, 2023; Bechauf et al., 2025; UNDP, 2025). Despite such aims aligning with much NbS discourse, Urban Political Ecology warns that in postcolonial contexts characterised by land dispossession, informal tenure, and fragmented governance, technocratic NbS — expert-driven, metric-based interventions — can entrench inequalities (Trisos et al., 2021; Bauer, 2022). Freetown is a particularly instructive case as the city's rapid population growth has led to the development of extensive informal settlements on steep hillsides and coastal floodplains, which are among the most vulnerable to hazards — yet the least served by infrastructure (Frediani, 2022).

To interrogate these dynamics, this review adopts an environmental justice perspective, defined as "*the equitable distribution of environmental benefits and burdens, meaningful participation in governance, and recognition of diverse cultural and ecological values*" (Pellow, 2025: p.6). This framework shifts attention beyond technocratic metrics (e.g. carbon sequestration, tree survival) to consider how distributive, procedural, and recognitional dimensions shape who benefits from urban greening and who remains excluded. Although African research documents inequities in canopy cover (Barrass, 2024), shallow participation (Opoku et al., 2024), and the marginalisation of local knowledge (Ramcilovic-Suominen et al., 2024), few documented studies apply Fraser's model systematically to post-conflict African cities. The following sections therefore synthesise these debates, identify key knowledge gaps, and situate FTT within broader questions of justice, access, governance, and recognition.

2.2 Technocratic metrics and distributive gaps

Distributive justice addresses how environmental benefits and burdens are shared across populations, and yet most NbS evaluation frameworks prioritise technocratic metrics such as carbon sequestration, survival rates, or numbers of jobs created (Bauer, 2022). These measures, while presented as neutral, direct resources to sites with secure tenure and high survival potential, sidelining precarious settlements (Buijs et al., 2024). The result in African cities is an uneven distribution of green infrastructure, with shade, cooling, and flood regulation concentrated in wealthier, tenure-stable districts (Marsters et al., 2025). Sultana (2022: p3) terms this *climate apartheid* — where those most exposed to hazards often benefit least. Access is critical here. Canopy presence does not necessarily equate to canopy access, as steep terrain, unsafe pathways, or exclusionary governance can limit usability. Global North studies show that low-income and minority communities face both canopy deficits and barriers to safe access (Nesbitt et al., 2019).

African evidence is emerging. Durban's vulnerability-weighted planting explicitly targeted informal flood-prone settlements, redistributing benefits to those most exposed (Douwes, 2022). By contrast, in Freetown, informal settlements — home to about 60% of residents — received just 35% of FTT's trees (Bechauf et al., 2025), suggesting a preference for highly visible sites that deliver quick results for donors but fail to expand equitable access (Hickey, 2022). Recent continent-wide research reinforces these concerns. A study mapping 53 million trees in 54 Sub-Saharan African (SSA) cities revealed systematic canopy shortages in informal areas, addressing what it described as a *knowledge vacuum* in urban forestry (Lian et al., 2025). The study underscored how planting strategies rarely align with patterns of vulnerability, population density, or equitable access to ES. While inequities in canopy cover and access are well-established in Global North research, few African studies assess how planting strategies align with vulnerability, population distribution, and access — limiting the understanding of whether NbS redistribute resilience or reinforce exclusion. Global comparative studies In Latin America show similar dynamics, where climate adaptation projects systematically bypass informal settlements due to tenure insecurity and high monitoring costs (Fernandez-Bou et al., 2021); with these parallels

highlighting how distributive inequities in African cities are embedded in wider structural patterns of NbS evaluation.

2.3 Procedural justice

Distributive justice is inseparable from procedural justice, which requires redistributing governance authority rather than simply offering participation (Fraser, 2005). Yet, NbS projects in African cities often exhibit *tokenism* — where elites control agendas and marginalised groups provide labour (Anguelovski & Corbera, 2022; Pellow, 2025). FTT illustrates this problem: monitoring technologies such as GreenStand's TreeTracker and short-term planting contracts meet donor reporting needs - casting residents as implementers rather than decision-makers (Rochell et al., 2024a; FCC, 2024). Similar patterns are evident in Kumasi, where communities were consulted yet reported little say in species selection or planting design (Opoku et al., 2024). Such limitations are widespread. Studies show that Sub-Saharan reforestation projects frequently rely on technical blueprints, neglect prior, and informed consent, and rarely embed equitable benefit-sharing (Peroches et al., 2025). This reflects what Sultana (2022) calls *instrumental inclusion* — where participation legitimises pre-determined plans. Critical scholarship argues that these practices reflect deeper institutional incentives, as municipalities and NGOs often frame participation to secure donor legitimacy rather than to redistribute authority (Calderón-Argelich et al., 2021). This suggests that procedural justice is measured not by participation alone but by the degree of deliberative power communities hold. In this regard, Lambert and Hofmann (2021) suggest that co-produced forest governance in peri-urban Freetown could redistribute authority and improve ecological outcomes, illustrating alternative pathways. Systematic reviews confirm the gap as Pasgaard et al. (2025) found that urban greening research in South Africa rarely interrogates power redistribution, with participation often reported descriptively rather than analysed as governance transformation. Although critiques of *tokenism* are widespread, there is limited empirical evidence on how procedural justice can redistribute genuine decision-making authority — over budgets, planting sites, or species — in African urban forestry. This restricts understanding of whether NbS governance can alter entrenched power asymmetries.

2.4 Recognitional justice

Recognitional justice — the extent to which governance acknowledges and values diverse knowledge systems, cultural relationships to nature, and locally embedded priorities — is the least developed environmental justice dimension in FTT's evaluations (FCC, 2024; Grant et al., 2024). As Anguelovski and Corbera (2022) suggest, most NbS literature continues to be anthropocentric with little cross-pollination of ecological justice perspectives, such as the establishment of relational cultural values and non-market ecological services, with existing frameworks emphasising carbon accounting and formalisation of tenure over informal ecological practices central to local risk avoidance (Ramcilovic-Suominen et al., 2024). Piroli (2025: p32) frames this as an instance of *epistemic injustice*, whereby the lived experiences of those exposed to environmental risk are systematically undervalued or excluded.

Nonetheless, recognition can enhance justice and ecological performance when prioritised; for example, in Tanzania's mangrove restoration, traditional tenure systems were incorporated into governance, which reduced conflict, increased cooperation, and improved ecological benefits (Nyangoko et al., 2022). In contrast, many valuation systems remain calibrated for global markets, prioritising standardised over relational knowledge (Grant et al., 2024). Yet evidence from East Africa shows that co-designing NbS with informal settlement residents improved trust and long-term stewardship by embedding local perspectives in governance (Diep et al., 2022) — these insights indicate that recognition is not merely symbolic but can materially shape outcomes, as projects acknowledging cultural and livelihood values are more likely to achieve sustained ecological benefits (Kamjou et al., 2024). Yet epistemic injustice in valuation frameworks, reinforced by donor demands for standardised indicators, means recognition remains the most neglected justice dimension in African urban forestry (Pasgaard et al., 2025)

2.5 Conclusion

The literature demonstrates that while NbS are promoted as multifunctional solutions, evaluations in African cities often neglect the dimensions of justice (Pasgaard et al., 2025). Distributive gaps persist where planting strategies fail to align with vulnerability, access, or population needs (Lian et al., 2025). Procedural shortcomings are evident in

participation frameworks that engage communities as labour rather than as decision-makers (Anguelovski & Corbera, 2022). While recognitional justice is even less developed, as valuation systems continue to privilege global metrics over locally embedded priorities and culturally significant species (Ramcilovic-Suominen et al., 2024). These gaps are particularly acute in post-conflict, rapidly urbanising contexts such as Freetown, where informal settlements bear the greatest risks yet remain marginal in planning (Lambert & Hofmann, 2021). Promising examples — including vulnerability-weighted planting, co-produced governance, and relational valuation — demonstrate that more equitable approaches are possible, but their systematic integration remains underexplored. Future scholarship should move towards integrated frameworks that combine vulnerability-weighted planting, deliberative governance, and culturally embedded valuation to redress structural inequities and strengthen long-term stewardship — with these gaps directly informing this thesis's objective to evaluate environmental justice in Freetown's urban reforestation campaign.

3. Methods

3.1 Mixed-methods approach

This study operationalised a mixed-methods approach combining qualitative and quantitative methods to capture the complexity of justice in Freetown's NbS (Das, 2021). Qualitative tools surface lived experience, while quantitative methods expose measurable disparities — yet each has limits (Davis & Ramírez-Andreotta, 2021). Integrating operationalised distributive, procedural, and recognitional justice ensures that evaluation moves beyond isolated indicators to a holistic account of equity in NbS governance (Mertens, 2023).

3.2 Site justification

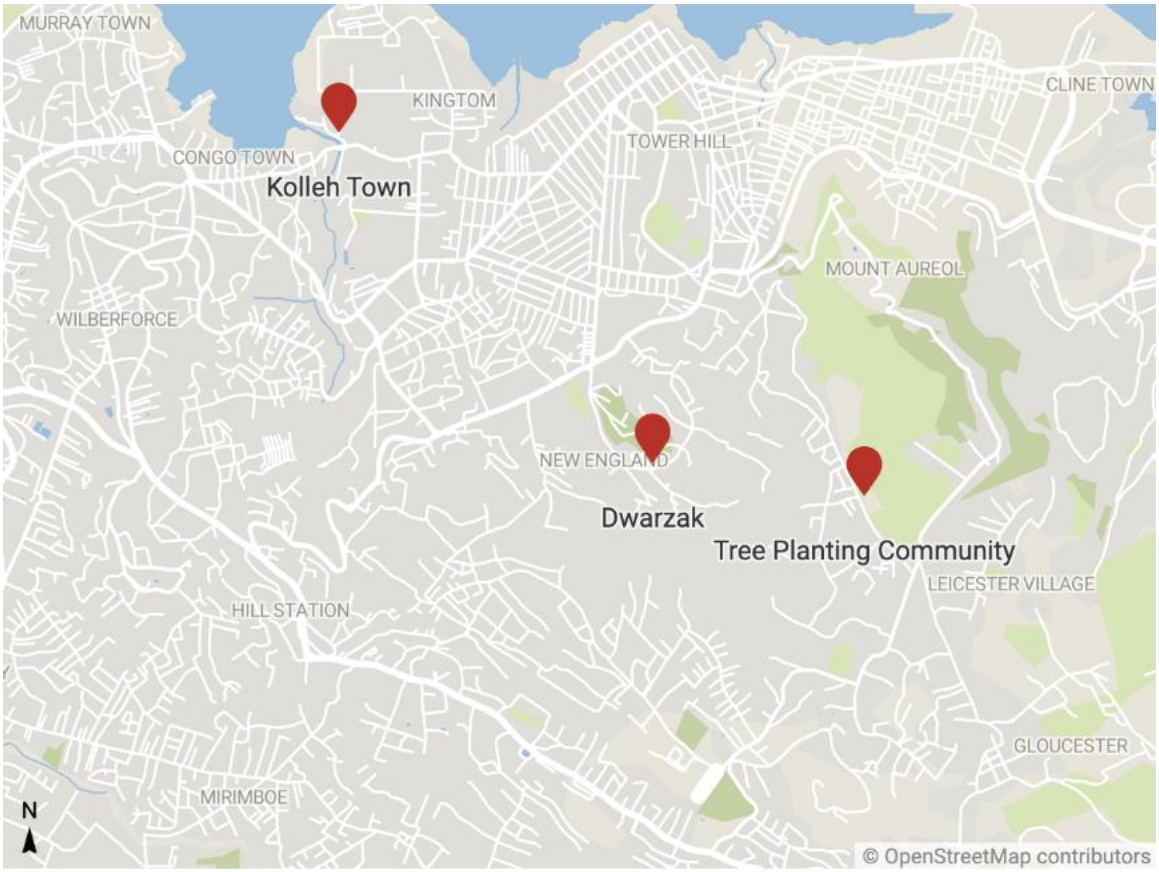


Figure 1 *Geographic scope of the three surveyed settlements in Freetown, Sierra Leone, highlighting case-study sites across coastal, hillside, and floodplain zones (1:10,000).*

Freetown, Sierra Leone — a post-conflict city of 1.35 million where 60% of residents live

in informal settlements lacking secure tenure, services, or adequate housing (Dodman et al., 2018; Barrass, 2024; Pellow, 2025). These areas exemplify informality, neglect, and socio-ecological risk across SSA, presenting a critical site to examine how NbS shape environmental justice (Thorn et al., 2021; Marsters et al., 2025). The city's FTT campaign planted 1.2 million trees with an 80% survival rate, framed as an equity intervention — but its justice outcomes remain unexamined (FCC, 2024; Bechauf et al., 2025). This study addresses that gap via a multi-scalar, justice-focused evaluation across three settlements — Dwarzak, Kolleh Town, and Tree Planting Community (figure 1) — selected for their hazard exposure, vulnerability, and FTT engagement (World Bank, 2018; Lambert & Hofmann, 2021; Macarthy et al., 2024b); offering insights into NbS implementation in post-conflict Africa, where justice outcomes are underexamined (Rochell et al., 2024b).

3.3 Site access

We implemented a justice-oriented site access strategy grounded in environmental methods literature (Davis & Ramírez-Andreotta, 2021). As part of the Imperial–SLURC Learning Alliance, the research team co-designed the project via online workshops through the African Natures Futures Lab. This participatory design ensured relevance and alignment with NbS research. An in-person strategy meeting in Freetown with SLURC, FEDURP, and CODASAPA embedded procedural justice by integrating local input into site selection and tool design (Das, 2021; Kato-Huerta & Geneletti, 2022).

We secured access through meetings with community chiefs supported by SLURC and local facilitators who helped interpret socio-cultural dynamics and navigate ethical concerns. Responding to partner feedback, we coordinated schedules, aligned interview logistics, and identified key stakeholders collaboratively. While not fully co-designed, this approach prioritised procedural inclusion, ethical practice, and sensitivity to local power dynamics (Mertens, 2023).

3.4 Data collection

Data collection adopted a justice-aware, multi-method strategy, meaning that methods were structured to capture distributive, procedural, and recognitional dimensions of equity. We ran 102 household surveys across three informal settlements, stratifying

participants by tenure, gender, ethnicity, and income. We also carried out 24 semi-structured interviews and five transect walks, recording observations in a field diary. Using ARCGIS, we mapped Freetown City Council's (FCC) 2023 TreeTracker data alongside 2015 census and WorldPop (2025) population heat maps. These methods allowed us to capture spatial patterns, resident experiences, and informal governance processes, enabling robust evaluation of environmental justice outcomes. Appendix A details the ethics and risk protocols supporting this justice-aware fieldwork.

3.5 Transect walks

To contextualise our data, we conducted five transect walks across varying sites (Pearsall, et al., 2024), which were co-led by local facilitators, who supported contextual interpretation as needed. Participants primarily spoke English, though Krio was occasionally used in resident interactions. The walks ranged between four and five hours, and we followed predefined routes, documenting land-use, infrastructure, vegetation, and environmental stressors, enabling us to connect ground-level observations to broader patterns of environmental inequality.

After initial walks, we excluded Portee to prioritise depth over breadth and added Kolleh Town, where mangrove planting and gendered participation in FTT offered important insights into questions of justice. This adaptive approach, grounded in hazard mapping and lived experience, enhanced validity and addressed critiques of technocratic bias in urban environmental justice research (Davis & Ramírez-Andreotta, 2021; Terdoo, 2024; Eakin et al., 2025).

3.6 Sampling

We employed a purposive-stratified sampling strategy to ensure inclusive and representative household survey coverage, grouping participants by tenure, gender, ethnicity, income, and age - key determinants of ecosystem service (ES) access (Haque & Sharifi, 2024). Respondents were randomly selected within strata to reduce bias (Yang & Tang, 2025).

For interviews, we adopted snowball sampling (Hussainzad & Gou, 2024), beginning with gatekeepers such as chiefs, CBO leads, and FCC staff. We then recruited

underrepresented voices — youth, renters, and women — with local facilitator support, addressing visibility gaps and reinforcing procedural and recognitional justice (Grant et al., 2024; Davis & Ramírez-Andreotta, 2021). We regularly reflected on representation during field debriefs, using these to recognise sampling limitations and reduce extractive dynamics (Fernandez-Bou et al., 2021).

3.7 Household surveys for distributive and recognitional justice

To address Objective 2 and 4, we surveyed 102 households across three informal settlements to assess how different social groups perceived the benefits (CIECS 5.2) — fruit, shade, and flood mitigation — and burdens — exclusion or land-use conflict. The survey also captured recognitional justice by reporting cultural values, tree species preferences, and ES access across diverse households (Grant et al., 2024).

We piloted the instrument with eight residents and refined it based on feedback from two FEDURP practitioners to ensure cultural and practical relevance. This process followed participatory design principles (Davis & Ramírez-Andreotta, 2021), enabling the tool to reflect both academic frameworks and locally embedded understandings of ES.

Final revisions included simplifying phrasing, reducing species-ranking tasks to lower cognitive load, and removing low-yield questions (Stantcheva, 2022; Shrestha et al., 2022). The final instrument (Appendix B) was co-facilitated by the researcher using Qualtrics alongside a local research assistant to mitigate power asymmetries and improve respondent comfort (Sibbald et al., 2025). Throughout surveying, we highlighted sampling reflections and response dynamics to surface potential positionality effects.

3.8 Semi-structured interviews for procedural and recognitional justice

We conducted 24 semi-structured interviews lasting between 30 and 60 minutes with a diverse range of respondents — including FCC officials, NGO staff, community leaders, youth, women, and informal residents (Appendix D). These interviews supported Objectives 3 and 4, which examine governance structures and recognitional justice, by capturing lived experiences of power, participation, and cultural values within FTT.

Using role-specific, justice-framed interview guides (Appendix E), we engaged both formal decision-makers and underrepresented voices, ensuring that marginalised actors excluded from official planning processes were heard (Terdoo, 2024). These accounts of participation and cultural attachment to urban trees align with environmental justice frameworks that highlight the importance of procedural equity and recognition (Pellerey et al., 2024; Pellow, 2025).

3.9 Analysis

We operationalised objective 1 through spatial analysis by mapping tree locations against population density using ARCGIS. We layered FCC's 2023 TreeTracker shapefile with a 2025 WorldPop population heat map and geolocated household survey points; calculating two equity metrics: proximity buffers (in metres) from each surveyed household to the nearest tree to measure immediate access, and Gini coefficients from tree-to-population ratios using the 2015 census and 2019 FCC ward boundaries (Appendix C), capturing spatial inequality (Statistics Sierra Leone, 2015; Wu et al. 2025).

To compliment this, we analysed survey responses in Python, visualising results with per capita graphs to offset sampling imbalances and highlight how different social groups perceived and accessed benefits and burdens (Objective 2, 4). This dual approach assessed household-level access and facilitated broader justice mapping across wards - linking tree distribution with access and population density, as called for in environmental justice literature (James & Conway, 2025). We validated these outputs against field-transect observations and surveyed perceptions of access, responding to environmental justice critiques urging the integration of lived experience into geospatial models (Langhans et al., 2023).

To address Objective 3, we developed a Power–Influence–Inclusion (PII) matrix (Gordon, 2024), scoring actors on formal authority, informal influence, and participation using a five-point scale. We triangulated these scores with organisational charts (Appendix F), field observations, and community narratives to reveal overlaps between formal governance and informal power. To show how these dynamics shape decision-making in the FTT campaign, we adapted a social network analysis (SNA) aligned with Objectives 3 and 4. Using PII scores to represent formal and informal power, we

mapped actor relationships and participation gaps, linking power structures to justice outcomes (York & Yazar, 2022).

3.10 Limitations

This mixed-methods design balanced depth and breadth but encountered key justice challenges. The survey provided detailed distributive and recognitional insights, though some groups remained underrepresented (Langhans et al., 2023). We mitigated this by normalising responses per capita and aligning with 2015 census data. Spatial analysis gave a static equity snapshot, overlooking dynamic processes like tree mortality (Segarra et al., 2024); we addressed this by using land-use data from the *Freetown City Hazard and Risk Report* (2018) and recent planting updates from FCC's 2024 FTT campaign documentation. Interviews risked amplifying dominant voices, so we foregrounded marginal actors in the PII matrix and noted gaps in representation during analysis (York & Yazar, 2022).

3.11 Researcher positionality and reflexivity

I actively engaged with my positionality as a Western researcher working in post-conflict informal settlements. Aware of the power asymmetries, I, as a foreign academic, co-facilitated all interactions with a local assistant whose proximity helped mitigate gendered and racialised dynamics, and our daily debriefings improved contextual understanding (Sibbald et al., 2025). To counter Eurocentric bias in environmental justice, I centred resident narratives and locally grounded socio-environmental values, cross-validating emergent themes with over 30 community stakeholders during fieldwork and a feedback meeting. This approach reduced epistemic dominance and ensured that marginalised knowledge informed the findings (Langhans et al., 2023).

4. Results

4.1 Spatialising tree-planting in relation to access, vulnerability and population density in Freetown

4.1.1 Dwarzak

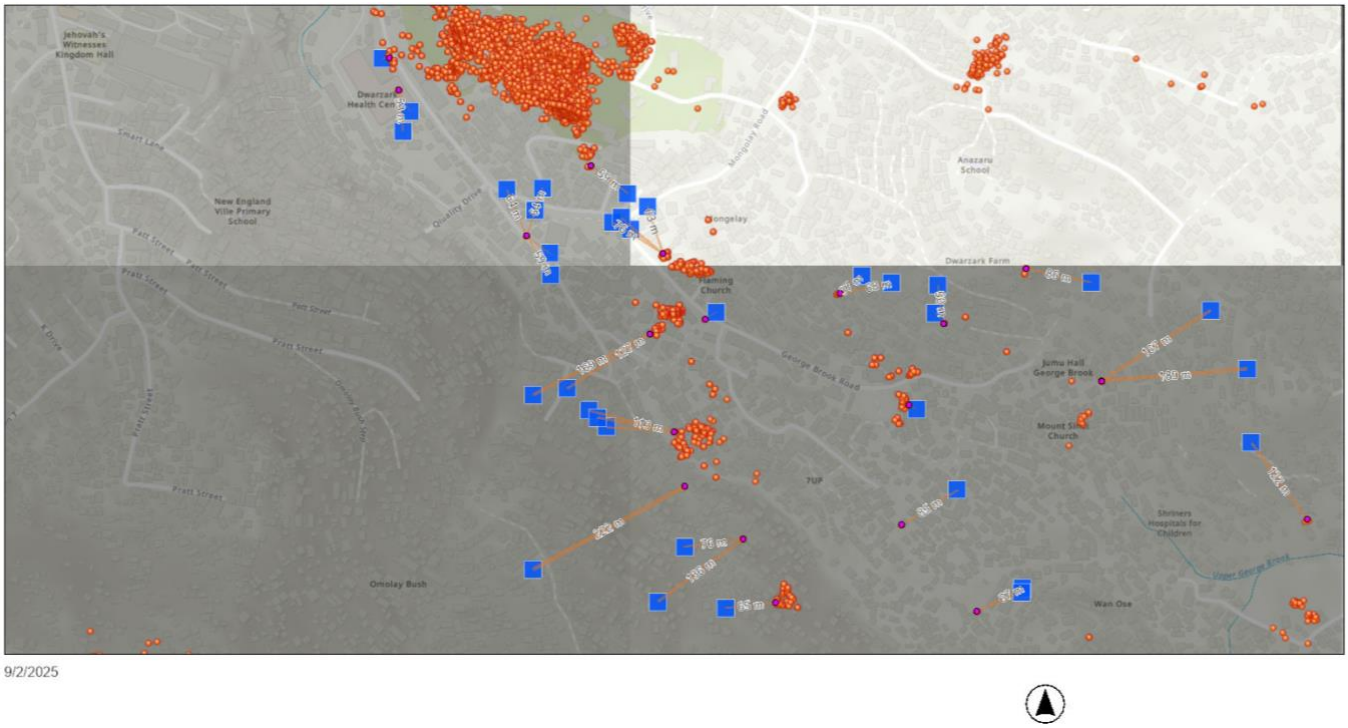


Figure 2. *Dwarzark tree planting distribution and household survey locations - household survey points (blue) and 2023 tree planting sites (orange) over 2025 WorldPop density estimates (black-to-white gradient)* - (1:20,000).

Most of the tree planting in Dwarzark was executed along the northern ridgeline, identified as a landslide high-risk area (World Bank, 2018). Despite aligning with hazard mitigation, it neglected population vulnerability since the southern and central sections — home to high-density informal residents — received minimal investment. As shown in Figure 2, greyscale overlays reveal a sharp spatial misalignment as the darkest shaded zones, indicating the highest population density, fall outside the planted areas. Household survey clusters reinforce this, with most residents far from interventions.

This spatial distribution constitutes an apparent distributive injustice as tree provisioning avoided the very communities most in need of microclimate regulation, erosion control, and runoff absorption. Furthermore, planting along the ridgeline

created a physical barrier, with few ecological corridors facilitating downslope benefit. Although terrain risk was partially addressed, the lack of access pathways or buffers reveals limited systems thinking. This exclusion is spatial and procedural, reflecting a technocratic model prioritising feasibility over lived exposure (Ramcilovic-Suominen et al., 2024).

4.1.2 Kolleh Town

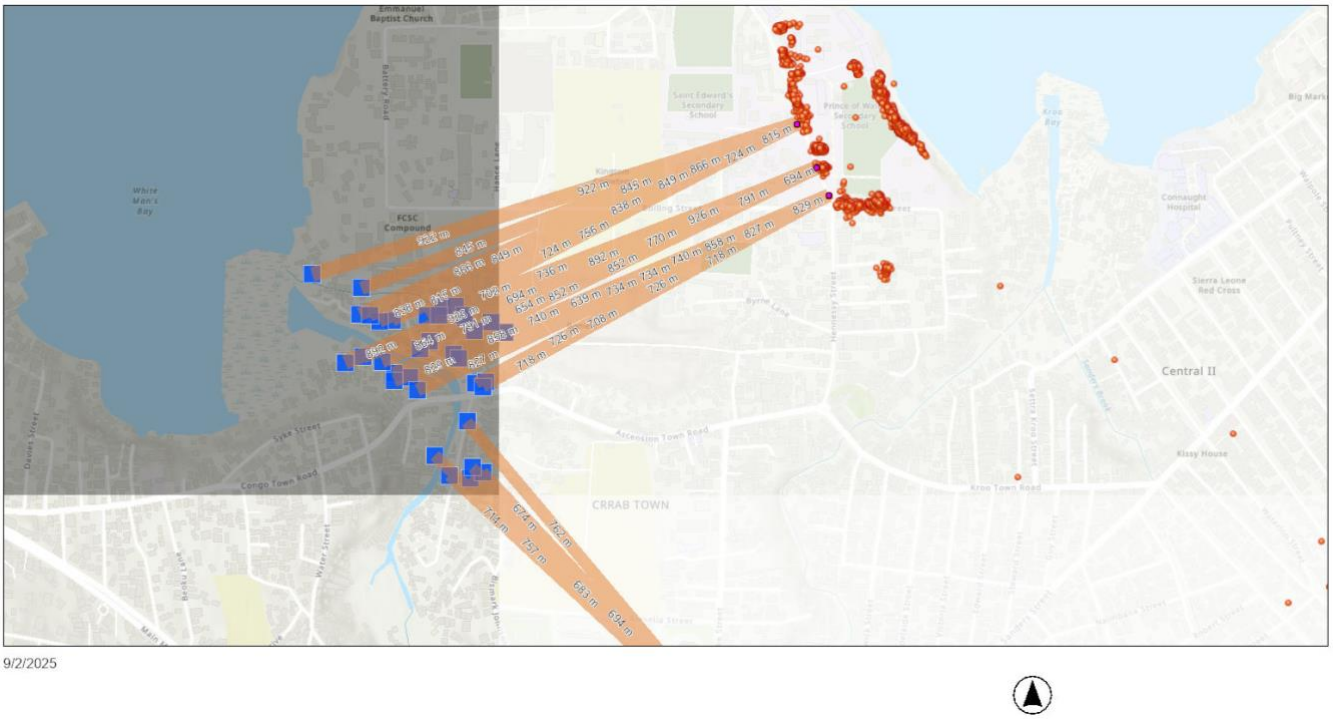


Figure 3. *Kolleh Town tree planting distribution and household survey locations (1:10,000)*

Despite its classification as a high-risk zone for flooding (World Bank, 2018), Kolleh Town received no terrestrial tree planting in 2023. The ward's dense inland core, home to some of the city's most vulnerable clusters, remained unserved, with limited planting occurring along an opposing coastal strip offering minimal access to ES benefits. Figure 3 shows dense shading across the ward, yet no overlap with planted areas. The scale of inaccessibility further highlights this disconnect as most households fall within a continuous 500-metre inland band with no mapped planting sites within 300 metres - exceeding international benchmarks for equitable green access (Owen et al., 2024). This translates into near-total exclusion from any ecological benefit associated with tree coverage.

The justification that Kolleh Town was "*unsuitable for terrestrial planting*" (P23) overlooked available open spaces and verges that could have supported greening. Although mangrove planting began in later project phases (P23), it remains spatially disconnected from terrestrial needs. Compared with Dwarzark, where the slope edge was planted, Kolleh Town remained excluded, with the map illustrating spatial exclusion, since no ecological infrastructure was attempted in one of the most vulnerable and densely populated parts of the city.

4.1.3 Tree Planting Community

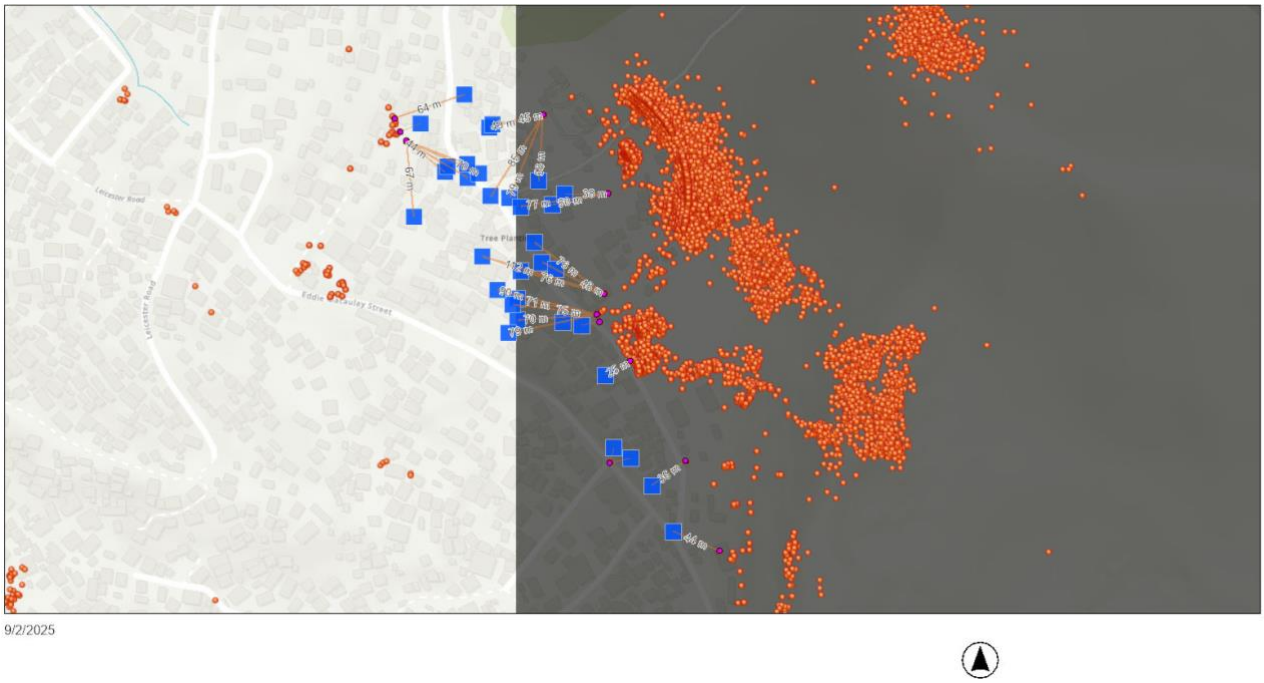


Figure 4. *Tree Planting Community tree planting distribution and household survey locations (1:20,000)*

Tree Planting Community received the highest volume of trees, yet spatial analysis reveals a sharp disconnect between provision and access. As shown in Figure 4, planting is densely concentrated along the eastern upland ridge — an area with low residential density but logistically convenient. Meanwhile, the ward's residential core, visible in darker greyscale tones, lies downslope and receives little to no canopy cover. Mapped distance annotations demonstrate that while some planted areas are within 30–90 metres of nearby structures, these are mostly aligned with infrastructural corridors rather than dense residential clusters. As such, most households remain outside green service buffers. This reflects a pattern Langhans et al. (2023) identify as typical of NbS misalignment: feasibility is prioritised over equitable access.

Bauer's (2022: p1) *green optics* fallacy is evident — the ward appears statistically well-provisioned yet planting bypasses the densest and most exposed populations. Without population-weighted buffers, siting logic reinforces vertical and spatial exclusion. The map makes this inequity explicit: clustered trees in uninhabited terrain contrast starkly with unmet need in settlement cores, revealing a distribution model more aligned with ease than justice.

4.1.4 Proximity-based gini analysis of urban tree access in Freetown

Table 1. *Equity analysis of 2023 tree planting by ward, using 2015 population data. Tree counts per 1,000 residents and person-weighted Gini index (0 = equal, 1 = unequal) reveal spatial concentration of planting, highlighting distributive injustice in high-need areas (Appendix G).*

Ward	Ward No.	Population (2015)	Tree count (inside ward polygon)	Trees per 1,000 residents
Dwarzak	434	20,985	**10,134**	**482.916**
Kolleh Town	438	15,918	**0**	**0.000**
Tree Planting Community	429	14,452	**25,093**	**1,736.299**
Person-weighted Gini				**0.520**

The person-weighted Gini coefficient of 0.52 confirms inequality in tree planting distribution, as James and Conway (2025) assert; metrics expose inequities masked by aggregates, evident in spatial patterns. Kolleh Town (Figure 3) received no trees, with most households over 700 metres from any planting. In Tree Planting Community (Figure 4), significant planting occurred, but was confined to upland ridges, leaving dense residential areas downslope unserved. Dwarzark (Figure 2) shows partial slope planting, yet major clusters remain well-above 150–220 metres.

The Gini score reflects a misalignment in investments, which favoured feasibility over vulnerability, and despite what appears as successful provisioning, it is, in practice, spatially exclusionary, which indicates an overreliance on aggregate targets that obscure functional exclusion; showing how technocratic delivery, absent equity

metrics, can reproduce the very injustices FTT seeks to redress (Sekulova et al., 2021; Anguelovski & Corbera, 2022).

4.2 Experiences of benefit and burden across social groups

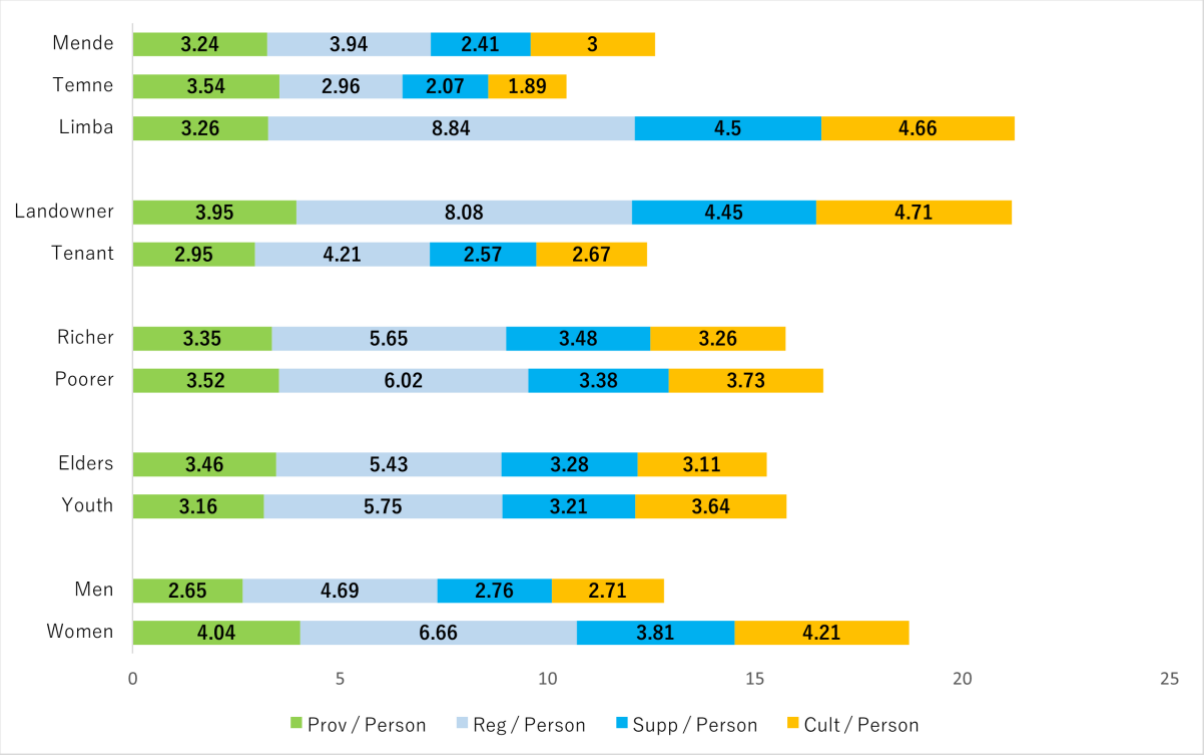


Figure 5. *Per-person ecosystem service benefits in Freetown's reforestation. Landowners, women, and Limba households gain more regulating and cultural services; tenants and men gain fewer, revealing tenure- and gender-based inequities (Kato-Huerta & Geneletti, 2022).*

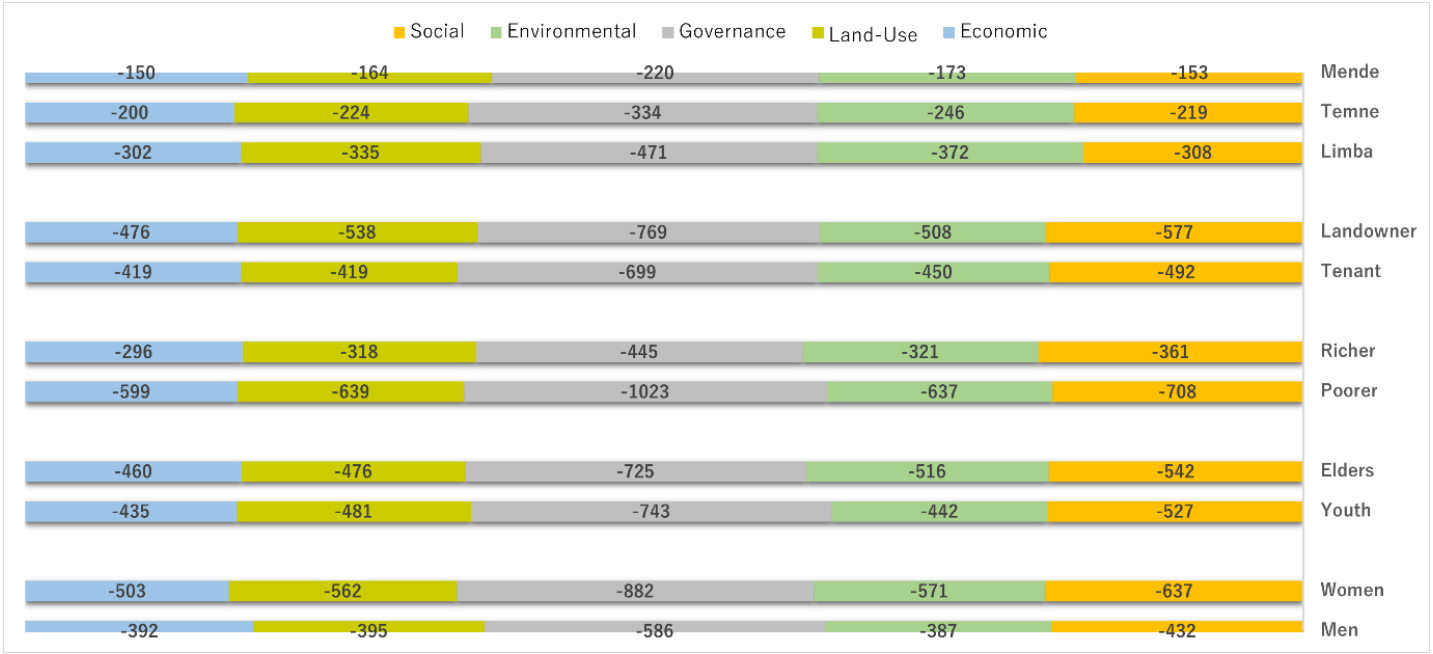


Figure 6. *Cumulative NbS burdens in Freetown. Landowners and women bear the heaviest costs from governance and land-use trade-offs; tenants and men the lightest. Ethnically, Mende households are least affected, Temne moderate, and Limba most burdened, showing intersecting gender, income, tenure, age and ethnic inequities (Haque & Sharifi, 2024).*

Figures 5 and 6 reveal that FTT's burden–benefit distribution is uneven along tenure, gender, ethnicity, class, and generation, confirming what Haque & Sharifi (2024: p110) call a *burden–benefit paradox*: groups most engaged in sustaining greening gain ecological benefits yet shoulder disproportionate costs. When recalculated as benefit-to-burden ratios, the paradox becomes even clearer as poorer households (0.0046), tenants (0.0050), women (0.0059), and youth (0.0060) extract the least value relative to what they sacrifice — while elites such as richer households (0.0090), Limba (0.0119), and Landowners (0.0074) capture more sustainable gains. These patterns reflect Fraser's (2005) three justice dimensions and reveal how they intersect.

From the figures, several critical insights emerge:

- Landowners record the highest benefits (21.2) but simultaneously absorb severe burdens (–2868; ratio 0.0074) as their proximity to viable planting sites, alongside procedural visibility in land negotiations, provides tangible access to ES and political leverage. However, as a local chieftain explained, involvement in settlement mediation exposes landowners to disputes and restrictions that can erode those advantages (P5). Tenants, by contrast, receive far fewer benefits (12.4) while facing almost comparable burdens (-2479; 0.0050). This reflects what Anguelovski & Corbera (2022: p115) call the *procedural invisibility* of non-landholders: excluded both from durable benefits and from meaningful say in NbS governance, their marginalisation is reproduced through tenure.

- Women achieve higher benefits than men (18.7 vs 12.8) because of their 40% share of FTT's planting labour, embedding them directly in greening activities and yet their heavier burdens (–3155 vs –2192) reveal a sharp contradiction, as while their contributions generate visible ecological outcomes, they are structurally undervalued, with little compensation or decision-making power.

Although their ratio (0.0059) is marginally stronger than men's (0.0058), this does not signal empowerment but rather labour-driven exposure — exemplifying the feminisation of ecological labour (Grant et al., 2024), where symbolic recognition disguises material disempowerment.

- Limba households secure the highest benefits (21.3) and a strong ratio (0.0119), reflecting their entrenched roles in informal governance and land mediation (Macarthy et al., 2024a). Yet this authority comes at a cost: elevated governance burdens (–1788) tied to dispute resolution and compliance enforcement. Mende (12.6; –860; 0.0147) and Temne (10.5; –1223; 0.0086) households, by contrast, record fewer benefits and lighter burdens, and their higher (Mende) or mid-range (Temne) ratios illustrate "*efficiency through exclusion*" (Anguelovski & Corbera, 2022: p.115): procedural invisibility that shields them from overexposure but also denies them influence and access. Injustice here is double-edged — overburdened embedded groups coexist with excluded, under-recognised ones.

- Poorer households appear to approach richer ones in benefits (16.7 vs 15.7), yet their burdens are far greater (–3606 vs –1741), yielding the lowest ratio overall (0.0046). As one resident explained, "*Sometimes we have to step in to talk to people, explain the planting, or calm tensions*. "*We are not paid for this — it's just expected*" (P9) — suggesting their access often stems from incidental, labour-driven exposure (shade, fruit, or field tasks) rather than autonomous or durable entitlements (Langhans et al., 2023). Wealthier households, by contrast, achieve stronger ratios (0.0090) through distributive advantage: benefits accrue via ownership, leadership, and institutional ties, while burdens are mitigated.

- Youth, who constitute 88% of FTT's workforce, record moderate benefits (15.8) but heavy burdens (–2628; 0.0060), representing what Sultana (2022)

terms instrumental inclusion: where groups essential for implementation are excluded from long-term gains. Elders, with slightly fewer benefits (15.3) but near-equal burdens (–2719; 0.0056), absorb the strain of coordination and dispute mediation without compensation. These generational imbalances illustrate how greening labour is differentially distributed: youth bear the physical weight, while elders absorb institutional strain — without either group receiving stable benefits or formal inclusion.

4.2.1 Synthesis: structural drivers of inequity

The convergence of these findings suggests three systemic justice contradictions. First, distributive inequity: ecological benefits are not absent from marginalised groups, but conditional — secured through labour (poor households, women, youth) or withheld (tenants, some ethnic groups), revealing a maldistribution of costs and gains. Second, procedural exclusion: tenants, women, poorer households, and youth are positioned as implementers rather than agenda-setters, their agency constrained to labour-intensive participation while elites retain agenda-setting authority. Finally, recognitional injustice: symbolic celebration of women's, youths', and elders' contributions obscures their structural disempowerment, while entrenched ethnic hierarchies legitimise certain groups as gatekeepers, normalising uneven authority. Taken together, these dynamics show that residents' experiences of benefits and burdens diverge systematically along tenure, gender, ethnicity, income, and age, directly addressing the research aim to interrogate differentiated perceptions of NbS while also revealing that exposure to ES cannot be equated with equity; benefits are mediated by land, labour, and legitimacy, with burdens falling most heavily on those with the least protection. Unless mechanisms against extractive participation are embedded into governance, NbS initiatives like FTT may entrench what Sultana (2022: p3) terms *climate apartheid*.

4.3 How power, participation, and institutional roles shape procedural justice in FreetownTheTreetown

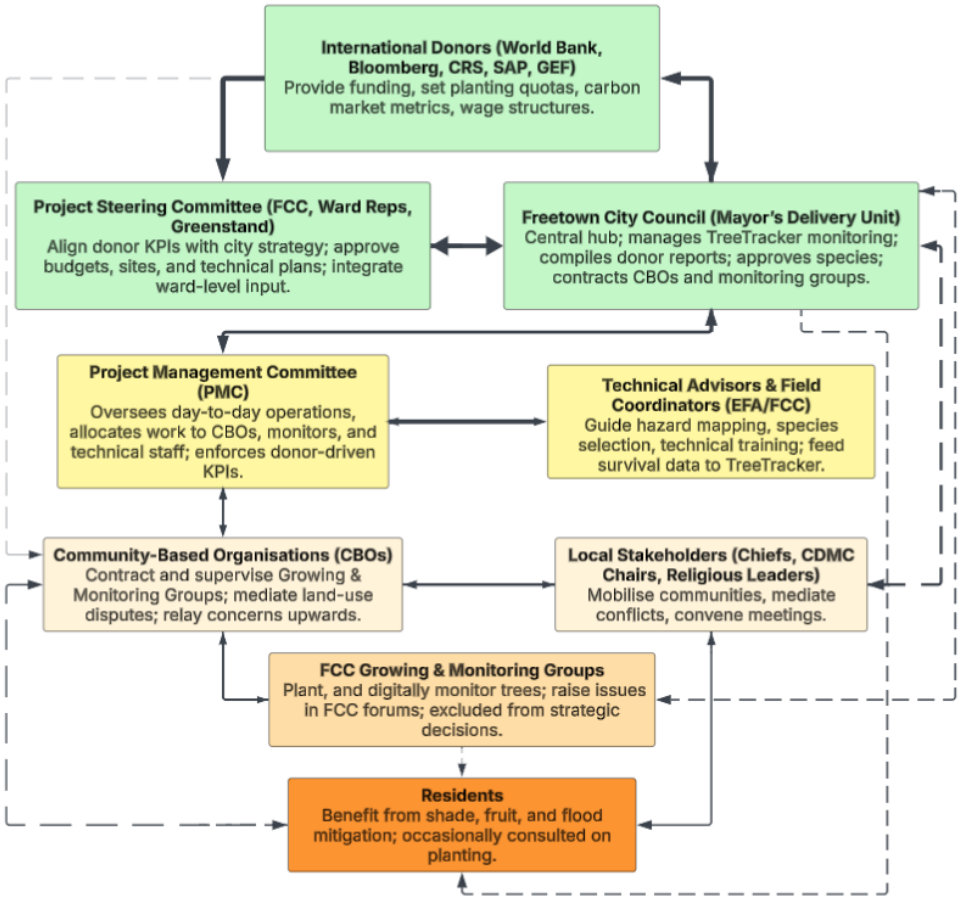


Figure 7. *Social Network Analysis of FTT, triangulated with the PII matrix, organogram, interviews, and field diaries - Nodes are shaded green to red (high to low inclusion) and tiered by role. Solid arrows show formal authority, dashed arrows informal ties; thickness and node size indicate influence and power. The structure, while vertically efficient, is procedurally exclusive — marginalising community actors with critical local knowledge (Buijs et al., 2024).*

Figure 7 and Appendix H expose FTT's governance as technocratic and hierarchical: participation is embedded, but exclusion is institutionalised. Although the diagram suggests tiered engagement, authority moves vertically via strategic gatekeeping and delegated operations that constrain procedural justice (Ramcilovic-Suominen et al., 2024). This is *governance-by-design* (Pulido & De Lara, 2018; p52): institutions reproduce exclusion rather than undo it.

Power–Influence–Inclusion (PII) scores confirm the asymmetry. Average inclusion (inclusion in decision-making, not parity with others) 1.5 lags far behind power 3.9 and

influence 3.6, quantifying the absence of parity across tiers. Appendix H shows that no non-elite actor exceeds 3 for inclusion, and even donors/Steering/FCC cap at 4. In Fraser's (2005) terms, *parity of participation* — the minimum for procedural justice — is structurally foreclosed. Oversized, densely connected elite nodes and smaller, peripheral grassroots nodes crystallise these inequities (Figure 7).

Several linked dynamics emerge:

- Elite dominance and top-down metrics. Donors and FCC are oversized, densely tied nodes with PII 5–5–3/4. Participation is framed as compliance with KPIs and planting targets (Sekulova et al., 2021). Platforms such as TreeTracker entrench *managerial environmentalism* (Rochell et al., 2024a: p76), shrinking deliberative space.

- Loops without influence. Dense reciprocal loops bind elites, consolidating control. Loops among residents, monitors, and CBOs are thin and hierarchically mediated — loops on paper rather than practice — supporting the claim that justice requires decision-shaping, not consultation (Ramcilovic-Suominen et al., 2024).

- Gatekeepers at the centre. The Steering Committee and PMC are centrally positioned (PII 4–4–2). As one implementer noted, "*PMC filters grievances — some issues get escalated to FCC, others are kept internal*" (P10). These bodies act as bottlenecks, not just connectors.

- Instrumentalising informal authority. Chiefs, CDMC chairs, and stakeholders sit at the periphery (PII 2–2–2). They mobilise and resolve disputes but are excluded from agenda-setting. "*You only get invited if the chief knows your family*" (P20) illustrates gatekeeping within a hybrid institutional ecology (Macarthy et al., 2024a).

- Brokered participation without representation. CBOs appear central, yet with 3 3–2 inclusion. “We don’t set the terms, we just implement and report back” (P2). This is brokered participation: information flows upward; decisions do not return for deliberation (Ramcilovic-Suominen et al., 2024).

- Labour without agency. Growers, monitors, and residents are the smallest nodes (2–2–1; 1–1–1) with unidirectional ties—labour without decision traction. “*We plant what they say; we just follow the instructions*” (P19) exemplifies *instrumental inclusion* (Sultana, 2022; Piroli, 2025).

- Knowledge overlooked. Residents hold fine-grained ecological/tenure knowledge, yet consultations are “*mostly for explaining, not deciding*” (P15). This is epistemic injustice (Rochell et al., 2024b).

4.3.1 Synthesis: procedural justice and environmental-justice contradictions

The PII pattern shows how FTT’s governance generates procedural inequities mapping onto Fraser’s (2005) justice triad. Distributively, labouring groups absorb costs while control over budgets, quotas, and metrics clusters at the top. Procedurally, inclusion never exceeds 3 for non-elites and caps at 4 for elites — strong formal authority but no parity — producing visible participation without decision power. Recognitionally, informal leaders are tolerated for mobilisation, and residents’ ecological expertise remains advisory. Quotes — “*PMC filters grievances*” (P10), “*We plant what they say*” (P19), “*Consultations are mostly for explaining*” (P15) — are symptomatic of a model where symbolic involvement substitutes for agency (Chumo et al., 2025).

Here, mid-tier variance is narrow (CBOs 3–3–2 vs informal leaders 2–2–2), and all are dwarfed by elites (5–5–3/4) with Appendix H confirming this compression: inclusion is low, and no actor achieves procedural parity. These findings address Objective 3 by showing that procedural equity is less absent than deliberately constrained: residents and grassroots actors serve as labour, brokers, or symbolic invitees but remain

excluded from agenda-setting, while committees filter grievances, donors and FCC reassert authority through dashboards, and chiefs provide legitimacy without traction, producing equity in form but not in substance.

Comparatively, Freetown reflects wider African NbS contradictions yet with distinctive dynamics. In Kumasi, chiefs gatekeep tenants, mirroring PMC and community bottlenecks (Gagakuma et al., 2025); Dar es Salaam, donor-driven projects oversized elites and reinforced vertical accountability (Dupar et al., 2023), echoing FCC–donor dominance. Durban contrasts: vulnerability-weighted planting redistributed decision authority, shrinking elites and empowering peripheral actors (Boyland et al., 2022). Freetown therefore resembles Kumasi's gatekeeping and Dar's metricisation more than Durban's redistributive design, showing how technocratic NbS replicate exclusion unless corrected. In EJ terms, contradictions cut across scales: maldistribution in clustered control; misrepresentation in grievance filtering; misrecognition of local knowledge. Appendix H quantifies this: no non-elite exceeds inclusion 3, despite power peaking at 5. Without redistributive reforms, FTT risks entrenching divides where elites monopolise voice and residents remain confined to labour and compliance.

4.4 Exclusion and misrecognition of marginalised knowledge and cultural values

By examining field data against Greenstand's (2025) planting records, this analysis explores recognitional justice across ethnic, gender, and generational lines, drawing on Piroli's (2025: p7) *misrecognition* and Macarthy et al.'s (2024a: p37) *donor urbanism* to show how institutional frameworks sideline local ecological valuation and knowledge.

4.4.1 Ethnicity and ecological misrecognition

The Temne prioritised mango (1.96), coconut (0.89), and tamarind (0.64), species essential to food and ritual (Appendices I & J). Yet none are meaningfully present in GreenStand's (2025) planting records. In contrast, red mangrove (59K, absent from Temne preferences, dominate and while these donor-favoured species may offer erosion control or carbon storage, their imposition still forms what Pulido and De Lara (2018) call *ecological erasure* - replacing culturally rooted ecologies with technocratic ones.

For the Mende, coconut (1.24), soursop (0.88), and mango (1.96) were preferred for their provisioning and community utility (Appendices I & J). As one Mende elder described *"We used to plant soursop, moringa, mango… in compounds"* (P20) - linking these species to domestic and ancestral life. However, these species hold a minority place in planting totals, while externally favoured species like teak (33K) and flame tree (26K) dominate. Despite holding ecological utility, their prominence reflects donor priorities over community preferences, reinforcing Macarthy et al.'s (2024a) view that post-conflict greening privileges external metrics over lived ecologies.

Among Limba, mango (2.24), coconut (1.05), and tamarind (0.79) were most valued, associated with ceremony and nutrition (Appendices I & J) and yet none appear among the most planted species. This consistent mismatch illustrates *ethnobotanical disenfranchisement* — where donor-defined goals systematically override community-informed preferences, reinforcing structural misrecognition (Pulido & De Lara, 2018).

4.4.2 Gender and age: exclusion in practice

Figure 5 reveals women report the highest average access to provisioning and cultural services (Figure 6) — exceeding all other social groups. This reflects their embedded roles in caregiving, community mobilisation, and ecological labour. Yet their contributions remain unrecognised institutionally despite proximity to daily ecological care. As one participant detailed, *"Most of the time, the men are the ones deciding… the women only help to mobilise people"* (P17). This procedural exclusion translates into the underplanting of trees, key to women's livelihood strategies and community well-being.

Elders, custodians of ancestral knowledge, reported lower average access to ecosystem benefits (Figure 6), challenging assumptions that symbolic authority ensures influence; their favoured species, such as coconut and mango, remain tied to continuity and ritual — *"Ancestors treated mighty trees as sacred, with prayers and offerings"* (P20) — yet, as another elder noted, *"Elders and women are informed, but they don't have much say"* (P7), representing what Piroli (2025) terms *misrecognition*: token inclusion that masks genuine disempowerment. Macarthy et al. (2024a) also contend that post-conflict governance often removes ritual and relational authority from decision-making, weakening long-term stewardship.

Although youth had mid-range access to ecosystem benefits (Figure 4), they were central to planting operations. Their main choices — mango (2.02), tamarind (0.64), and coconut (0.55) — aligned with the wider community's values (Appendix I). Yet these species are marginal in GreenStand's (2025) planting data. This disjuncture shows how youth's ecological knowledge is visible in labour but absent in influence, highlighting a failure of recognitional justice: their preferences are not reflected in planting outcomes, nor do they receive equitable benefits, underscoring how participation without recognition reinforces structural marginality (Grant et al., 2024) - this generational exclusion is evident in Figure 7, where youth occupy a peripheral position, reinforcing unequal recognition and weakening ecological ownership.

4.4.3 Donor-favoured species vs. community-valued trees

Appendices I and J show that communities most value provisioning and cultural services; yet trees supporting these benefits — mango, coconut, and tamarind — remain underrepresented in planting records (Greenstand, 2025). Instead, donor-favoured species like red mangrove (59K) and neem (34K) dominate, despite offering little provisioning or cultural value. These species may help with erosion or carbon goals, but their prioritisation shows how donor agendas often override local values. *"Donors dictate quotas and carbon-linked species… community values are secondary",* noted one FCC official (P22). This misalignment reveals whose knowledge gets institutional backing and whose doesn't. As a local chief stated, *"When they don't ask, trees often get uprooted" (P5)* — a form of active resistance, not neglect, underscoring how social legitimacy is as vital as biological survival.

This resistance is structural: Freetown's post-colonial/conflict reconstruction has created a top-heavy governance system (Figure 7), where donors and officials dominate, while local actors are sidelined. As Macarthy et al. (2024a) argue, donor urbanism has displaced grassroots ecologies; while FCC's alignment with GreenStand enacts what Pulido and De Lara (2018) call *technocratic erasure* - a system that overwrites situated ecological knowledge with external metrics.

4.4.4 Conclusion

Freetown's greening demonstrates how donor-led priorities can overshadow local ecological values, revealing gaps in recognitional justice across social groups and showing how selective recognition of knowledge reinforces structural inequality in urban reforestation.

5.0 Discussion

5.1 Spatial distribution and vulnerability in FTT planting

The spatial patterning of FTT planting (Figures 2-5) reveals how distributive inequities were not accidental oversights but the product of structural governance logics. Although the campaign was framed as targeting climate-vulnerable areas, the majority of plantings clustered in upland wards with stable terrain and lower population density, while lowland, population dense zones, most exposed to flooding, heat stress, and overcrowding, received relatively sparse coverage. This spatial mismatch alongside the Gini coefficient undermines claims that scale alone guarantees equity in urban greening, challenging Gwedla and Shackleton's (2015) view that large-scale planting tends to equalise benefits across urban populations and instead, the case aligns with Anguelovski et al.'s (2022) critique that aggregate delivery metrics — in FTT's case, "*one million trees by 2025*" — obscure inequitable distributions by emphasising numerical achievement over lived access. Such counting logics produce statistical gains legible to donors while concealing persistent disparities in who benefits, confirming Bauer's (2022:p1) concept of *green optics*.

These inequities emerge because feasibility, rather than vulnerability, structured site selection, with terrain stability, logistical ease, and expert assessments dominating decision-making, reflecting a technocratic mode of NbS delivery (Anguelovski & Corbera, 2022). Kamjou et al. (2024) document similar biases in African municipalities, where "safe" sites are prioritised to minimise project risk, even at the expense of equity. FTT echoed this: while project documents emphasised participatory planning (FCC, 2024), in practice communities were mobilised for labour but excluded from meaningful power-sharing — an arrangement Hickey (2022) characterises as *tokenism*, and one repeatedly highlighted in interviews (P2,4,19). By contrast, Mguni et al. (2025) show that embedded co-production in Cape Town enabled planting in high-need areas, suggesting that equitable outcomes depend less on technical feasibility and more on redistributive institutional design. Peripheral siting in informal settlements further underscores recognitional deficits. Residents' ecological knowledge and spatial priorities were sidelined, echoing Lambert and Hofmann's (2021) account of weak

municipal–informal feedback loops in Freetown. Yet this exclusion was not inevitable: respondents identified viable planting sites — such as underused community fields (P7) — that could have enhanced legitimacy and resilience but were omitted. Their omission is a missed opportunity to draw on what Kamjou et al. (2024) call *community spatial intelligence* — instead, vulnerability mapping was filtered through expert feasibility screening (UNDP, 2025), diluting its redistributive potential, reflecting Rochell et al.'s (2024b) wider critique that NbS governance privileges environmental modelling while relegating social equity metrics.

Taken together, these dynamics show that FTT operationalised participation and vulnerability mapping in form but not in substance, aligning with global critiques of technocratic NbS (Kato-Huerta & Geneletti, 2022). Importantly, the distributive outcomes cannot be explained by ecological limits alone — they reveal how donor optics and municipal convenience systematically outweighed justice — entrenching what Pellow (2025) terms *maldistribution*. In Freetown, privileging feasibility over vulnerability undermines the equity commitments of Transform Freetown, threatens Phase III legitimacy, and anticipates the benefit–burden trade-offs (Objective 2) and procedural gatekeeping (Objective 3). Theoretically, this extends urban political ecology critiques of donor urbanism (Kato-Huerta & Geneletti, 2022) by foregrounding how metrics themselves operate as governance devices; the case reframes distributive justice from a question of allocation to one of epistemic and institutional design, offering a transferable critique for NbS governance across postcolonial cities.

Internationally, the findings reinforce calls for metrics that move beyond aggregate outputs towards distributive, procedural and recognitional justice (Anguelovski et al., 2022), with justice-oriented alternatives integrating hazard overlays with population-weighted accessibility modelling and community co-design to embed vulnerability as a decisive factor. Evidence from Durban and Cape Town demonstrates that these approaches can redistribute planting towards precarious communities without compromising ecological effectiveness (Douwes, 2022; Mguni et al., 2025). In this sense, Freetown illustrates the risks of technocratic NbS and the possibility of recalibration: Phase III could operationalise vulnerability-weighted siting and locally defined indicators, transforming NbS from symbolic optics to socially grounded

resilience (Terdoo, 2024). Taken together, this distributive maldistribution, shaped by procedural and recognitional gaps, demonstrates the interdependence of Fraser's (2005) three dimensions in FTT.

5.2 Experiences of benefits and burdens across social groups

FTT's benefits and burdens are experienced across justice dimensions and mediated by tenure, ethnicity, gender, income, and age. This explains how spatial misalignment (5.1) translates into lived benefit–burden trade-offs and sets up the procedural mechanisms examined in 5.3. Status-based legitimacy illustrates how secure tenure and embedded ethnic leadership conferred a dual advantage: procedural visibility and privileged access to planting opportunities. Limba and landowners exemplified this pattern by gaining access through established networks while also absorbing unpaid mediation and compliance obligations — a double-edged position documented in Freetown's hybrid governance (Macarthy et al., 2024a). Similar tensions in Tanzania's mangrove restoration caution against viewing elite capture as simple extraction, since influence also entails responsibility (Nyangoko et al., 2022). One might argue such obligations or influence compensate for inequities, but without authority over key decisions, recognition substitutes for power, reinforcing stratification rather than offsetting it. In contrast, where tenure insecurity and ethnic marginalisation coincide, double exclusion emerged, with Temne, Mende, and tenants excluded from both benefits and voice. This confirmed Thorn et al.'s (2021) findings that tenure security privileges landholders and also shows how hybrid governance in Freetown amplifies advantage for some. Analytically, this mechanism links to distribution (unequal allocation of benefits), recognition (privileging some forms of legitimacy over others), and procedure (exclusion from authority), demonstrating Fraser's (2005) interdependence.

Labour-contingent access shows how NbS distributes benefits through conditional trade-offs. For poorer households, gains were tied to insecure planting and monitoring roles, inflating delivery metrics without durable rights. As one FEDURP member noted, "*Trackers use smartphones while growers use their bodies… both deserve equal value*" (P2), highlighting how digital access gated higher-value roles. Women and youth carried disproportionate burdens alongside their benefits, as they are visible in delivery statistics but excluded from decision-making and vulnerable to irregular payments and

heavy planting and maintenance labour. While some might argue these roles provided short-term provisioning, their contingent nature left households dependent on donor cycles, embedding precarity rather than empowerment. These dynamics align with Salcedo-La Viña et al.'s (2023) critique of *feminised labour* and Langhans et al.'s (2023) notion of *extractive participation*, where presence substitutes for influence. By contrast, Mguni et al. (2025) show that co-production in Cape Town redistributed labour and authority, underscoring that in FTT benefit–burden trade-offs were structurally produced by design logics privileging visibility and reporting over justice.

Generational divisions compounded these inequities by allocating burdens along age and class lines. Youth from poorer households absorbed the most hazardous planting labour, while elders carried the political and social strain of mediation without authority or compensation. Some might argue that elders at least gained symbolic authority, but absent decision-making power this authority was nominal, sustaining delivery while suppressing contestation (Du Toit et al., 2018). These patterns resonate with Osewe et al.'s (2025) findings in Nairobi's Karura forest and extend Du Toit et al.'s (2018) insight that both youth and elders can be marginalised in NbS. Crucially, in FTT such marginalisation was not incidental but structurally reproduced by donor logics that commodified labour and valorised community engagement without redistributing power (Boyland et al., 2022). This shows that NbS stratify not only by tenure and gender but across life stages, embedding intergenerational inequity as a recurrent governance feature.

Together, these mechanisms created layered justice deficits, where access was conditional, mediated by factors such as land, labour, income, and legitimacy, and where burdens offset benefits — supporting Calderón-Argelich et al.'s (2021) call for intersectional NbS frameworks and showing that distributive inequities cannot be separated from recognitional and procedural gaps. Critically, these findings also reinforce Objective 1's results: even when planting reached vulnerable areas, benefits were stratified by social status. For Freetown, this undermines the inclusivity claims of Transform Freetown and suggests that unless Phase III embeds redistributive safeguards, digital inclusion, and genuine feedback loops, the campaign risks reproducing entrenched hierarchies seen in Nairobi (Osewe et al., 2025). More broadly,

Freetown challenges donor-led NbS assumptions in the Global South, showing that equity deficits are structural features of metrics privileging visibility and reporting over justice (Boyland et al., 2022).

5.3 Governance structures, decision-making, and procedural equity

Procedural deficits in Freetown are not incidental but structurally embedded in metrics, gatekeeping, and hybrid arrangements; achieving procedural justice requires more than nominal inclusion, it demands genuine influence over decisions (Fraser, 2005; Sekulova et al., 2021). Yet in FTT, KPI logics — planting targets and milestone verification — exemplify what Rochell et al. (2024a: p76) call *managerial environmentalism*: performance indicators that legitimise authority while narrowing participation. An implementer noted that "donors and FCC decide what metrics to use for reports, controlling which problems escalate and which areas keep funding" (P23) — aligning with Pulido and De Lara's (2018; p52) *governance-by-design*: where data infrastructures become procedural gatekeepers. FCC might argue that KPIs ensure accountability, but in practice, accountability was upwards to donors rather than downwards to residents — confirming Eakin et al.'s (2025) concern that transparency without responsiveness entrenches injustice. Therefore, rather than redistributing decision power, metrics consolidated it upward, validating critiques that KPI-based participation masks inequity (Sekulova et al., 2021) and challenging claims that network governance inherently broadens agency (Wang & Ran, 2021).

Second, elite capture and accountability asymmetry reflect a multi-scalar governance approach. PII scores revealed donors/municipal actors averaged 5–5–3, while CBOs clustered at 3–3–2, signalling connectivity without authority. This mirrors Nyangoko et al.'s (2022) findings in Tanzanian mangrove restoration, where intermediaries facilitated compliance yet were excluded from technical decisions; arguments would suggest that intermediaries at least gain symbolic influence — but without reciprocal loops, visibility substitutes for power, it instead echoes Sultana's (2022) critique of *instrumental inclusion* as two-way accountability is absent: inputs did not return as negotiable propositions, meaning capture extended across scales rather than remaining a local

phenomenon. In FTT, elite capture is inseparable from epistemic exclusion since residents' tenure and ecological knowledge were mobilised for labour but were excluded from agenda-setting; reflecting Schaafsma et al.'s (2023) critique that valuation frameworks appropriate local labour without granting authority, supporting Diep et al's., (2022) finding that forestry governance often extracts ecological labour while sidelining recognition. While operational use of community knowledge might appear to provide recognition, in practice it reproduces inequities because recognition without decision authority cannot deliver procedural justice (Fraser, 2005). Therefore, epistemic exclusion and capture are not sequential issues but are entwined since, within FTT, intermediaries lack decision autonomy while residents' knowledge is devalued - creating a loop of procedural marginalisation.

Comparative cases highlight commonality and distinctiveness in FTT: Across African NbS, KPI-driven reviews dominate, often with no indicators of community decision power (Dupar et al., 2023), for instance, in Accra, the AMA Resilience Strategy (2021) institutionalised KPIs, which Kato-Huerta & Geneletti (2022) critique as blind to procedural justice. Similarly, Nairobi's Karura Forest saw the implementation of participatory forestry, albeit with limited grassroots agenda-setting (Osewe et al., 2025). Freetown extends these critiques by embedding KPI logics within a hybrid governance ecology — here, dual gatekeeping concentrated power upward through donors/municipalities and downward through socially embedded informal authorities mediating access yet remaining procedurally marginal. Hybridity, often assumed to expand inclusion, can be seen to function as a gatekeeping device, reinforcing stratification rather than fostering co-production. The implications for Transform Freetown and FTT Phase III are blatant. If KPI-led frameworks continue to prioritise visibility over influence, procedural inequities will persist, undermining legitimacy. In the survey, respondents repeatedly called for stronger decision-making rights above training or protection (Appendix K), aligning with justice-centred indicator design and benefit-relevant approaches that link social and ecological outcomes (Marion, 2020). Therefore, monitoring systems should integrate metrics of participation quality alongside ecological outputs. More broadly, FTT illustrates that procedural justice deficits are predictable outcomes of donor-driven NbS governance: metrics,

intermediaries, and hybrid forums configure exclusion by design, confirming decolonial critiques of restoration logics (Ramcilovic-Suominen et al., 2024).

5.4 Representation, local ecological knowledge, and cultural legitimacy among marginalised groups

By situating recognition alongside distribution (Objective 1) and procedure (Objective 3), recognition is not a supplementary dimension but the foundation of redistributive and procedural justice. For Objective 4, representation matters because it reveals who can set agendas, explaining distributive mismatches in Objective 1 and procedural exclusions in Objective 3. Figures 5, 6 and 7 show how women combine planting with provisioning roles, youth absorb the bulk of labour, and elders hold symbolic authority — yet none exercise agenda power — supporting Piroli's (2025) claim that nominal participation without influence constitutes structural misrecognition, while extending East African findings where women-led groups sustained forests but remained excluded from planning (Diep et al., 2022; Duguma et al., 2022). Such partial visibility exemplifies Hickey's (2022) *negotiated erasure*, where symbolic acknowledgement masks exclusion. Fraser's (2005) framework sharpens this critique, since recognition without agenda-setting legitimises consultation, without shifting outcomes — explaining why portfolios diverged from community preferences in FTT Phase II and confirming Grant et al.'s (2024) observation that recognition is the least operationalised justice dimension.

These representational gaps enabled *epistemic filtering*, showing how misrecognition cascades into distributive inequities, where preference counts only when aligned with donor metrics (Piroli, 2025: p32). This is represented across Temne, Mende, and Limba respondents who prioritised mango, coconut, and tamarind for food, ritual, and shade, yet these species were largely absent from planting portfolios. As one resident put it, "*We ask for mango and coconut, but they bring trees we cannot eat*" (P3) — this process is evident in Pulido and De Lara's (2018) concept of *ecological erasure*, as donor priorities displace provisioning and cultural species. Yet in Freetown, the erasure is hybrid: donor species dominate public spaces while preferred trees persist in compounds, excluding tenants from durable gains. The recognition–outcome gap —

mango desired by 22% but present in only 3% of records — demonstrates how filtering produces material exclusion. A donor might argue that climate-resilient exotics are ecologically rational yet this technocratic logic is counterproductive: by sidelining provisioning species central to food and ritual systems, it undermines cultural legitimacy and community stewardship, increasing the risk of neglect, uprooting, and costly replanting (Rochell et al., 2024). In other words, ecological durability cannot be separated from social legitimacy, meaning donor rationales erode the very sustainability they claim to secure.

This erosion of representation and knowledge also undermines cultural legitimacy, showing how misrecognition destabilises ecological outcomes. Legitimacy matters because it explains why procedural exclusions in Objective 3 and distributive mismatches in Objective 1 persist in practice. Without ritual sanction, trees were neglected or uprooted. As elders stressed, "*If a tree is not blessed, it will not stand*" (P40) - extending Macarthy et al.'s (2024a: p37) critique of *donor urbanism* by showing legitimacy to be as decisive as soil or rainfall. In this context, bypassing ritual authority shifts maintenance burdens onto FCC and its labourers, reinforcing Section 5.2's finding that donor logics redistribute risks downward. Ghana's sacred groves illustrate this principle, as ritual legitimacy has preserved forest cover where state policy failed (Osei & Asantewa, 2025). In Freetown, by contrast, neglect and uprooting did not simply signal ecological failure but operate as an absence of care and as a subtle form of resistance to misrecognition. While some might contend that ecological metrics alone are sufficient indicators of success, without legitimacy such measures mask fragility while ultimately undermining the very donor goals they were intended to secure (Langhans et al., 2023).

Recognition must be operationalised because representation gaps enable epistemic filtering, which erodes cultural legitimacy; this cascade reproduces maldistribution (5.1) and gatekeeping (5.3). Ghana's urban forest experience illustrates the risk as consultation without recognition reproduces misfit portfolios (Adzah, 2024). Freetown's Recognition–Outcome Gap (22% vs. 3%) confirms this danger and therefore, Phase III represents more than technical reform: it must integrate legitimacy protocols, secure

fruit rights, and rebalance donor and cultural portfolios. Without such reforms, technocratic greening will repeat; with them, NbS could model socially sustained resilience (Kato-Huerta & Geneletti, 2022). Linking back to Objectives 1–3, recognition offers the connective tissue: without it, distributive reforms remain partial and procedural spaces hollow; with it, FTT can embed justice across all dimensions.

5.5 Limitations

The 2023 dataset records planting sites but not survival, replacement, or maintenance, and it is already outdated. As trees are lost or replaced, inequities in Section 5.1 may evolve differently, meaning the distributive maldistribution identified here is likely conservative — reliance on 2015 census data compounds this risk, understating vulnerability in rapidly densifying settlements.

For Sections 5.2 and 5.4, the household survey reflects a single point in time, it cannot capture shifting benefit–burden trade-offs, while purposive–stratified sampling may have missed less-connected households. My positionality and reliance on local partners inevitably shaped both interactions and interpretation. Such biases do not negate the findings but rather underscore the importance of reflexivity when claims about justice are advanced.

The procedural dynamics in Section 5.3 may shift with future political and donor phases. In Section 5.4, preferences were self-reported, dynamic, and partly constrained by ecological realities, while acts of resistance remain under documented. Despite these constraints, the structural patterns remain clear: inequities in FTT were not incidental. Rather, they reflect how NbS governance embeds exclusion by design — reinforcing why Phase III must recalibrate metrics and embed co-production.

6.0 Conclusions

This thesis examined the FTT campaign through distributive, procedural, and recognitional justice lenses to assess whether urban reforestation in post-conflict Freetown fostered inclusive resilience or reinforced inequality. The findings reveal a contradiction. Although FTT has gained international acclaim, expanded canopy cover, and mobilised residents, these gains were unevenly distributed, procedurally constrained, and culturally fragile. Spatial analysis (Objective 1) showed that planting was shaped by feasibility and donor optics rather than vulnerability, concentrating trees in upland wards while population dense lowlands remained underserved. These distributive mismatches translated into the lived benefit–burden trade-offs explored in Objective 2, where secure landholders and elites gained procedural visibility while tenants, women, youth, and poorer households absorbed the most insecure and labour-intensive roles. Such stratification was reinforced by governance arrangements in Objective 3, where KPI logics consolidated accountability upwards, intermediaries remained visible but powerless, and residents' ecological knowledge was instrumentalised without decision authority. Recognition analysis (Objective 4) revealed how cultural and ecological preferences were filtered out of planting portfolios, producing a recognition–outcome gap that undermined legitimacy and ecological durability, with neglect and uprooting reflecting resistance as much as ecological fragility.

Taken together, the four objectives demonstrate how maldistribution, labour-contingent access, procedural exclusion, and misrecognition were mutually reinforcing dynamics, confirming Fraser's (2005) view that the justice dimensions are interdependent. Theoretically, this reframes NbS justice as an institutional and epistemic design problem extending critiques of *managerial environmentalism* to postcolonial urban governance (Rochell et al., 2024a; p76) - underscoring that FTT must operationalise justice across distribution, procedure, and recognition if they are to move beyond symbolic optics and deliver socially grounded resilience.
Empirically, the research contributes by (1) quantifying distributive justice in African urban forestry using accessibility and Gini measures, evidencing feasibility-led siting

that risks green optics; (2) extending debates on the burden–benefit paradox by documenting its stratification by gender, tenure, ethnicity, income and age, revealing labour-contingent access and the feminisation of ecological labour; and (3) showing how hybrid governance can entrench rather than mitigate exclusion when donor KPIs act as procedural gatekeepers.

6.1 Future research directions

Future work should address this study's key limitations by running a city-wide, stratified longitudinal design and linking strata to updated planting–survival records to track distributive change over time. Equity should be assessed with standard accessibility/Gini measures and a set of benefit-relevant indicators that capture lived gains to follow environmental-justice trajectories while reducing reliance on one-off, self-reported outcomes (James & Conway, 2025). To mitigate spatial and epistemic biases, incorporate participatory GIS that integrates community spatial knowledge with updated hazard and population surfaces (Dupar et al., 2023). Finally, analyse governance mechanisms by process-tracing KPI and procurement records over time to identify how frame translation and metric design shape siting and species decisions (Rochell et al., 2024b).

References

Accra Metropolitan Assembly (AMA) (2021) *Accra Resilience Strategy Accra Metropolitan Assembly 100 Resilient Cities*. https://ama.gov.gh/documents/Accra-Resilience-Strategy.pdf?utm_source=.

Adzah, B.Y. (2024) Institutional Arrangement for Urban Forest Management in Ghana: Assessing the Role of the Local Communities and Youths. *Sprin Journal of Arts, Humanities and Social Sciences*. 3 (4), 12–19. doi:https://doi.org/10.55559/sjahss.v3i4.261.

Ali, F.S.M., Sommer, J.H., Borgemeister, C. & Biber-Freudenberger, L. (2025) Participatory and non-participatory forest ecosystem services valuation in Sub-Saharan Africa: a systematic literature review. *Discover Sustainability*. 6 (1). doi:https://doi.org/10.1007/s43621-025-00907-5.

Anguelovski, I. & Corbera, E. (2022) Integrating justice in Nature-Based Solutions to avoid nature-enabled dispossession. *Ambio*. 52 (12). doi:https://doi.org/10.1007/s13280-022-01771-7.

Barrass, K. (2024) *Building low-carbon resilience into Freetown's future*. 2024. International Institute for Environment and Development. https://www.iied.org/building-low-carbon-resilience-freetowns-future?utm_source [Accessed: 16 August 2025].

Bauer, W. (2022) Reframing Urban Nature-Based Solutions Through Perspectives of Environmental Justice and Privilege. *Urban Planning*. 8 (1). doi:https://doi.org/10.17645/up.v8i1.6018.

Bechauf, R., Carlucci, E., Kapetanakis, M. & Guzzetti, M.G. (2025) *Tree Planting for Climate Resilience in Freetown, Sierra Leone an Economic Valuation of the 'Freetown the Treetown' Initiative* . https://nbi.iisd.org/wp-content/uploads/2025/01/tree-planting-freetown-sierra-leone.pdf.

Boyland , M., Tuhkanen , H., Green, J. & Barque, K. (2022) Principles for just and equitable nature-based solutions. *SEI - Principles for just and equitable nature-based solutions*. https://www.sei.org/wp-content/uploads/2022/05/principles-for-just-and-equitable-nature-based-solutions.pdf?utm_source=chatgpt.com.

Buijs, A.E., Gulsrud, N.M., Rodela, R., Diduck, A.P., van der Jagt, A.P.N. & Raymond, C.M. (2024) Advancing environmental justice in cities through the Mosaic Governance of nature-based solutions. *Cities*. 147 (20), 104799. doi:https://doi.org/10.1016/j.cities.2024.104799.

Buitendijk, T., Cahillane, A., Brannigan, J. & Crowe, T.P. (2024) Valuing plurality: Environmental humanities approaches to ecosystem services and Nature's Contributions to People. *Environmental Science & Policy*. 162 (103907). doi:https://doi.org/10.1016/j.envsci.2024.103907.

Calderón-Argelich, A., Benetti, S., Anguelovski, I., Connolly, J., Langemeyer, J. & Baró, F. (2021) Tracing and building up environmental justice considerations in the urban ecosystem service literature: A systematic review. *Landscape and Urban Planning*. 214 (104130), 104130. doi:https://doi.org/10.1016/j.landurbplan.2021.104130.

Chumo, I., Kabaria, C., Steege, R., Teixeira, N., Shankland, A., Elsey, H., Phillips-Howard, P.A. & Mberu, B. (2025) Addressing the near absence of formal governance in service provision: governance practices thriving in informal settlements. *Discover Public Health*. 22 (1). doi:https://doi.org/10.1186/s12982-025-00805-1.

Das, U. (2021) Environmental justice research – limitations and future directions using qualitative research methods. *Qualitative Research Journal*. 21 (4), p.469-482. https://www.emerald.com/qrj/article-abstract/21/4/469/452467/Environmental-justice-research-limitations-and?redirectedFrom=fulltext.

Davis, L.F. & Ramírez-Andreotta, M.D. (2021) Participatory Research for Environmental Justice: A Critical Interpretive Synthesis. *Environmental Health Perspectives*. 129 (2), 026001. doi:https://doi.org/10.1289/ehp6274.

Diep, L., Mulligan, J., Oloo, M.A., Guthmann, L., Raido, M. & Ndezi, T. (2022) Co-building trust in urban nature: Learning from participatory design and construction of Nature-Based Solutions in informal settlements in East Africa. *Frontiers in Sustainable Cities*. 4 (12). doi:https://doi.org/10.3389/frsc.2022.927723.

Dodman, D., Archer, D. & Mayr, M. (2018) *Pro-Poor Climate Action in Informal Settlements*. https://unhabitat.org/sites/default/files/2019/05/pro-poor_climate_action_in_informal_settlements-.pdf.

Douwes, J. (2022) Transforming River Management and Shifting Mindsets in South Africa and Beyond. *Transforming River Management and Shifting Mindsets in South Africa and Beyond*. https://www.giz.de/de/downloads/giz2022-transforming-river-management-and-shifting-mindsets-in%20south-africa-and-beyond.pdf?utm_source.

du Toit, M.J., Cilliers, S.S., Dallimer, M., Goddard, M., Guenat, S. & Cornelius, S.F. (2018) Urban green infrastructure and ecosystem services in sub-Saharan Africa. *Landscape and Urban Planning*. 180, 249–261. doi:https://doi.org/10.1016/j.landurbplan.2018.06.001.

Duguma, L.A., Nzyoka, J., Obwocha, E., Minang, P., Wainaina, P. & Muthee, K. (2022) The forgotten half? Women in the forest management and development discourse in Africa: A review. *Frontiers in Forests and Global Change*. 5 (17). doi:https://doi.org/10.3389/ffgc.2022.948618.

Dupar, M., Henriette, E. & Hubbard, E. (2023) *Nature-based green infrastructure: A review of African experience and potential*. https://media.odi.org/documents/Nature-based_green_infrastructure_-_A_review_of_African_experience_and_potenti_ic8LcVA.pdf.

Eakin, H., Enqvist, J., Hamann, M., Methner, N., Sibanda, M.N., Sullivan, J., van Wyk, E. & Ziervogel, G. (2025) Negotiating informality and urban resilience: implications for equity. *Ecology and Society*. 30 (2). doi:https://doi.org/10.5751/es-16059-300220.

Fernandez-Bou, A.S., Ortiz-Partida, J.P., Dobbin, K.B., Flores-Landeros, H., Bernacchi, L.A. & Medellín-Azuara, J. (2021) Underrepresented, understudied, underserved: Gaps

and opportunities for advancing justice in disadvantaged communities. *Environmental Science & Policy*. 122 (32), 92–100. doi:https://doi.org/10.1016/j.envsci.2021.04.014.

Fraser, N. (2005) *Reframing Global Justice* . 1 November 2005. www.proquest.com. https://www.proquest.com/openview/f9d33dcc2b1f080b129edd0c9d52fbd6/1?pq-origsite=gscholar&cbl=1819646 [Accessed: 3 September 2025].

Frediani, A. (2022) *Breaking the cycle of housing deprivation in Freetown's informal settlements - ACRC*. 20 April 2022. African Cities Research Consortium . https://www.african-cities.org/breaking-the-cycle-of-housing-deprivation-in-freetowns-informal-settlements/ [Accessed: 12 May 2025].

Freetown City Council (FCC) (2023) *Freetown Climate Action Plan – Final Report*. https://fcc.gov.sl/wp-content/uploads/2023/01/CAP-Freetown-FINAL.pdf.

Freetown City Council (FCC) (2024) *Transform Freetown Four Year Report*. 2024. Fcc.gov.sl. https://fcc.gov.sl/transform-freetown-4th-year-report/ [Accessed: 21 April 2025].

Freetown City Council (FCC) (2019) *Western Wards – Freetown City Council*. 2019. Fcc.gov.sl. https://fcc.gov.sl/cleanest-zone-competition/you-sabi-you-zone/western-ward/ [Accessed: 13 August 2025].

Gachuiri, A., Paez-Valencia, A.M., Elias, M., Carsan, S. & McMullin, S. (2022) Gender and Generational Differences in Local Knowledge and Preference for Food Trees in Central Uganda and Eastern Kenya. *Frontiers in Sustainable Food Systems*. 5 (21). doi:https://doi.org/10.3389/fsufs.2021.746256.

Gagakuma, D., Takyi, S.A., Amponsah, O. & Quagraine, V.K. (2025) The functionality of urban green spaces in the greater Kumasi Metropolis of Ghana: categorisation of green spaces, prospects, challenges and implications for sustainable management. *SN Social Sciences*. 5 (4). doi:https://doi.org/10.1007/s43545-025-01079-9.

Gordon, C. (2024) Rhetorical Powermapping Converging Solidarities for Translocal Ecological Justice. In: *The Routledge Handbook of Rhetoric and Power*. New York, Routledge. pp. 443–458. doi:https://doi.org/10.4324/9781003430858-39.

Grant, A., Edge, S., Millward, A.A., Roman, L.A. & Teelucksingh, C. (2024) Centering Community Perspectives to Advance Recognitional Justice for Sustainable Cities: Lessons from Urban Forest Practice. *Sustainability*. 16 (12), 4915. doi:https://doi.org/10.3390/su16124915.

Greenstand (2025) *Freetown City Council Trees - Organization | Treetracker by Greenstand*. 2025. Treetracker.org. https://map.treetracker.org/organizations/1642?bounds=-13.296546936035158 [Accessed: 28 August 2025].

Gwedla, N. & Shackleton, C.M. (2015) The development visions and attitudes towards urban forestry of officials responsible for greening in South African towns. *Land Use Policy*. 42, 17–26. doi:https://doi.org/10.1016/j.landusepol.2014.07.004.

Haque, Md.N. & Sharifi, A. (2024) Who are marginalized in accessing urban ecosystem services? A systematic literature review. *Land Use Policy*. 144 (107266), 107266. doi:https://doi.org/10.1016/j.landusepol.2024.107266.

Hickey, C. (2022) Climate Justice and Informal Representation. *Ethics & International Affairs*. 36 (2), 179–198. doi:https://doi.org/10.1017/s0892679422000193.

Hussainzad, E.A. & Gou, Z. (2024) Climate Risk and Vulnerability Assessment in Informal Settlements of the Global South: A Critical Review. *Land*. 13 (9), 1357–1357. doi:https://doi.org/10.3390/land13091357.

James, A. & Conway, T.M. (2025) Using the Gini Index to quantify urban green inequality: A systematic review and recommended reporting standards. *Landscape and Urban Planning*. 254 (34), 105231–105231. doi:https://doi.org/10.1016/j.landurbplan.2024.105231.

Kamjou, E., Scott, M. & Lennon, M. (2024) A bottom-up perspective on green infrastructure in informal settlements: Understanding nature's benefits through lived experiences. *Urban Forestry & Urban Greening*. 94 (31), 128231. doi:https://doi.org/10.1016/j.ufug.2024.128231.

Kato-Huerta, J. & Geneletti, D. (2022) Environmental justice implications of nature-based solutions in urban areas: A systematic review of approaches, indicators, and outcomes. *Environmental Science & Policy*. 138 (5), 122–133. doi:https://doi.org/10.1016/j.envsci.2022.07.034.

Lambert, R. & Hofmann, P. (2021) *Transformative strategies for a just Freetown*. https://discovery.ucl.ac.uk/id/eprint/10188430/1/report_transformativestrategiesfreetown.pdf.

Langhans, K.E., Echeverri, A., S. Caroline Daws, Moss, S., Anderson, C.B., Chaplin-Kramer, R., J. Nicholas Hendershot, Liu, L., Mandle, L., Nguyen, O., Ou, S.X., Remme, R.P., Schmitt, R., Vogl, A.L. & Daily, G.C. (2023) Centring justice in conceptualizing and improving access to urban nature. *People and Nature*. 5 (3), 897–910. doi:https://doi.org/10.1002/pan3.10470.

Lemke, L.K.-G., Beier, J. & Hanger-Kopp, S. (2024) Exploring procedural justice in stakeholder identification using a systematic mapping approach. *Environmental Science & Policy*. 162 (12), 103900. doi:https://doi.org/10.1016/j.envsci.2024.103900.

Lian, X., Liu, W., Liu, Z., Jiao, L., Shackleton, C.M., Li, B., Zhong, J., Yang, R., Fu, M., Zhang, H., Sumari, N. & Liu, Y. (2025) Tree shortages in informal settlements across African cities. *Nature Cities*. 14 (2). doi:https://doi.org/10.1038/s44284-025-00284-0.

Loos, J., Benra, F., Berbés-Blázquez, M., Bremer, L.L., Chan, K.M.A., Egoh, B., Felipe-Lucia, M., Geneletti, D., Keeler, B., Locatelli, B., Loft, L., Schröter, B., Schröter, M. & Winkler, K.J. (2022) An environmental justice perspective on ecosystem services. *Ambio*. 52 (3), 477–488. doi:https://doi.org/10.1007/s13280-022-01812-1.

Macarthy, J., de Bruijne, K., Conteh, F., Hitchen, J., Koroma, B. & Reffell, F. (2024a) Freetown: City report. *SSRN Electronic Journal*.34 (1). doi:https://doi.org/10.2139/ssrn.4916071.

Macarthy, J., Koroma, B., Rigon, A., Frediani, A. & Klingel, A. (2024b) *Urban Transformations in Sierra Leone: Knowledge co-production and partnerships for a just city*. UCL Press. doi:https://doi.org/10.14324/111.9781800086852.

Marion, K.R. (2020) Procedural justice matters - Power, representation, and participation in environmental governance. In: B. Coolsaet (ed.). *Environmental Justice*. London, Routledge. pp. 37–51. doi:https://doi.org/10.4324/9780429029585-5.

Marsters, L., Collins, N., Wanjohi-Opil, H.N. & Anderson, J. (2025) *In Sub-Saharan Africa, Nature-Based Solutions Take Root*. 2025. World Resources Institute. https://www.wri.org/insights/nature-based-climate-solutions-sub-saharan-africa?utm_source [Accessed: 9 August 2025].

Mertens, D. (2023) Mixed methods designs to further social, economic and environmental justice. In: C. Poth (ed.). *Mixed Methods Research Design*. SAGE Publications Limited. pp. 83–100. https://www.torrossa.com/en/resources/an/5730651#page=83.

Mguni, P., Herslund, L.B., Abrams, A.L., Carden, K., Tanyanyiwa, C., McLachlan, J., Schneuwly, R. & Armitage, N. (2025) Scaling deep at the margins: coproduction of nature-based solutions as decolonial research praxis in Cape Town. *npj Urban Sustainability*. 5 (1). doi:https://doi.org/10.1038/s42949-024-00190-9.

Mngumi, L.E. (2020) Ecosystem services potential for climate change resilience in peri-urban areas in Sub-Saharan Africa. *Landscape and Ecological Engineering*. 16 (2), 187–198. doi:https://doi.org/10.1007/s11355-020-00411-0.

Nesbitt, L., Meitner, M.J., Girling, C., Sheppard, S.R.J. & Lu, Y. (2019) Who has access to urban vegetation? A spatial analysis of distributional green equity in 10 US cities. *Landscape and Urban Planning*. 181 (0169-2046), 51–79. doi:https://doi.org/10.1016/j.landurbplan.2018.08.007.

Nyangoko, B.P., Berg, H., Mangora, M.M., Shalli, M.S. & Gullström, M. (2022) Local perceptions of changes in mangrove ecosystem services and their implications for livelihoods and management in the Rufiji Delta, Tanzania. *Ocean & Coastal Management*. 219 (32), 106065. doi:https://doi.org/10.1016/j.ocecoaman.2022.106065.

Olander, L.P., Johnston, R.J., Tallis, H., Kagan, J., Maguire, L.A., Polasky, S., Urban, D., Boyd, J., Wainger, L. & Palmer, M. (2018) Benefit relevant indicators: Ecosystem services measures that link ecological and social outcomes. *Ecological Indicators*. 85 (31), 1262–1272. doi:https://doi.org/10.1016/j.ecolind.2017.12.001.

Opoku, P., Eric Kwame Simpeh, Mensah, H., Dorothy Asare Akoto & Weber, N. (2024) Perception of the services and disservices from urban forest and trees in the Garden City of West Africa. *Trees, forests and people*. 16 (12), 100550–100550. doi:https://doi.org/10.1016/j.tfp.2024.100550.

Osei, B.K. & Asantewa, J. (2025) Traditional Leadership, Indigenous Knowledge and Environmental Conservation in Ghana: A Content Analysis. *Open Journal of Social Sciences*. 13 (06), 136–156. doi:https://doi.org/10.4236/jss.2025.136009.

Osewe, E.O., Popa, B., Kagombe, J.K., Osewe, I. & Abrudan, I.V. (2025) Ecosystem services values for local people in participatory forestry context: The case of karura urban forest reserve. *Trees, Forests and People*. 20 (11), 100834. doi:https://doi.org/10.1016/j.tfp.2025.100834.

Owen, D., Fitch, A., Fletcher, D., Knopp, J., Levin, G., Farley, K., Banzhaf, E., Zandersen, M., Grandin, G. & Jones, L. (2024) Opportunities and constraints of implementing the 3–30–300 rule for urban greening. *Urban forestry & urban greening*. 98 (20), 128393–128393. doi:https://doi.org/10.1016/j.ufug.2024.128393.

Öz, G. & Timur, Ş. (2022) Issues of Power and Representation in/of the Local Context: The role of self-reflexivity and positionality in design research. *The Design Journal*. 16 (45), 1–18. doi:https://doi.org/10.1080/14606925.2022.2088097.

Pasgaard, M., Breed, C., Engemann Jensen, K. & Brom, P. (2025) Connecting urban green infrastructure and environmental justice in South Africa: Integrating social access, ecology, and design. *Journal of Political Ecology*. 32 (1). doi:https://doi.org/10.2458/jpe.6213.

Pearsall, H., Pierce, J. & Campbell, L.K. (2024) Walking as a method for epistemic justice in sustainability. *Ambio*. 53 (6), 907–915. doi:https://doi.org/10.1007/s13280-024-01985-x.

Pellerey, V., Torabi Moghadam, S. & Lombardi, P. (2024) A systematic review of justice integration to climate resilience: Current trends and future directions. *Urban Climate*. 59 (7), 102250. doi:https://doi.org/10.1016/j.uclim.2024.102250.

Pellow, D.N. (2025) *What is Critical Environmental Justice?* 2025. Google Books. https://books.google.co.uk/books?id=jHpeEQAAQBAJ&lpg=PA1986&ots=1AxagW8gEG&dq=Pellow%2C%20D.%20N.%20(2025).%20What%20is%20critical%20environmental%20justice%3F.%20John%20Wiley%20%26%20Sons.&lr&pg=PA1982#v=onepage&q&f=false [Accessed: 5 August 2025].

Peroches, A., Dubiez, E., Fayolle, A., Koutika, L.-S., Mapenzi, N., Vermeulen, C., Oswald, M. & Lescuyer, G. (2025) From Tree Fellers to Planters: A Systematic Review of Forest Restoration Initiatives Involving Local Populations in Central Africa. *Small-scale Forestry*. 24 (1-2), 1–34. doi:https://doi.org/10.1007/s11842-025-09586-6.

Piroli, D. (2025) Climate Justice, Recognition, Pluralism. *Brazilian Political Science Review*. 19 (1). doi:https://doi.org/10.1590/1981-3821202500010003.

Pulido, L. & De Lara, J. (2018) Reimagining 'justice' in environmental justice: Radical ecologies, decolonial thought, and the Black Radical Tradition. *Environment and Planning E: Nature and Space*. 1 (1-2), 76–98. doi:https://doi.org/10.1177/2514848618770363.

Rakotonarivo, S., Rakotoarisoa, M., Rajaonarivelo, H., Raharijaona, S., Jones, J. & Hockley, N. (2023) Resolving land tenure security is essential to deliver forest

restoration. *Communications earth & environment* . 4 (1). doi:https://doi.org/10.1038/s43247-023-00847-w.

Ramcilovic-Suominen, S., Chomba, S., Larson, A. & Sinclair, F. (2024) Decolonial environmental justice in landscape restoration. In: *Restoring Forests and Trees for Sustainable Development: Policies, Practices, Impacts, and Ways Forward*. Oxford University Press. pp. 74–101. https://books.google.co.uk/books?hl=en&lr=&id=RvMiEQAAQBAJ&oi=fnd&pg=PA74&dq=environmental+justice+reforestation+west+africa&ots=DFlBXDjd5U&sig=okUJXRsPaZsTrR4Ev576V0qcxck#v=onepage&q&f=false.

Rochell, K., Bulkeley, H. & Runhaar, H. (2024a) Different shades of green: how transnational actors frame nature as a solution to sustainability challenges in African cities. *Local Environment*. 29 (9), 1204–1220. doi:https://doi.org/10.1080/13549839.2024.2353047.

Rochell, K., Bulkeley, H. & Runhaar, H. (2024b) Nature for resilience reconfigured: global-to-local translation of frames in Africa. *Buildings & Cities*. 5 (1). doi:https://doi.org/10.5334/bc.379.

Salcedo-La Viña, C., Trivedi, A. & Grace, K. (2023) Enabling Women as Key Actors in Nature-based Solutions. *World Resource Institute*. doi:https://doi.org/10.46830/wriwp.21.00164.

Schaafsma, M., Ahn, S., Castro, A., Dendoncker, N., Filyushkina, A., González-Jiménez, D., Huambachano, M., Mukherjee, N., Mwampamba, T., Ngouhouo-Poufoun, J., Palomo, I., Pandit, R., Termansen, M., Ghazi, H., Jacobs, S., Lee, H. & Contreras, V. (2023) Whose values count? A review of the nature valuation studies with a focus on justice. *Current Opinion in Environmental Sustainability*. 64 (12), 101350. doi:https://doi.org/10.1016/j.cosust.2023.101350.

Segarra, J., González-Fernández, A., Osorno-Covarrubias, J. & Couturier, S. (2024) The role of critical remote sensing in environmental justice struggles. *Progress in Environmental Geography*. 24 (3). doi:https://doi.org/10.1177/27539687241269331.

Sekulova, F., Anguelovski, I., Kiss, B., Kotsila, P., Baró, F., Palgan, Y.V. & Connolly, J. (2021) The governance of nature-based solutions in the city at the intersection of justice and equity. *Cities*. 112, 103136. doi:https://doi.org/10.1016/j.cities.2021.103136.

Shackleton, C. (2023) Urban Green Infrastructure, Biodiversity, Poverty, and Equity. In: *Routledge Handbook of Urban Biodiversity*. London, Routledge. pp. 307–319. doi:https://doi.org/10.4324/9781003016120-25.

Shrestha, R., Telkmann, K., Schüz, B., Koju, P., Shrestha, R., Karmacharya, B. & Bolte, G. (2022) Measuring Environmental Justice in Real Time: A Pilot Study Using Digital Participatory Method in the Global South, Nepal. *International Journal of Environmental Research and Public Health*. 19 (8), 4752. doi:https://doi.org/10.3390/ijerph19084752.

Sibbald, K.R., Phelan, S.K., Beagan, B.L. & Pride, T.M. (2025) Positioning Positionality and Reflecting on Reflexivity: Moving From Performance to Practice. *Qualitative Health Research*. 0 (0). doi:https://doi.org/10.1177/10497323241309230.

Stantcheva, S. (2022) How to Run Surveys: A Guide to Creating Your Own Identifying Variation and Revealing the Invisible. *SSRN Electronic Journal*. 15 (1), 205–234. doi:https://doi.org/10.2139/ssrn.4238254.

Statistics Sierra Leone (2015) *Population and Housing Census* . https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf.

Sultana, F. (2022) Critical Climate Justice. *The Geographical Journal*. 188 (1), 118–124. https://rgs-ibg.onlinelibrary.wiley.com/doi/full/10.1111/geoj.12417.

Terdoo, F. (2024) Assessing the role of participatory planning approach in enhancing informal settlements upgrading in low income regions. *Discover Global Society*. 2 (1). doi:https://doi.org/10.1007/s44282-024-00117-w.

Thorn, J.P.R., Biancardi Aleu, R., Wijesinghe, A., Mdongwe, M., Marchant, R.A. & Shackleton, S. (2021) Mainstreaming nature-based solutions for climate resilient

infrastructure in peri-urban sub-Saharan Africa. *Landscape and Urban Planning*. 216 (15), 104235. doi:https://doi.org/10.1016/j.landurbplan.2021.104235.

Trisos, C.H., Auerbach, J. & Katti, M. (2021) Decoloniality and anti-oppressive practices for a more ethical ecology. *Nature Ecology & Evolution*. 5 (9), 1205–1212. doi:https://doi.org/10.1038/s41559-021-01460-w.

UNDP (2025) Building climate resilience through reforestation Case Study on the City of Freetown, Sierra Leone. *Freetown The Treetown, Sierra Leone*. https://sdglocalaction.org/wp-content/uploads/2025/06/ENG_Freetown-guidelines.pdf.

UNDRR (2024) Ecosystem-Based Disaster Risk Reduction Implementing Nature-based Solutions for Resilience. *Undrr.org*. https://www.undrr.org/media/48333.

Wang, H. & Ran, B. (2021) Network governance and collaborative governance: a thematic analysis on their similarities, differences, and entanglements. *Public Management Review*. 25 (6), 1–25. doi:https://doi.org/10.1080/14719037.2021.2011389.

World Bank (2018) *The World Bank Sierra Leone Multi-City Hazard Review and Risk Assessment Final Report (Volume 2 of 5): Freetown City Hazard and Risk Assessment Public Disclosure Authorized Public Disclosure Authorized Public Disclosure Authorized Public Disclosure Authorized*. https://documents1.worldbank.org/curated/en/151281549319565369/pdf/130797-v2-Final-Report-Volume-2-of-5-Freetown-City-Hazard-and-Risk.pdf.

Worldpop (2025) *Sierra Leone - Spatial Distribution of Population (2015-2030)* | *Humanitarian Dataset* | *HDX*. 2025. Humdata.org. https://data.humdata.org/dataset/worldpop-population-counts-2015-2030-sle [Accessed: 16 August 2025].

Wu, X., Liu, J. & Hou, Y. (2025) Data and methods for assessing urban green infrastructure using GIS: A systematic review C. Hu (ed.). *PLOS One*. 20 (6), e0324906. doi:https://doi.org/10.1371/journal.pone.0324906.

Yang, Y. & Tang, S. (2025) Examining Residents' Perceptions and Usage Preferences of Urban Public Green Spaces Through the Lens of Environmental Justice. *Sustainability*. 17 (6), 2627. doi:https://doi.org/10.3390/su17062627.

York, A. & Yazar, M. (2022) Leveraging shadow networks for procedural justice. *Current Opinion in Environmental Sustainability*. 57 (6), 101190. doi:https://doi.org/10.1016/j.cosust.2022.101190.

Appendices

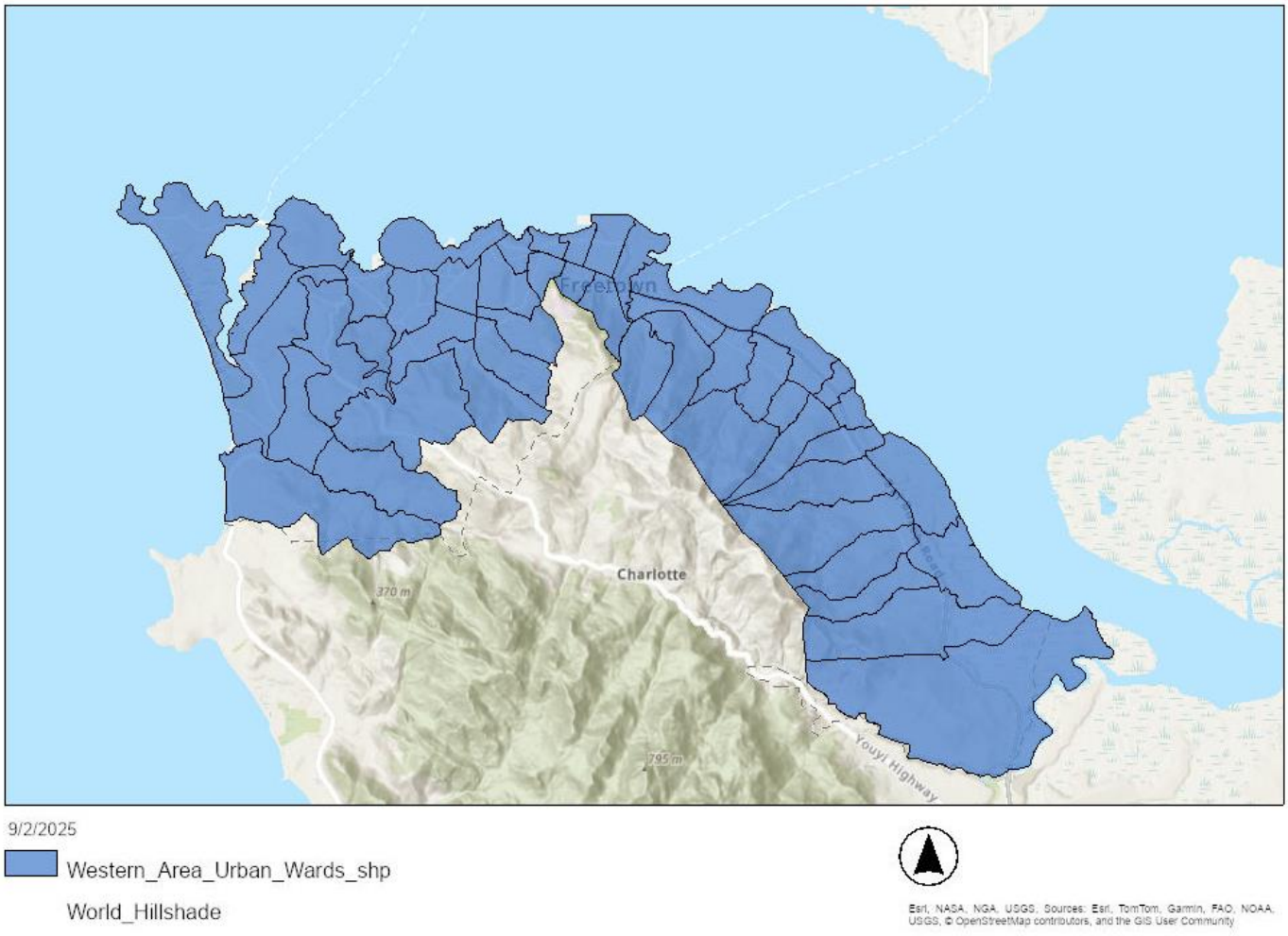
Appendix A: *Ethics and risk assessment documentation*

This appendix includes the ethics approval form and participant information sheets used during the study. All procedures complied with justice-aware research ethics standards. [Access Here]

Appendix B: *Final survey instrument*

This instrument assessed distributive and recognitional justice within the Freetown Tree Town (FTT) campaign. It includes structured questions on perceived benefits (e.g., shade, fruit, flood mitigation), burdens (e.g., land-use conflict, exclusion), and tree preferences, grouped by tenure, gender, income, and ethnicity. [Access Here]

Appendix C: *FCC 2019 Ward Boundaries, Freetown*



Administrative ward boundaries for Freetown City Council (FCC), derived from official shapefiles (FCC, 2019). These polygons provide the spatial framework for aligning household survey anchors, population data, and 2023 tree planting locations in subsequent environmental justice analyses.

Appendix D: *Summary of Interview Participants*

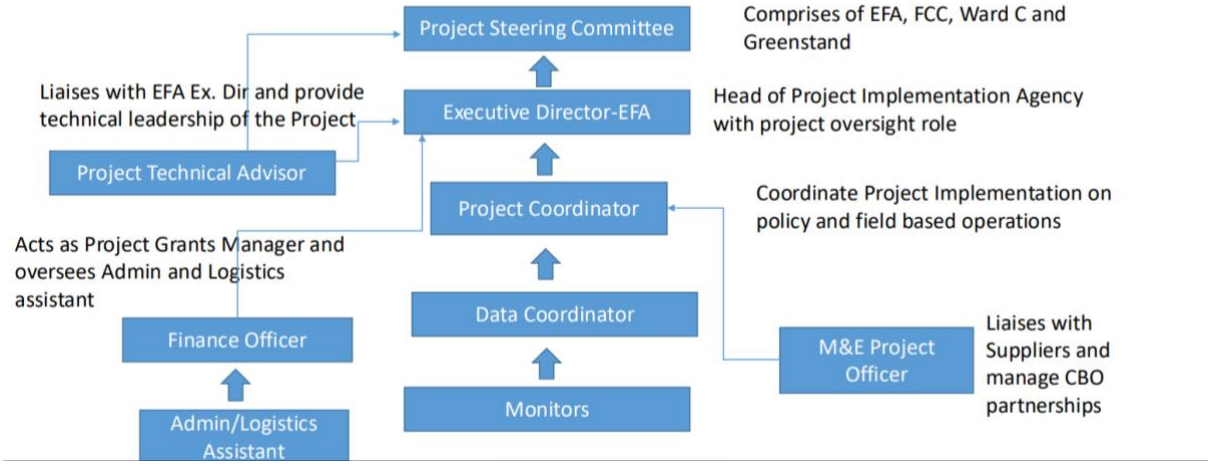
This table presents an anonymised overview of individuals interviewed during the stud each identified by a participant code (P1, P2, etc.) outlining their roles, institutional affiliations, sectors of engagement, and scale of operation. The data supports the qualitative analysis by offering insight into the diversity of perspectives included.

Participant ID	Scale of Operation	Sector	Institution Type
P1	**Community/City**	Community development	Religious group/ local govt
P2	**Community/City**	Community development	CBO/resident
P3	**Community**	Community development	Youth group
P4	**Community**	Community development	Women's group/ resident
P5	**Community**	Community lead	Local govt/ resident
P6	**Community**	Community development	Local govt/ resident
P7	**Community**	Community development	Relgious group/ local govt/ resident
P8	**Community**	Community development	Local govt/ resident
P9	**Community**	Community development	Women's group/resident/ tracker
P10	**City**	Development	FCC (Freetown the Treetown)
P11	**City**	Community development	FCC (Freetown the Treetown)
P12	**City**	Development	FCC (Freetown the Treetown)
P13	**Community/City**	Development	FCC (Freetown the Treetown)
P14	**National**	Informality	CBO
P15	**National**	Informality	CBO
P16	**Community**	Community lead	Local govt/ resident
P17	**Community**	Community development	Women's group/resident/ tracker
P18	**Community**	Community development	Religious leader
P19	**Community**	Community development	Youth group / grower
P20	**Community**	Community development	Stakeholder/ resident
P21	**Community/City**	Community development	CBO/ resident
P22	**City**	Development	FCC (Freetown the Treetown)
P23	**City**	Development	FCC (Freetown the Treetown)
P24	**Community**	Informality	CBO/ resident
P25	**Community**	Community development	Women's group/ resident
P26	**Community/City**	Informality	CBO/ resident

Appendix E: *Justice-framed interview guides*

This appendix provides the semi-structured interview guides developed to investigate procedural and recognitional justice in Freetown's FTT project. Guides were tailored by stakeholder role and aligned with environmental justice principles. [Access Here]

Appendix F: *Formal governance structure of the 2021 The Resilient Urban Sierra Leone Project (RUSLP) Tree Planting Project.*



The organogram shows a centralised hierarchy led by EFA, FCC, and Greenstand, with limited procedural influence from local actors. This top-down model highlights a key procedural justice concern around participation, transparency, and local accountability (Hickey, 2022).

Appendix G: *Gini Analysis Parameters*

Method parameters:

Accessibility radius: 2019 ward shapefiles, each ward's 2015 census and household survey anchors.

Ward boundaries: Derived from catchment shapefiles, used for spatial context and verification of anchor locations (FCC, 2019).

Inclusion rule: Tree counts assigned to ward whose nearest anchor is closest (no double-counting).

Population source: 2015 Census ward totals (Statistics Sierra Leone, 2015).

Tree dataset: Raw points from planting, no deduplication applied.

Formula for person-weighted Gini:

Formula for person-weighted Gini:

$$G = \frac{\sum_i \sum_j p_i \, p_j \, |a_i - a_j|}{2 \, \bar{a} \, (\sum_i p_i)^2}$$

$$where:$$

$$p_i = population\ in\ ward\ i$$

$$a_i = trees\ per\ capita\ in\ ward\ i$$

$$\bar{a} = population - weighted\ mean$$

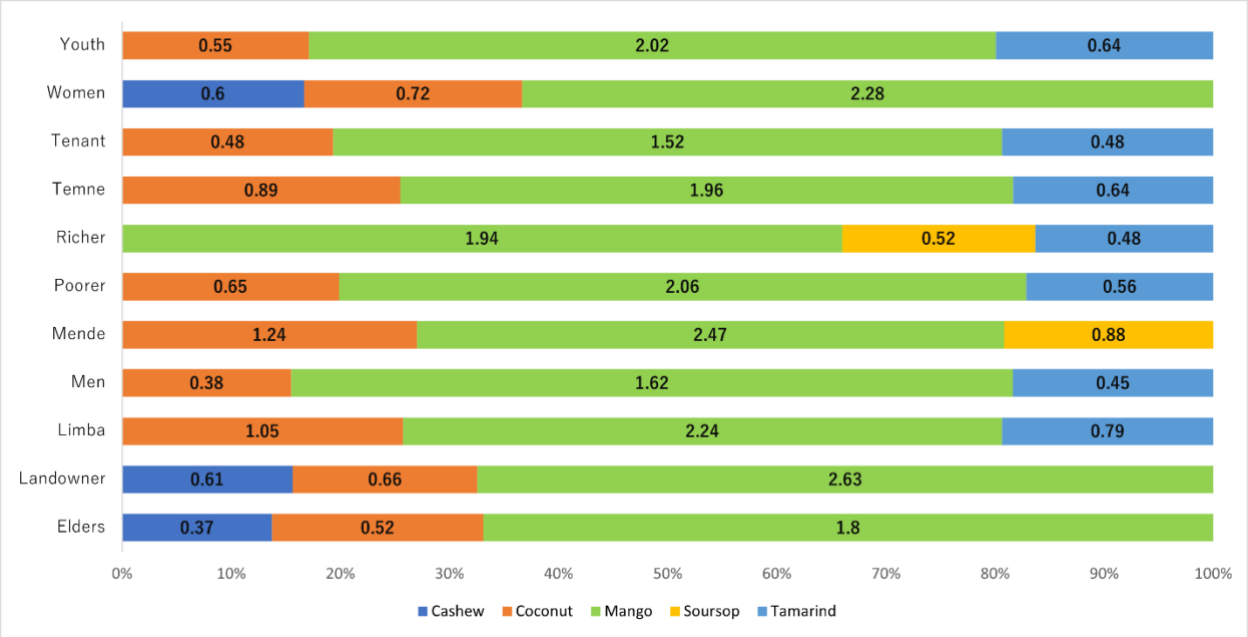
Appendix H: *Stakeholder scoring of power, influence, and inclusion (PII) in FTT governance, adapted from procedural justice framework, organogram and field data (Gordon, 2024; Lemke et al., 2024).*

Actor	Power (1–5)	Influence (1–5)	Inclusion (1–5)	Role & Position in Governance	Justification of Scores
International Donors (World Bank, Bloomberg, CRS, SAP, GEF)	5	5	4	**Strategic Controllers:** Top-tier funders setting quotas, wage frameworks, and carbon priorities via FCC and Steering Committee.	Scored high per *Sekulova et al. (2021)* on top-down NbS governance where donors dictate pace/species, sidelining local priorities.
Project Steering Committee (FCC, Ward Reps, Greenstand)	5	4	4	**Institutional Gatekeepers:** Align donor agendas with FCC, approve budgets, sites, and workplans.	*Bauer (2022)* highlights institutional gatekeeping, where ward voices are consultative but decision power sits with FCC and donors.
Freetown City Council (Mayor's Delivery Unit & TreeTracker Division)	5	4	4	**Municipal Chokepoint:** Executes planting, contracts, and reporting; manages TreeTracker and species approvals.	*Loos et al. (2022)* identify municipalities as regulatory chokepoints, prioritising KPI compliance (tree survival, carbon) over local decision-making.
Project Management Committee (PMC)	4	3	3	**Procedural Bottleneck:** Supervises daily operations, allocates work, enforces donor KPIs, escalates grievances selectively.	*Hickey (2022)* and *Sekulova et al. (2021)* describe such committees as procedural bottlenecks, controlling what community grievances reach higher tiers. Scores reflect mid-level control but limited autonomy.
Technical Advisors & Field Coordinators (EFA/FCC)	3	4	3	**Expert Brokers:** Provide hazard mapping, species recommendations, and logistics; integrate data into TreeTracker.	*Pulido & De Lara (2018)* critique technocratic hierarchies where experts steer agendas, often at the expense of local ecological knowledge (Calderón-Argelich et al., 2021). Scores reflect influence over strategy but limited participatory engagement.

Community-Based Organisations (CBOs, incl. FEDURP)	3	3	2	**Intermediary Brokers:** Deliver planting, train stewards, mediate land conflicts, run forums, link residents with FCC.	*Ramcilovic-Suominen et al. (2024)* frame CBOs as brokers of voice—they amplify concerns but, as *Bauer (2022)* notes, lack fiscal or strategic control, limiting procedural empowerment.
Local Stakeholders (Chiefs, CDMC Chairs, Religious Leaders)	3	4	2	**Community Gatekeepers:** Mobilise residents, host forums, resolve disputes, can block or enable planting.	Per *Frediani (2022)* and *Hickey (2022)*, chiefs and CDMCs hold informal gatekeeping power through land control and social legitimacy. While facilitating participation, they risk elite capture (biasing outcomes).
FCC Growing & Monitoring Groups	2	2	1	**Labour Force:** Plant, water, and monitor trees; raise operational issues via FCC forums and CBO's; execute KPIs.	*Haque & Sharifi (2024)* and *Shackleton (2023)* show these roles embody tokenistic inclusion: essential labour, some operational voice, but no influence over budgets or strategy.
Residents (Renters, Informal Workers, Youth)	1	1	1	**Marginalised End-Users:** Receive benefits (shade, fruit, hazard protection) but face burdens (land conflicts, space loss); excluded from strategic planting.	*Sultana (2022)* on climate justice exclusion and *Piroli (2025)* on recognitional gaps underscore why residents rank lowest: minimal agency beyond household species selection.

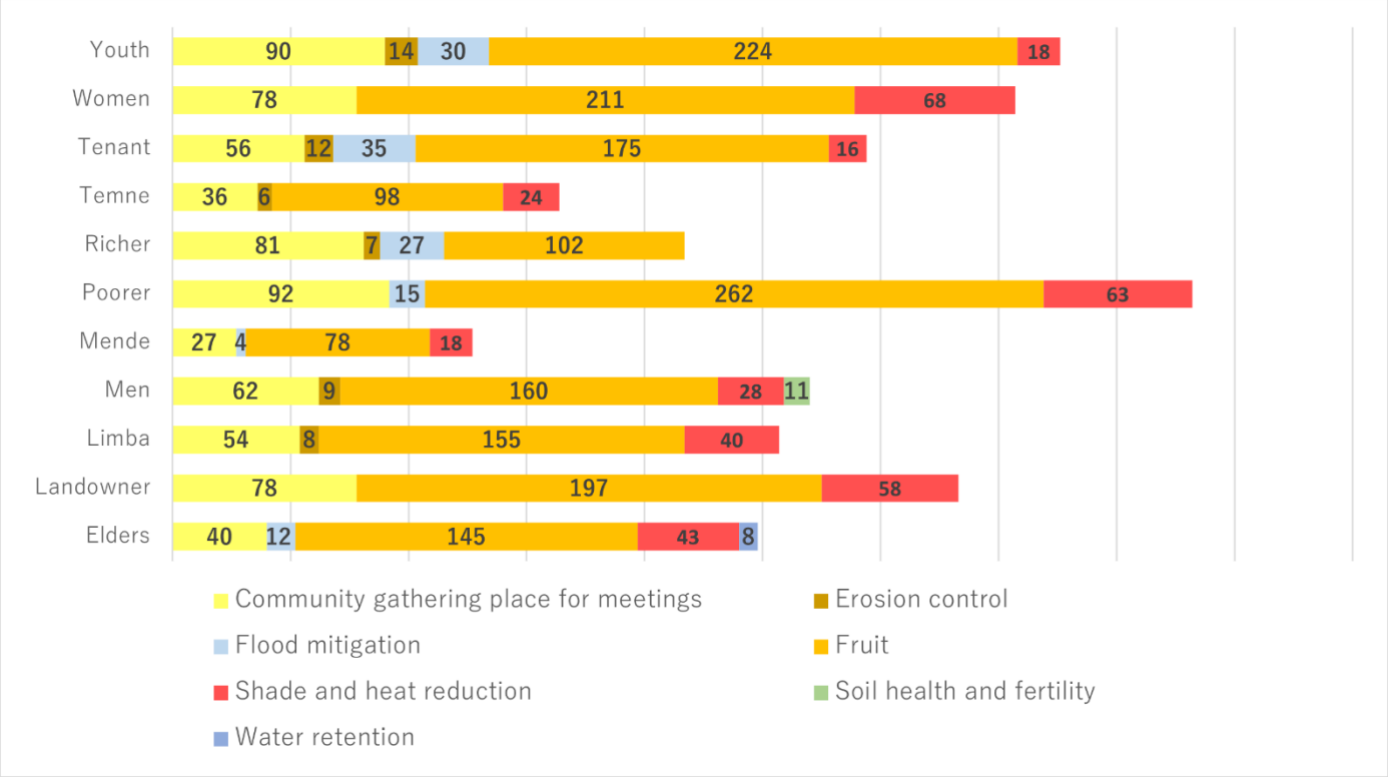
Power–Influence–Inclusion (PII) matrix assessing actor roles in Freetown's tree governance. Scores reflect formal authority, practical influence, and procedural inclusion. Analysis highlights a hierarchy of control, with international donors and municipal bodies dominating strategic decisions, while CBOs, informal leaders, and residents remain structurally marginalised. Justifications draw on relevant procedural justice literature.

Appendix I: *Average per-person preference scores for the top five tree species in Freetown's urban reforestation campaign.*



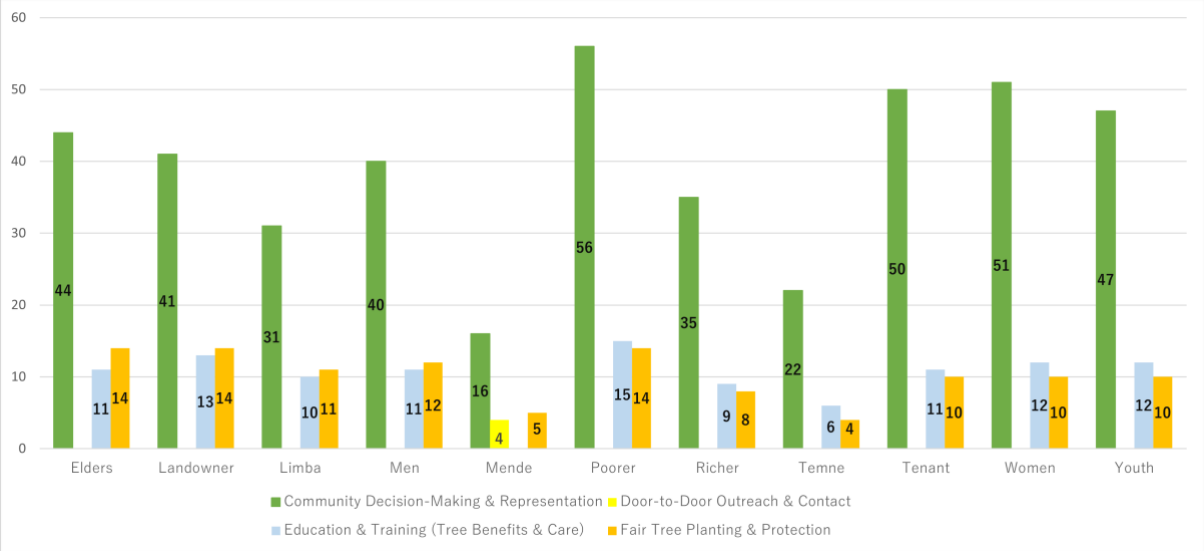
Mango dominates across all social and ethnic groups, reflecting its cultural and provisioning value. Coconut is most preferred by Mende and Limba households, while cashew is favoured by women, elders, and landowners. Soursop and tamarind remain niche, mainly among Mende and wealthier groups, underscoring socially and ethnically differentiated preferences important for culturally responsive NbS planning (Terdoo, 2024).

Appendix J: *Perceived ecosystem service benefits of preferred trees in Freetown's urban reforestation, by social and ethnic group (number of mentions).*



Fruit provision dominates across all groups, especially poorer households, women, and youth, highlighting the primacy of provisioning services for livelihoods. Cultural benefits such as community gathering are secondary, while regulating and supporting services (erosion control, flood mitigation, soil health) are far less cited. This pattern reflects a preference for immediate benefits over longer-term ecological functions, revealing recognitional and distributive justice gaps in NbS planning (Eakin et al., 2025).

Appendix K: *Frequency of suggested improvements to Freetown's urban reforestation campaign by social and ethnic group, thematically coded to procedural justice categories.*



Suggestions centred on decision-making, training, tree protection, and outreach. Poorer, tenant, women, and youth groups contributed most, while Mende and Temne offered fewer, revealing procedural and recognitional gaps concentrated among landless, vulnerable groups, and uneven ethnic participation in FTT (Grant et al., 2024).

Code block

Code A1. *Python script for cleaning survey data and aggregating ecosystem services by social group*

```
# ——————————— 1. LOAD SURVEY DATA ———————————

xlsx_path =
"Household+survey_+Assessing+equity+in+Freetown’s+urban+reforestation+efforts_July+7,+2025_07.22
.xlsx"

df = pd.read_excel(xlsx_path, skiprows=1)

# ——————————— 2. CLEAN & GROUP DEMOGRAPHICS ———————————

df["Age_Clean"] = pd.to_numeric(df["Age (years)"].astype(str).str.replace("+", "", regex=False),
errors="coerce")

df["Income_Clean"] = pd.to_numeric(df["If you are comfortable, Monthly household income (SLL)"],
errors="coerce")

df["Gender_Group"] = df["Gender"].apply(lambda x: "Women" if isinstance(x, str) and x.strip().lower() in
{"female", "woman"} else "Men")

df["Age_Group"] = df["Age_Clean"].apply(lambda x: "Youth" if pd.notna(x) and x <= 35 else ("Elders" if
pd.notna(x) else np.nan))

df["Income_Group"] = df["Income_Clean"].apply(lambda x: "Richer" if pd.notna(x) and x >= 4740 else
("Poorer" if pd.notna(x) else np.nan))

df["Tenure_Group"] = df["Tenure status"].apply(lambda x: "Landowner" if isinstance(x, str) and any(k in
x.lower() for k in ["own", "title", "landlord"]) else ("Tenant" if isinstance(x, str) else np.nan))

df["Ethnicity"] = df["Ethnic group - Selected Choice"]

mask_other = df["Ethnicity"].isna() | (df["Ethnicity"].astype(str).str.strip().str.lower() == "other")

df.loc[mask_other, "Ethnicity"] = df["Ethnic group - Other (please specify) - Text"]

df["Ethnicity"] = df["Ethnicity"].astype(str).str.strip()

df.loc[df["Ethnicity"].isin(["", "nan"]), "Ethnicity"] = np.nan

df.rename(columns={"Ethnicity": "Ethnicity_Group"}, inplace=True)

3. DEFINE ECOSYSTEM SERVICE CATEGORIES

ecosystem_services = {

   "Provisioning": [f"Tree {i}: For this tree, what materials do these plants provide for your household
(provisioning)? - Selected Choice" for i in range(1, 4)],

   "Regulating": [f"Tree {i}: How does this plant improve the risk of climate change (regulatory)? - Selected
Choice" for i in range(1, 4)],

   "Supporting": [f"Tree {i}: How does this plant support improving your environment (supporting)? -
Selected Choice" for i in range(1, 4)],

   "Cultural": [f"Tree {i}: Does this plant provide any social or cultural benefits (cultural)? - Selected
Choice" for i in range(1, 4)],

group_columns = {
```

Code B1. *Python script for calculating net perceived trade-offs by social group*

1. LOAD SURVEY

xlsx_path = ("Household+survey_+Assessing+equity+in+Freetown's+urban+reforestation+efforts_" "July+7,+2025_07.22.xlsx") df = pd.read_excel(xlsx_path, skiprows=1) # skip Qualtrics meta-row

2. CLEAN DEMOGRAPHICS

df["Age_Clean"] = (df["Age (years)"].astype(str).str.replace("+", "", regex=False)) df["Age_Clean"] = pd.to_numeric(df["Age_Clean"], errors="coerce") df["Income_Clean"] = pd.to_numeric(df["If you are comfortable, Monthly household income (SLL)"], errors="coerce")

df["Gender_Group"] = df["Gender"].apply(lambda x: "Women" if isinstance(x, str) and x.lower().strip() in {"female", "woman"} else "Men") df["Age_Group"] = df["Age_Clean"].apply(lambda x: "Youth" if pd.notna(x) and x <= 35 else ("Elders" if pd.notna(x) else np.nan)) df["Income_Group"] = df["Income_Clean"].apply(lambda x: "Richer" if pd.notna(x) and x >= 4740 else ("Poorer" if pd.notna(x) else np.nan)) df["Tenure_Group"] = df["Tenure status"].apply(lambda x: "Landowner" if isinstance(x, str) and any(t in x.lower() for t in ("own", "title", "landlord")) else ("Tenant" if isinstance(x, str) else np.nan))

Ethnicity: combine Selected + Other

eth_selected = df["Ethnic group - Selected Choice"].astype(str).str.lower().str.strip() df["Ethnicity"] = eth_selected.replace({"nan": np.nan, "": np.nan}) top3_eth = df["Ethnicity"].value_counts().head(3).index.tolist() df["Ethnicity"] = df["Ethnicity"].where(df["Ethnicity"].isin(top3_eth))

3. DEFINE TRADE-OFF COLUMNS BY THEME

tradeoff_cols = { "Social": [c for c in df.columns if c.lower().startswith("social")], "Environmental": [c for c in df.columns if c.lower().startswith("environmental")], "Governance": [c for c in df.columns if c.lower().startswith("governance")], "Land Use": [c for c in df.columns if c.lower().startswith("land use")], "Economic": [c for c in df.columns if c.lower().startswith("economic")], }

4. CALCULATE SIGNED BURDENS PER GROUP

group_defs = { "Gender": "Gender_Group", "Age": "Age_Group", "Income": "Income_Group", "Tenure": "Tenure_Group", "Ethnicity": "Ethnicity", }

records = [] for gtype, gcol in group_defs.items(): for gval, gdf in df.groupby(gcol): if pd.isna(gval): continue size = len(gdf) burdens = { theme: gdf[cols].apply(pd.to_numeric, errors="coerce").fillna(0).sum().sum() for theme, cols in tradeoff_cols.items() } total = sum(burdens.values()) records.append({ "Group Type": gtype, "Group": gval, **burdens, "Total Burden": total, "Group Size": size, "Burden per Person": round(total / size, 2) if size else np.nan, })

result_df = pd.DataFrame(records)

5. SAVE RESULTS

with pd.ExcelWriter(xlsx_path, mode="a", engine="openpyxl", if_sheet_exists="replace") as writer: result_df.to_excel(writer, sheet_name="Net_TradeOffs", index=False)

Code C1. *Python script for thematic tagging of community improvement responses*

```
# ——————————— 1. LOAD DATA ———————————

file_path =
"Household+survey_+Assessing+equity+in+Freetown’s+urban+reforestation+efforts_July+7,+2025_07.22
.xlsx"df = pd.read_excel(file_path, skiprows=1)

# ——————————— 2. CLEAN & GROUP DEMOGRAPHICS ———————————

df['Age_Cleaned'] = df['Age (years)'].astype(str).str.replace('+', '',
regex=False).str.extract(r'(\d+)')[0].astype(float)

df['Age_Group'] = np.where(df['Age_Cleaned'] <= 35, 'Youth', 'Elders')

df['Income_Cleaned'] = df['If you are comfortable, Monthly household income (SLL)'].apply(lambda x:
pd.to_numeric(str(x).replace(',', ''), errors='coerce'))

df['Income_Group'] = np.where(df['Income_Cleaned'] >= 4740, 'Richer', 'Poorer')

df['Gender_Group'] = df['Gender'].astype(str).str.lower().apply(lambda x: 'Women' if 'female' in x or
'woman' in x else 'Men')

df['Tenure_Group'] = df['Tenure status'].astype(str).str.lower().apply(lambda x: 'Landowner' if any(w in x for
w in ['own', 'title', 'landlord']) else 'Tenant')

df['Ethnicity_Raw'] = df[['Ethnic group - Selected Choice', 'Ethnic group - Other (please specify) -
Text']].bfill(axis=1).iloc[:, 0].fillna('').astype(str).str.strip()

top_ethnicities = df['Ethnicity_Raw'].value_counts().nlargest(3).index.tolist()

df['Ethnicity_Group'] = df['Ethnicity_Raw'].apply(lambda x: x if x in top_ethnicities else 'Excluded')

# ——————————— 3. PREPARE TEXT RESPONSES (QID72) ———————————

qid72_col = [col for col in df.columns if 'Freetown The Treetown' in col][0]

df['QID72_Response'] = df[qid72_col].fillna('').astype(str).str.lower()

# ——————————— 4. DEFINE THEMES (STRICT KEYWORDS) ———————————

themes_strict = {

  'Community Decision-Making & Representation': ['community', 'engagement', 'meeting', 'meetings',
'stakeholder', 'decision', 'planning', 'involve', 'women', 'youth', 'voice', 'community engagement',
'community meetings', 'stakeholder engagement', 'decision-making', 'let everyone participate', 'include
elders, women and youth', 'residents involved in planning'],

  'Door-to-Door Outreach & Contact': ['door', 'house', 'campaign', 'sensitisation', 'sentizasation',
'mobiliser', 'radio', 'door-to-door campaign', 'visit every house', 'house-to-house sensitisation', 'radio
sensitisation', 'community mobilisers', 'household visits'],

  'Education & Training (Tree Benefits & Care)': ['education', 'educate', 'awareness', 'training', 'workshop',
'workshops', 'explain', 'benefits', 'knowledge', 'educate the community about tree benefits', 'school
education sessions', 'tree care training', 'community workshops', 'awareness drives'],

  'Fair Tree Planting & Protection': ['tree', 'trees', 'planting', 'plant', 'protect', 'replace', 'underserved',
'bylaws', 'tree planting', 'plant more trees', 'spread trees evenly', 'replace dead trees', 'enforce bylaws to
protect trees', 'plant in flood-prone areas', 'more fruit and mangrove trees'],
```

Code D1. *Python script for analysing tree preference scores and ecosystem service benefits across social groups*

```
# Load data

df = pd.read_excel("Household+survey_+Assessing+equity+in+Freetown’s+urban+reforestation+efforts_July+7,+2025_07.22.xlsx", skiprows=1)

# Clean and classify groups

df["Age_Cleaned"] = pd.to_numeric(df["Age (years)"].astype(str).str.replace("+", "", regex=False), errors='coerce')

df["Income_Cleaned"] = pd.to_numeric(df["If you are comfortable, Monthly household income (SLL)"], errors='coerce')

df["Gender_Group"] = df["Gender"].astype(str).str.lower().apply(lambda x: "Women" if x in ["female", "woman"] else "Men")

df["Age_Group"] = df["Age_Cleaned"].apply(lambda x: "Youth" if pd.notna(x) and x <= 35 else "Elders")

df["Income_Group"] = df["Income_Cleaned"].apply(lambda x: "Richer" if pd.notna(x) and x >= 4740 else "Poorer")

df["Tenure_Group"] = df["Tenure status"].astype(str).str.lower().apply(lambda x: "Landowner" if any(k in x for k in ["own", "title", "landlord"]) else "Tenant")

df = df[df['Ethnic group - Selected Choice'].notna()]

# Tree ranking columns and names

tree_rank_cols = [col for col in df.columns if "What are the three most important trees" in col and "Text" not in col]

tree_name_map = {col: re.search(r"- (.+)", col).group(1).strip() if re.search(r"- (.+)", col) else col for col in tree_rank_cols}

rank_points = {1: 3, 2: 2, 3: 1}

# Ecosystem benefit columns

ecosystem_cols = {

  cat: [f"Tree {i}: {q}" for i in [1,2,3]]

  for cat, q in {

    "Provisioning": "For this tree, what materials do these plants provide for your household (provisioning)? - Selected Choice",

    "Regulating": "How does this plant improve the risk of climate change (regulatory)? - Selected Choice",

    "Supporting": "How does this plant support improving your environment (supporting)? - Selected Choice",

    "Cultural": "Does this plant provide any social or cultural benefits (cultural)? - Selected Choice"

  }.items()

}
```