Covenant of Mayors
in Sub-Saharan Africa

STRATEGIC PAPER

CLIMATE INFRASTRUCTURE & CITY GOVERNMENTS: A STRATEGIC FRAMEWORK FOR AFRICAN CITY-LABS

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List of acronyms

ACC – African Centre for Cities, University of Cape Town

ACDI – African Climate and Development Institute, University of Cape Town

AU – African Union

BRT – Bus Rapid Transit

CoM SSA – Covenant of Mayors in Sub-Saharan Africa

CP – Convening partner

CSAG – Climate Systems Analysis Group, University of Cape Town

CURI – Centre for Urban Research Innovations, University of Nairobi

DMP – Decision-making partner

ESRF – Economic and Social Research Foundation

FBO – Faith-based organisation

FCDO – Foreign Commonwealth and Development Office, United Kingdom

FRACTAL – Future Resilience in African Cities and Land, University of Cape Town

G8 – Group of Eight (highly industrialised nations)

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit

ICT – Information Communication Technology

INGO – International non-government organisation

IPCC – International Panel on Climate Change

KPI – Key performance indicators

MLG – Multi-level government

MUF – Mistra Urban Future

NDCs – Nationally Determined Contributions

NGO – Non-governmental organisation

RDP – Reconstruction and Development Programme

SDGs – Sustainable Development Goals

SP – Strategic partner

Executive summary

Introduction

African countries have not created the climate crisis – however, they must respond to it. As many of the risks and hazards related to climate change impact on cities and urban infrastructure systems, city authorities are increasingly asked to confront this crisis.

The imperative to work at the urban infrastructure and climate nexus: Development partners are increasingly concerned with how African cities will face the climate crisis. A myriad of climate-informed interventions have been developed in and for African cities. But they are often informed by assumptions, ideas, and structures that originate in the global North, without a clear understanding of Africa's material and institutional dynamics. The deficit in understanding of issues shores up in concrete ways. It takes up the time and energy of stretched officials who now must participate in cumbersome and ill-fitting processes. Interventional development agencies have a critical role to play in directing resources and using their convening power. However, the current models for climate intervention require revision.

The challenge for Africa's cities: The status quo of infrastructure investment and local government capacity do not adequately address the climate risks facing African cities. Challenging this inertia requires contending with troubled and political realities. Africa's infrastructure deficits and delivery models are embedded in entrenched systems. The continent has endured prolonged exploitation. Over the past 20 years, incredible efforts have been made to redress problematic legacies. However, structural challenges circumscribe transformation. Thinking holistically about infrastructure pathways in the context of various climate scenarios demands new sense-making and planning ideas and practices.

The purpose: This paper provides a framework to support the development of 'city-labs' in African cities. The focus is specifically on labs that tackle the challenging intersection between urban infrastructure development, climate resilience, and local governance. We propose the city-lab as an inclusive approach that seeks to foster necessary capacities and capabilities and identify resources, addressing critical and vexing challenges in African cities.

City-labs: addressing complex urban problems

What is a city-lab? 'City-labs' are structured processes for bringing together different stakeholders, such as government, civil society, and academia, to co-produce and utilise knowledge aimed at addressing complex urban problems. One of the core ideas underpinning the lab method is that new and innovative ideas for how to solve urban issues can come from co-producing knowledge with diverse stakeholders.

Tackling complex problems requires bringing together different rationalities, types of knowledge (practical, theoretical, academic, local, etc.), mandates, and resources to co-produce knowledge and co-construct action plans.

The basic structures to support labs: City-labs have taken different forms in different places, depending on the local context. The basis of the city-lab is a set of core partnerships: The Strategic Partner is an external organisation that provides funding and technical support and enables sharing among city-lab platforms in different cities. The Convening Partner is a local partner that acts as an intermediary organisation to ground and facilitate the lab process. The Decision-Making Partner is an actor – usually a government actor – nested within the decision-making space that is willing to support the lab. City-labs should be supported by formal agreements between the Core Partners. A well-crafted agreement protects the process from political shifts, staffing changes, and financial risk any partners might face. The lab is nested within a larger network of stakeholders (sometimes called the 'platform' or the 'ecosystem'). This includes a wide range of actors from the academy, civil society, state, and private sectors.

City-lab methods: City-labs can be used to address all sorts of complex issues facing cities. A key part of developing innovative ways of working is to develop richer and more complex understandings of the problems at hand. Once the general lab topic and approach are identified, the activities and tactics for co-production can be designed. While the lab process provides an indication of the outcomes required, it does not provide a rigid framework for producing them. Examples of activities that can be used include: Workshops; Seminars; Field trips; Collaborative research; and Embedding/dis-embedding researchers, officials, or activists in new contexts. In addition to these activities within city-labs, it is also useful to share experiences, practices, and knowledge with other city-labs, to be able to learn from other sectors or other cities.

'Doing' city-labs: three phases

There is no blueprint for city-labs. However, based on experience and a review of literature, city-labs have three broad phases, which are unpacked in detail in this section.

Formulation: The Formulation phase is essential for establishing the basis for the lab. This phase determines if the context is suitable for a lab, what issue the lab should focus on, and how the institutional structures should be established. If a key issue is not immediately apparent, a diagnostic study can be used to generate a high-level understanding of the problems in the city. In the Formulation phase, the resourcing of the implementation structure can be done on a case-by-case basis. It is important to mark the end of the Formulation phase and the launch of the lab. This generally takes the form of a curated event open to a wide group of stakeholders. Its purpose is to activate the wider network, share an overview of the process, and get buy-in. By the close of the Formulation phase the Core Partners should be established, and the problem the lab will address should have been selected and stress-tested. There should also be widespread understanding of what a lab is (and is not), and how people and institutions can get involved.

Generation: The Generation phase is the core of the lab process. While a problem has been selected in the Formulation phase, the unpacking of this problem is on-going through the Generation phase. This involves asking a set of important questions, for example: Who is involved in the problem? How do different stakeholders in the network 'see' the problem differently? What sorts of interventions have been tried to address this problem in the past? It is important to create a shared understanding of what it would look like for this problem to be adequately addressed. Once both the status quo and the desired future have been mapped, it is possible to craft tentative pathways toward this future. It is important to be creative and expansive in this process. Once a long and imaginative list of pathways is developed, it is important to bring this back to reality, to where the network can effect meaningful change. The sorts of barriers that might be identified could include things like: Policy or institutional issues; Social or political constraints. Understanding the problem, the desired future, and the challenges and blockages provides a foundation for identifying viable entry points to change the system. For each entry point, programmes of action need to be developed. For these programmes to be meaningful, they need to be developed with the idea that such programmes will be taken forward by strong coalitions of actors within the lab network and decision-making space.

Institutionalisation and reflection: Labs, as structured processes, require closure and evaluation. They are meant to initiate different activities, ways of thinking, and ways of working. However, the lab itself is an incubator and must eventually allow for its work to be institutionalised. At the close of the lab, it is important to reflect on what worked and did not work, as well as how insights and relationships can be taken forward. Depending on what the lab set out to do, institutionalisation of the lab processes will differ. However, the goal is that the new knowledge and plans become embedded in the decision-making space. The activities of the city-lab will need to be monitored and evaluated to reflect on learnings and impact.

African cities: Climate infrastructure & governance

Labs can (only) address the complexity and inherent uncertainties African cities face if they are grounded in a solid understanding of African city contexts. This section not only provides the framework for understanding what a city-lab is (and is not), it also provides a frame for understanding how infrastructure, climate, and urban governance intersect in African contexts.

African urban patterns and projections: Despite incredible diversity, there are some common dynamics and trends which shape African cities in particular and similar ways: Africa is rapidly urbanising, with a compounding effect on demographics (e.g. concentration of young people); informality is increasing across African cities; and the nature of urban governance is determinative.

Infrastructure of African cities: Owing to complex colonial histories, key urban infrastructures in many African cities often serve only small areas, and are not sufficient to meet demand. Supplemental providers fill the gaps, raising questions around safety and other concerns, and resulting in a lack of uniformity

(Credit: Liza Rose Cirolia)

in city infrastructure – with users generally paying higher costs for the more distributed infrastructure technologies. Hybrid services also create problems for city governments trying to mitigate climate change.

Impacts of a changing climate and a net-zero carbon transition: Physical changes leading to heatwaves and other intense weather events create extra hazards and risks in African cities, which also face risks and potential opportunities associated with global low-carbon or net-zero carbon transitions, including the potential for lowering costs.

Investing in climate-resilient, low-carbon urban infrastructure: In developing the infrastructures needed to meet urban and demographic pressures, cities can continue along the status quo, or they can consider the need for adaptive capacity, responsiveness, ecological resilience, and carbon-neutrality. Efforts are needed to ensure that infrastructure choices do not lock African cities, countries, and regions into unsustainable development pathways. The city-labs approach is designed to support and foster the engagements and thinking needed to underpin climate-compatible infrastructure planning and investment.

Conclusion

It is important that cities develop adaptive and sustainable responses to the risks and impacts which climate change create on urban infrastructure and service-delivery systems. These approaches must involve developing capacity to think and act differently, breaking silos between sectors, spheres of government, the state, and urban citizens.

(Credit: Liza Rose Cirolia)

1. INTRODUCTION

African countries have not created the climate crisis – however, they must respond to it. There is an urgent need to improve the relationship between existing and desired infrastructure systems, planning processes, and climate change in Africa. This imperative is underpinned by dynamics that play out in particular ways in the continent's urban centres and urbanising areas. Cities are critical to national development ambitions, and to international plans such as the UN's sustainable development goals (SDGs) and the AU's Agenda 2036. There is an urgent need to improve the capacity of cities, and local governments in particular, to respond to the imperatives created and risks posed by climate change. While African city authorities often have limited powers and fiscal resources, they experience the implications of the global climate crisis. Meaningful intervention must be attentive to the scale and urgency of the challenge, the particular confluences of risks and uncertainties in African cities, and the reality of urban governance constraints impacting on local authorities.

1.1 The imperative to work at the urban infrastructure and climate nexus

A myriad of climate-informed interventions are being developed in and for African cities. These interventions often operate with partial and insufficient knowledge and information. They are often informed by assumptions, ideas and structures that originate in the global North, without a clear understanding of Africa's material and institutional dynamics.

The deficit in understanding of issues that emerge at the intersections between infrastructure, climate, and local governance shore up in concrete ways. They take up the time and energy of stretched officials who must participate in cumbersome and ill-fitting processes. They are also reflected in severe investment backlogs, plans that fail over years to secure finance, or projects that fail to deliver promised local benefits.

International development agencies have a critical role to play in directing resources and using their convening power to facilitate urban climate interventions that support and improve the capacities of local governments to respond to unprecedented challenges on the horizon. These interventions must simultaneously develop critical urban sense-making capacity, generate information, knowledge and insight to support decision-making, trial new modes of responses, and have concrete and felt impacts for cities and those who live there.

1.2 The challenge for Africa's cities

While the challenges of climate, infrastructure and local governance play out differently across African cities, most cities will have to grapple with a pervasive tension. On the one hand, urban areas require investment to meet infrastructure backlogs and address future growth. At the same time, the status quo of infrastructure investment and local government capacity – from technology choices to financing

options – do not adequately address the climate risks and vulnerabilities which African cities face. Changing this trajectory is not easy. Africa's infrastructure deficits are embedded in entrenched systems. The continent has endured prolonged exploitation through colonisation and structural adjustment, and nations have had to work to overcome that legacy within the institutional parameters of mechanical modernism. Efforts to decentralise power over the past 30 years have been partial and fragmented, and have not resulted in strong local governments. The development of African cities today, and the tensions urban authorities face in grappling with contemporary crises and needs, cannot be understood outside of this historical palimpsest.

Over the past 20 years, incredible efforts have been made to redress problematic legacies. However, structural challenges circumscribe transformation. From practices of local planning to the structures of global development aid, plans and policies to address core deficits in material and institutional systems often unintentionally reproduce material and governance arrangements that are insufficient in the face of daunting and unprecedented ecological and social challenges. Some of the issues that limit the developmental impact of infrastructure and reinforce problematic outcomes include inadequate access, affordability (linked to poverty), vulnerability to biophysical risk, fragmentation between infrastructure systems, and appropriateness to local form and use. The emergent climate crisis and the transition response exacerbate the need for course correction while creating additional layers of complexity which decision-makers must contend with.

African local-governance actors, governments and others face a critical challenge in stewarding local development, driving infrastructure investment, and ensuring that such investments are resilient and adaptive to the emergent climate and transitions risks. There is a clear need to intervene with an anticipatory approach at these critical urban intersections. This intervention can involve a range of approaches drawing on different tools. However, thinking holistically about infrastructure pathways in the context of various climate scenarios demands new sense-making and planning ideas and practices.

These new approaches differ from entrenched ways of working in several ways. Most importantly, they aim for higher levels of integration, learning and adaptive capacity, from governance agreements through to implementation. These approaches are labelled, framed, and packaged in a variety of ways with various antecedents, with more and less applicability to particular contexts. What these ideas and tools have in common is a sensitivity to dynamic and contextual interconnectivity between infrastructure, biophysical systems, and human and social systems. They enable the iterative building of specific capacities, capabilities, and resources to navigate this complexity.

1.3 The purpose: developing relevant and effective city-labs

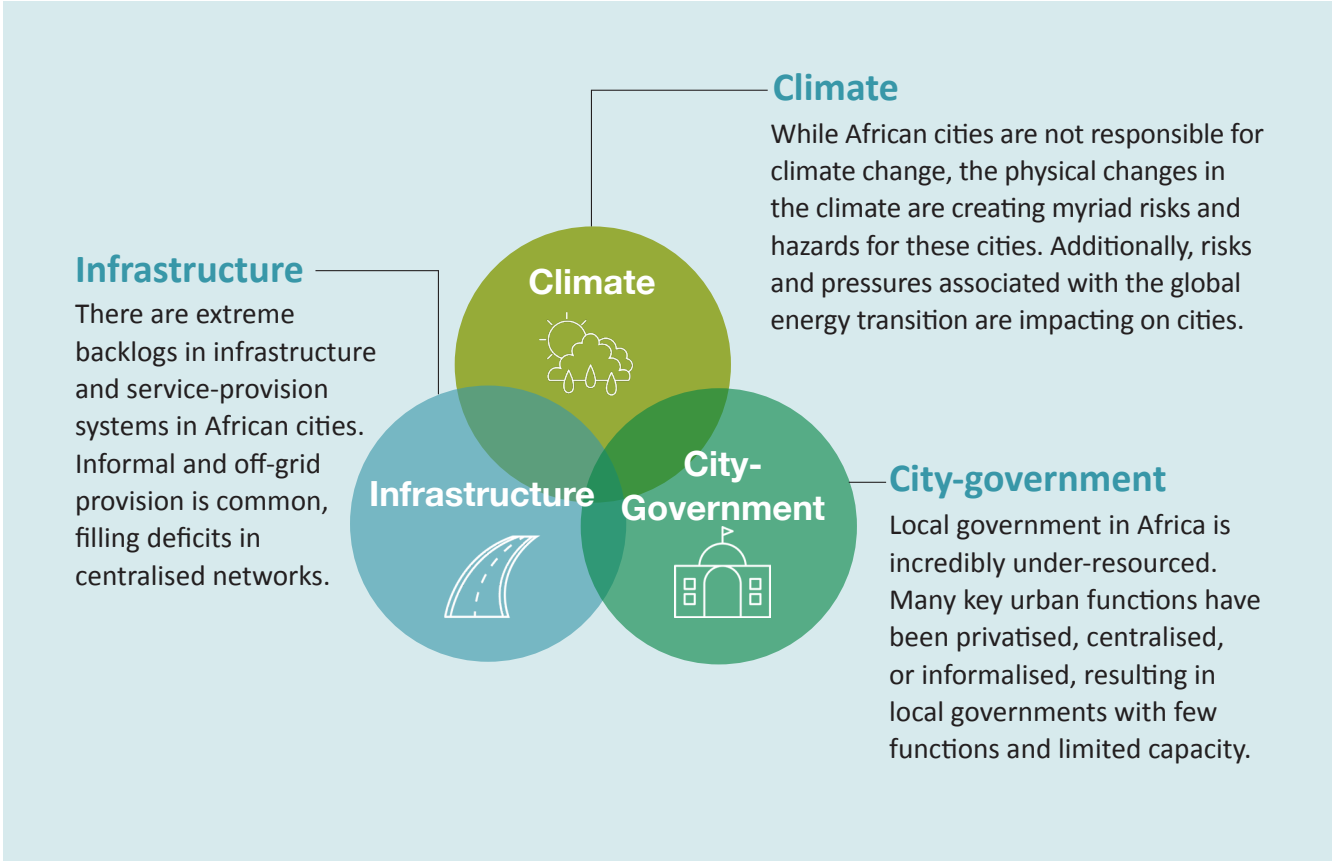
This paper provides a framework to support the development of 'city-labs' in African cities.

City-labs differ from other development approaches as they are:

- Centred on process
- Grounded in local institutions and experiences
- Dynamic and iterative, evolving as the process unfolds
- Focused on building capacity across the systems to respond to unknown futures

The focus is specifically on labs that tackle the challenging intersection between urban infrastructure development, climate resilience, and local governance. The figure below explains this:

Figure 1: Intersecting issues that city-labs can address



At the intersection of urban infrastructure and climate, there are a plethora of intertwined challenges, risks, and opportunities. These do not neatly fall into the ambit of a level of government (national versus local), particular sector, department, disciplinary expertise, or developmental paradigm. They require robust governance ecosystems to tackle them. We propose the city-lab as an inclusive approach that seeks to foster necessary capacities and capabilities and identify resources, addressing critical and vexing challenges in African cities.

(Credit: Liza Rose Cirolia)

1.4 Structure of this framework

This framework is divided into five sections:

- Section 1 has outlined the imperative into which this framework speaks. It has made the high-level case for new ways of working, attuned to the specificity of the African context, and the complexity of the challenges at hand
- Section 2 unpacks the case for the city-lab method, explaining what this framework means by 'city-labs', and the basic roles which need to be fulfilled in labs. This section also includes practical issues such as setting up lab agreements and funding
- Section 3 outlines how to 'do' labs. Lab processes are broken down into three steps: formulation, generation, and institutionalisation. Across these steps, the core teams may experiment with different activities and methods, iteratively refining the process
- Section 4 provides a conceptual exploration of the key themes of this lab: infrastructure, climate, and local governance. It is the intersections between these themes that drive the lab process. These are situated within important processes in Africa
- Section 5 provides a conclusion, outlining the way forward
- Annex 1 provides a tool for the rapid assessment of a city context. This tool is specifically for developing a baseline in a city under consideration for a city-lab process
- Annex 2 provides an overview of the lab processes which were reviewed to inform this paper
- Annex 3 provides a table of activities, and their application in different lab contexts

2. CITY-LABS: ADDRESSING COMPLEX URBAN PROBLEMS

There is increasing recognition of the mismatch between established development policy and practice conventions, and the scale, complexity, and local specificity of actual development challenges as they manifest in cities (Smit et al., 2015; Perry and Smit, forthcoming; Vincent & Conway, 2021). Years of entrenched convention, working toward reductive templates, outputs, key performance indicators and 'best practice', are being challenged by methods gathered under various labels, including 'adaptive', 'systems-based', 'emergent', and others. This shift moves from output to process, from short-term targets to longer-term capacity and capability.

A city-lab, as we outline below, is a malleable methodology that aims to grapple with complexity without replicating it. This section provides the framework for understanding city-labs, the different types of activities that city-labs undertake, how they are funded, and what has been learned from the application of city-labs in practice. This framework synthesises lessons learned from labs undertaken by the African Centre for Cities and related partners.

2.1 What is a city-lab?

'City-labs' are structured processes for bringing together different stakeholders, such as government, civil society and academia, to co-produce and utilise knowledge aimed at addressing complex urban problems (Culwick et al., 2019). By bringing relevant stakeholders into processes to collaboratively generate and implement knowledge, it is possible to integrate knowledge registers, manage conflict and contestation, and develop new ways of thinking and doing (Edwards, 2011).

2.1.1 Utilising knowledge co-production and integrating competing rationalities

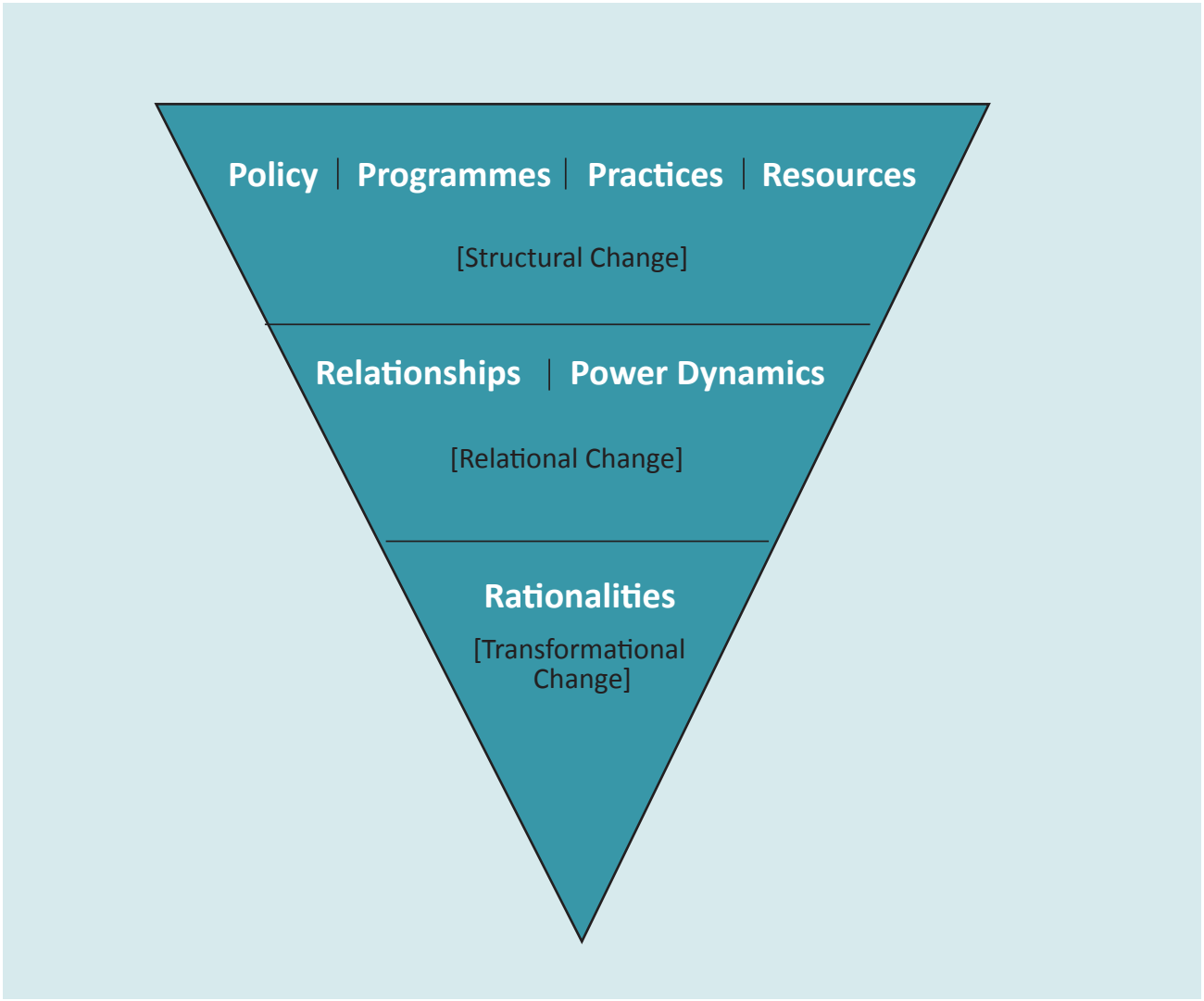
One of the core ideas underpinning the lab method is that new and innovative ideas for how to solve urban issues can come from co-producing knowledge with diverse stakeholders. These stakeholders may all see an urban problem as an issue, but may have very different ways of understanding why it exists and what should be done to address it. The 'conflicting rationalities' (Watson, 2003) held by different stakeholders form the generative basis for new ways of thinking and doing, outside of silos (Anderson et al., 2013; Hessels & van Lente, 2008; Jasanoff, 2004; Petts et al., 2008; Thompson Klein, 2004). Tackling complex and intractable problems requires bringing together different rationalities, types of knowledge (practical, theoretical, academic, local, etc.), mandates, and resources to co-produce knowledge and co-construct pathways for action (Smit et al., 2021).

The structure of the lab works to hold this diversity and chart a path toward interventions. It does so by creating a 'third space' or grey space, where network stakeholders and the Core Partners can step outside of their entrenched patterns and associated rationalities, meeting in the middle. For example, for many officials city-labs provide opportunities to get out of their day-to-day 'functional' environments, and into a different space in which to reflect and be creative (Culwick et al., 2019). For academics, they can step out of the confines of the academy to move into more propositional ways of thinking.

2.1.2 Using city-labs to seed systems change

The urban challenges that city-labs address are typically complex, inter-sectoral problems identified as a priority by multiple stakeholders with different rationalities. The aim is to reframe and intervene in the structures, relationships and rationalities that perpetuate the status quo and require change (Kania et al., 2018; Chroneer et al., 2019).

Figure 2: Systems of change (source adapted by authors from Kania et al., 2018)



To do this, city-labs must engage directly with decision-making spaces – sites where power sits – to create change. In a complex system, there are often many sites of power that interact with one another. Decision-making spaces are likely to be distributed between levels of government, formal and informal systems, and public and private actors. Identifying where in the system there is scope for change is vital to ensuring city-lab processes affect real decision-making. City-labs are interactive processes that complement but do not take the place of other important participatory processes and decision-making fora, such as for developing city plans or budgets.

2.2 The basic structures to support labs

There have been many examples of city-labs around the world, including in Africa. City-labs have taken different forms in different places, depending on the local context and needs of key stakeholders involved in that particular issue in that particular place (Smit, 2021). In this section, we provide an overview of the most common structure of a city-lab, the actors involved, and the resources needed.

2.2.1 Structure of labs

City-lab structures vary depending on context. In this section we outline a proposed structure for city-labs which are initiated by a global partner.

The basis of the city-lab is a set of core partnerships. These are the foundation of the lab, where critical decisions about how the lab will be structured and operationalised are made. The Core Partners generally include the main partners who are involved in funding, conceptualising, designing, and implementing the lab. The lab is nested within a larger network of stakeholders (sometimes called the 'platform' or the 'ecosystem').

Table 1: Structure of labs

Core Partners	Network of Stakeholders
Strategic Partner (SP)	Academics
Convening Partner (CP)	Civil society
Decision-Making Partner (DMP)	State actors
	Private sector

The Core Partners include the Strategic Partner, Convening Partner, and the Decision-Making Partner.

- **The Strategic Partner** is an external organisation that provides funding and technical support and enables sharing among city-lab platforms in different cities. Where strategic partners support several lab platforms, they can facilitate learning across contexts and cities. The Strategic Partner often includes several organisations, working together
- **The Convening Partner** is a local partner that acts as an intermediary organisation to ground and facilitate the process of the lab. In most cases, the Convening Partner is a university (Perry and May, 2010). An established NGO can also play this role. In some cases the convening role is shared by several partners, or a newly formed body[1]
- **The Decision-Making Partner** is an actor – usually a government actor – nested within the decision-making space that is willing to support the lab. In the context of this paper, the decision-making partner is ideally the local government, within which a more specific partnership might be formed with a particular city department. The decision-making partner sits within the wider decision-making space where the power to create change in the system resides

The city-lab network is the wider group of stakeholders who are involved in supporting the lab processes. This includes a wide range of actors from the academy, civil society, state, and private sector. The rapid diagnostic will provide some insights into who should form part of this network. The Core Partners will also have their own networks which they may want to bring into the space. At every step of the lab process, the Core Partners need to review the network, ensure that the right voices are being included in events and processes, and tend to the individual relationships needed to sustain network engagement.

2.2.2 Funding

Iterative, creative, and facilitated work requires resourcing. Therefore, city-labs require funding. Generally, city-labs are funded by international donors, with in-kind support from local partners. In unique cases city-labs have been funded by city governments, however, this is unlikely to be possible outside of the global North or South African context. For African city-labs, funding is required to support formation and implementation of city-labs.

1 Example: In Mistra Urban Futures Kisumu Local Interaction Platform (KLIP) in Kisumu, Kenya, formed a trust that hired employees to support the city-lab processes. In Gothenburg, Sweden, the two universities in the city (the University of Gothenburg and Chalmers University of Technology) formed joint teams with the City of Gothenburg that were jointly chaired by academics and officials. In most cases, however, as in the case of the African Centre for Cities' City-Lab programme and the Mistra Urban Futures Sheffield-Manchester Local Interaction Platform, the local university partner acts as convening partner.

Table 2: Resourcing labs

Activities that require resourcing	
SP	• Initial scoping work and background research • Travel to meet partners and establish lab • Contracting and project management • Refinement of the conceptual approach • Organisation of events among city-lab partners
CP	• Staff time for organising • Staff time for research and relationship-building • Costs for hosting events
DMP	• Travel costs to join international events
Outputs	• Budget for outputs such as publications, exhibition, policy proposal, etc.

It is essential that the funding for establishing a city-lab is flexible. Most research funding is fairly rigid in terms of specific budget lines and tight time frames, and shifting between budget lines ('viremens') is tightly restricted. By contrast, city-lab knowledge co-production processes are often very flexible and open-ended, and it is often not clear at the start what the time frames and activities will be, as these are co-produced by the participants and can change over time. City-labs therefore ideally require fairly flexible funding that can be shifted between budget lines and extended in terms of time frames where necessary.

Although flexibility is required in terms of the funding, a high level of monitoring and control over expenditure is still necessary. Transparency is the key to ensure that the Core Partners and network retain trust in the process. Working with multiple partners on co-production projects may involve complex flows of funds, as there may be other partners making financial and in-kind contributions to the project.

2.2.3 Agreements

City-labs should be supported by formal agreements between the Core Partners. These agreements protect the partners and manage risk. A well-crafted agreement is necessary to assist with:

- **Political shifts in the decision-making space:** City government contexts are constantly changing. Formal agreements with local government departments can ensure that changes in political representatives or technical personnel do not completely derail the city-lab process
- **Financial management:** In order to protect all the partners and facilitate the functioning of the lab, it is important that there are legal agreements between the relevant parties that set out the amounts to be transferred, the purpose of the funding, and how (and by whom) the expenditure will be monitored and reported on

- **Capacity changes for the Convening Partner:** It is important that the agreement with the Convening Partner be an institutional agreement. While there is generally a set of champions, the lab's functionality and momentum cannot be dependent on one person. There needs to be a clear process in place to determine responsibility and chart an appropriate response to shifting capacity and staffing for the Convening Partner

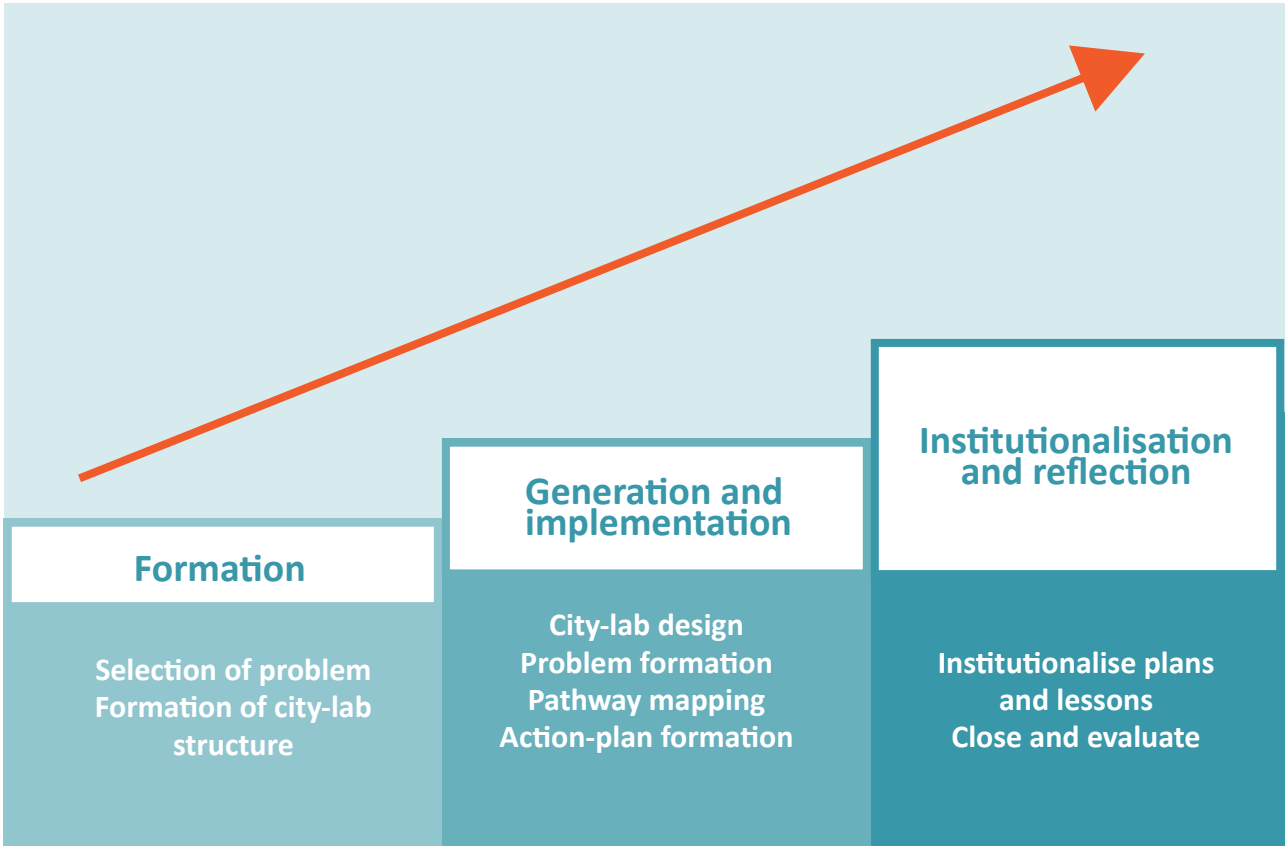
2.3 City-lab methods

The lab methodology is driven by the selection and framing of a complex problem facing the city. Addressing complexity requires some degree of iteration, revision, and adaptability. However, the process also requires programming and structure. In the section below we provide an overview of the process, and an indicative set of activities which might be used for the various steps.

2.3.1 The process

The city-lab process, as set out in this paper, has three phases. These phases are disaggregated and explained in detail in section 3.

Figure 3: High-level city-lab process steps



These phases generally happen in order. However, there are many smaller steps within these steps. These sub-steps are less linear and may require variation and adaption. At various points in the process, for example, it might be necessary to return to the problem statement.

2.3.2 Selection of problems and entry points for addressing them

A key part of developing innovative ways of working is to develop richer and more complex understandings of the problems at hand. City-labs can be used to address all sorts of complex issues facing cities. This process of 'problematisation' starts from the assumption that the way we understand complex issues shapes our assumptions about how we can address them. By refining our understanding of the problem, bringing in voices generally ignored, and merging practice with academic knowledge, we can refine the problem.

** Note: Annex 2 includes a list of city-labs that have been undertaken by the ACC. For the purpose of this strategic paper, the complex problems that city-labs need to address should sit at the intersections between urban infrastructure, climate, and local government. However, not all city-labs will have this focus area. Annex 1 provides a rapid assessment tool to get closer to identifying problem issues related to these intersections.*

An important step toward clarifying the lab approach is to identify a clear primary entry point to enable engagement with a complex issue. For each lab, the choice of initial entry point will be shaped by contextual factors, inter alia, the city size, infrastructure conditions (e.g. water, energy), economic drivers (which may differ for port cities, mining cities, or financial capitals, etc.). The entry point will vary in the scope and level of complexity, depending on the context and actors, and may need to be tightly circumscribed to enable clear thinking and action.

Examples of entry points include:

- A geographical site which reflects key cross-cutting issues, such as a neighbourhood;
- An infrastructure site such as a port or water-treatment facility;
- A particular 'technology', such as BRT, National Urban Plans, or mini-grids;
- An urban actor, such as a utility company or national metropolitan agency navigating internal and/or external complexities

Once the general lab topic and approach are identified, the methods and tactics for co-production can be designed, bearing in mind the need for iteration and flexibility. These tactics are not the only tools that can be used to shift patterns and practices. As labs develop, other methods and processes may be included.

Table 3: An example of a theme, problem, and entry point:

Lab theme and title	Human Settlements City-Lab (See Annex 1 for more details on this lab and other labs)
Problem statement	The Human Settlements City-Lab confronts the following vexing issue: On the one hand, South Africa has an impressive programme for housing delivery (called 'RDP housing'). In Cape Town, hundreds of thousands of houses have been built since 1994. This is impressive. On the other, these housing projects produce unsustainable urban areas. People are far from amenities and economic opportunities. It creates huge costs for the local government and poor people. The Western Cape province, the level of government responsible for addressing the housing crisis, seeks to convene this lab to help shift course – moving from the delivery of housing to sustainable human settlements. This will require working closely with city officials and implementing agents in the private sector. Many programmes have tried to address this issue, and there are many theories on why the housing delivery programme is not working. For example, some cite land constraints, others reference corruption, and still others say it can be blamed on the 'entitlement' of poor people who think they deserve free housing. Overall, there is ample evidence that – despite policy intention – the pressure to deliver rapidly, spend budgets, and meet KPIs pushes the provincial government to develop housing projects which are fragmented from urban networks and economic opportunities. The lab seeks to identify innovative ways to move closer to the vision for sustainable human settlements outlined in the Breaking New Ground Policy. This includes identifying why existing efforts fail, and which new approaches are needed. It aims to apply non-traditional methods to reframe the paradox and intervention options.
Entry points and action areas	Given the complexity of the human settlements issue, the lab identified three entry points: improving spatial form, increasing the supply of quality housing, and addressing governance issues between city and province. Within these, two or three action areas were developed. These action areas included things like: support the small-scale building sector; identify underutilised land (such as school sites) which could be developed for housing; and create a shared governance platform for the Cape metropolitan region.
Length and structure	The lab ran for four years and was led by the ACC, with funding from Mistra Urban Futures and the Western Cape Government.

2.3.3 Activities within and between platforms

While the lab process provides an indication of the outcomes required, it does not provide a rigid framework for how to get to these outcomes. The Strategic Partner and Convening Partner therefore play a central role in designing the activities that support each step of the lab process. City-labs can include a range of potential activities, depending on the problem being attended to and the step in the process (Smit, 2021). Examples of activities that can be used include:

- **Workshops:** Most labs have many workshops which can be used to gather and synthesise information from the network. The key to a good workshop is careful design and clear objectives
- **Seminars:** Seminars provide an opportunity to share knowledge which has been produced. Good seminars clearly state the topics that will be covered and provide carefully considered input from a Core Partner. They allow different partners to showcase their work and source feedback
- **Distillation sessions:** Distillation processes are smaller group sessions aimed at refining understandings. They can be less structured than large group workshops
- **Field trips:** Field trips provide an opportunity to take people out of their everyday context and see new things. Field trips to sites or projects related to the problem area, such as a wetland, housing project, or community development programme, allow for informal and creative engagement among lab partners and the network
- **Collaborative research:** At all phases of the lab there will be gaps in the knowledge base that require research. Collaborative research allows for different partners/stakeholders to contribute to the knowledge base in a pointed and impactful way
- **Collaborative writing:** Through the process of writing, ideas can be clarified and refined. Co-writing is a way in which co-production of knowledge can be refined and documented. Writing can be academic (e.g. articles or chapters), popular (e.g. blogs), or policy-related (e.g. policy briefs, policy recommendations)
- **Embedding/dis-embedding:** Moving stakeholders into unfamiliar spaces is a useful activity for creating new knowledge. This can include embedding academics in city departments or officials in NGO spaces

** Note: Annex 2 includes more details on these activities and examples.*

In addition to these activities within city-labs, it is also useful to share experiences, practices, and knowledge with other city-labs, to be able to learn from other sectors or other cities. Knowledge-sharing across city-labs could include joint field trips, knowledge-exchange visits between city-labs, multi-city comparative research projects, and the shared dissemination of learning and insights. When designing the interactive engagements which form part of the lab method, a variety of activities should be included to appeal to the preferred modes of engagement, which might differ across participants (both the Core Partners and the wider community that might partake).

(Credit: Liza Rose Cirolia)

3. ‘DOING’ CITY-LABS: THREE PHASES

In this section, we specify steps in a city-lab process. This is not a blueprint for city-labs. These steps need to be adapted on a case-by-case basis, depending on the context. Based on experience and a review of literature, city-labs have three broad phases (Polk and Westerberg, 2011). These include:

- **Formulation: Initiation of the city-lab process, including identification of the key issue, the Convening Partner, and the decision-making space;**
- **Generation and implementation: Joint production of knowledge and implementation of solutions;**
- **Institutionalisation and reflection: The lab process requires closure of the lab and ensuring that the ideas and practices developed get taken forward**

For each phase we have outlined what each partner, the SP, the CP, the DMP, and the network are primarily responsible for. Each phase includes several steps, which are in turn informed by the experiences of the African Centre for Cities and its partners. However, they are also extended and refined, in order to more appropriately map the process of arriving at viable and meaningful interventions in complex urban systems.

3.1 Formulation

The Formulation steps are essential for establishing the basis for the lab. This phase determines if the context is suitable for a lab, what issue the lab should focus on, and how the institutional structures should be established. Not only is the Formulation phase necessary for developing the process and milestones, it also includes upfront evaluation of the preparedness of a particular context for this kind of intervention. This is a step often left out of development projects incentivised to drive implementation as an end in itself.

Table 4: Actors' roles in Formulation phase

Actor	Role	Key Assumptions
SP	Initiate rapid information-gathering; Determine if city context is suitable for city-lab; Co-develop appropriate institutional structure; and resource the structure.	SP should already have network of consultants and researchers to draw from. If this does not exist, basic work is needed.
CP	Provide appropriate institutional design for the convening partnership; Undertake resourcing (hiring, etc.); host lab launch.	The team assembled under 3.1.1 may also be appointed as the CP if deemed appropriate.
DMP	Provide in-principle support for the process; Share necessary documentation and data on key issues; Participate in the launch.	The scope of this role depends on the appetite and capacity of the DMP.
Network	Provide data and insights necessary for determining problem areas the lab should focus on; Attend the launch event.	

3.1.1 Rapid information-gathering

To begin the lab process, it is important that whoever is initiating the lab (this is likely to be the Strategic Partner) undertake a rapid scoping diagnostic of the city. This scoping and diagnostic exercise has two core aims: First, it aims to develop a high-level overview of the state of infrastructure, the climate challenges and risks, and the roles of local government in that city. It also aims to understand the capacity of local stakeholders – including local government, universities, and the wider network – to engage with a lab process. This includes, for example, resources and interest. Without a basic understanding of what is happening in the city and who is involved, it is difficult to formulate a lab process.

A small team should be established to undertake this diagnostic, with the Strategic Partner and a local consultant or research team that has experience in the city included. The consultant or research team could be the Convening Partner, if the CP is initiating the lab process or has already been selected. In many cases a CP would not yet have been identified, and part of the objective of this step would be to identify one.

Note: Section 4 of this framework provides a template which can be used for the development of labs which focus on infrastructure, climate change, and local governance.

3.1.2 Problem selection and formulation

The diagnostic study should be used to generate a high-level understanding of the problems in the city. A long list of problems should be identified based on the scoping studies and supplementary research conducted by the Convening or Strategic Partner. These problems need to be ones that:

- Exist at the intersections between urban infrastructure and climate issues;
- Are complex and multi-sectoral;
- Impact on the city in discernible ways

Using this short list, it is necessary to select a problem that the lab can focus on. This can be done in many ways, but generally includes a workshop with the Strategic Partner, the research team, and selected participants from the wider network. In addition to the above criteria, it is important that the selected issue has the following traits:

- Local government is both influenced by them and has some influence over them;
- There is sufficient interest across the network to influence action;
- There are not already existing lab-like programmes, rendering the lab redundant;
- There is the actual possibility or potential to effect change;
- All Core Partners can agree that this issue is urgent, and they would be willing to work on it for an extended period

It is important that by the time the lab is being formally set up, a high-level understanding of the problem it will focus on is determined.

** Note: If it is decided at this point that the context is not currently suitable for a lab, the information collected so far should be synthesised and shared with stakeholders.*

3.1.3 Forming the implementation structures and Core Partners agreements

In order to implement the lab, structure is needed. The design and resourcing of the implementation structure can be done on a case-by-case basis. Generally, implementation is driven by a set of Core Partners, which include the Strategic Partner, the Convening Partner, and – if possible – a Decision-Making Partner.

If the Convening Partner has not been selected up front, it can be selected by the Strategic Partner based on insights from the rapid scoping diagnostic. If there are several options of configurations or institutions, it is also possible that the selection happens through open bidding, whereby the Strategic Partner issues an open call for proposals from academic institutions and NGOs. It is difficult to implement labs without buy-in from decision-making spaces. Therefore, where possible, the Core Partners and city-lab agreement process should also include actors from the decision-making space, ideally from local government. If it is possible to include local government as a Core Partner, they should also form part of the city-lab agreement. If contractual issues make this a challenge, letters of support annexed to the agreement are also an option. These agreements provide legitimacy to the lab process.

Once the Core Partners have been established, formal agreements need to be made. City-lab agreements, outlining the role of the Core Partners and Convening Partners in the platform, would usually detail the broad objectives of the city-lab (including broad topic areas), commitment of staff in terms of broad amounts of time, commitment of other resources, and the identification of key contact people. It is also important to ensure the skills and capacity needed to implement the lab are in place, so the partner is properly resourced. This includes skills related to project management, facilitation, and financial management. A keen knowledge of the problem is also required.

3.1.4 Launch of city-lab and network activation

It is important to mark the end of the Formulation phase and the launch of the lab. This generally takes the form of a curated event open to a wide group of stakeholders. Its purpose is to activate the wider network, share an overview of the process, and get buy-in. At this event the Core Partners can present an overview of findings to date and sense-check them with the wider audience.

Sense-checking of the initial findings requires a careful synthesis and sharing of the information collected to date, creating space for critique, inputs, and concerns about the material to be raised. Given the sensitivity of the content, the facilitator should be careful how information is presented, and what narratives underpin this synthesis.

To develop support for the lab, it is important that it is made clear how the lab process aligns with other processes under way and ensure that it is clear what its value proposition and added contribution to the space is. It is also important to articulate the limitations of the lab process, to manage the expectations of stakeholders.

By the close of the Formulation phase the Core Partners should be established, and the problem the lab will address should have been selected and stress-tested. There should also be widespread understanding of what a lab is (and is not) and how people and institutions can get involved in the process. It should also include some basic objectives and goals, so that progress can be iteratively monitored.

3.2 Generation

The Generation phase is the core of the lab process. The steps outlined below reflect the outcomes of each step of the lab. For each step, different activities and methods may be used to reach this outcome. This will depend on the stakeholders involved, the opportunities existing at that time (e.g. in terms of policy-making processes), and the resources available. The Core Partners – including the Strategic Partner and Convening Partner – will identify appropriate activities, fills gaps, synthesise insights, and draw in the wider network of stakeholders at key moments in the process. The indicative set of steps below is not a blueprint, as the lab process may be different in different contexts.

Table 5: Actors' roles in Generation phase

Actor	Role	Key Assumptions
SP	Co-conceptualise activities; Resource activities; Provide strategic guidance.	The resourcing arrangements will differ by lab.
CP	Co-concepwtualise, drive, and coordinate all activities.	SP may need to provide hands-on support, depending on capacity and skills of CP.
DMP	Participate in key activities; Co-conceptualise key activities.	The scope of this role depends on the appetite and capacity of the DMP.
Network	Attend activities; Ensure alignment between city and other actors; Initiate and share information on complementary work.	

3.2.1 Creating a safe space for difference: What are the principles of engagement?

It is important to build a 'safe space' for the lab process, where people can discuss their different – and likely conflicting – perspectives on the problem, and their visions for the future. Activities which support building this safe space include setting ground rules for engagement among the core partners which can also be used for other activities (such as field trips or workshops). Selection of a suitable venue where planning and core activities can take place – a space that is neutral, accessible, and acceptable to all Core Partners – is also important. The aim is to create a neutral space – a third space or grey space – that sits outside of the everyday workings of each partner. This 'space' is both metaphorical and practical. Having a 'neutral' space for meetings is important, as it can help separate the non-academic participants from their everyday work and institutional politics, and create an open space for thinking, debating, and engaging.

3.2.2 Problem formation: Where are we now, and why?

Once a safe space is established for the lab process, it is important to get a clear sense of the current nature of the problem. This involves asking a set of important questions, for example: Who is involved in the problem? How do different stakeholders in the network 'see' the problem differently? What are the different perspectives on why the problem exists? What sorts of interventions have been tried to address this problem in the past? At this initial phase, it is important to unpack the problem from many perspectives, breaking down assumptions and coproducing new ways of seeing the issue. This process depends on differences being highlighted despite it being uncomfortable. It is important that a range of

different activities –such as workshops, field trips or focus groups – be used to surface these differences and create space for productive engagement with different perspectives. Additional research might also be needed to document and synthesise past and current efforts to address the problem. Ultimately a document needs to be developed that sets out the shared understanding of the 'problem statement' (Smit, 2021).

3.2.3 Creating shared future goals: What do we want?

It is important that the lab create a space not only for understanding problems, but also for creating solutions. As such, it is important to create a shared understanding of what it would look like for this problem to be adequately addressed. This requires undertaking some form of visioning exercise, whereby the Core Partners and network can contribute to developing a clear idea of what they are working toward. This vision, as best as possible, should be mapped onto different timescales, short-, medium-, and long-term. It should hold space for conflicting ideas about ideal city futures. Like the problem formation, building this future-facing picture requires inputs from many stakeholders.

Once both the status quo and the desired future have been mapped, it is possible to craft tentative pathways toward this future. At this point it is important to source as many ideas as possible for what is needed to achieve this. It is important to be creative and expansive in this process of identifying pathways to reach future goals.

3.2.4 Understanding barriers and constraints: What is stopping us?

Once a long and imaginative list of pathways is developed, it is important to bring this back to reality, to where the network and partners can effect meaningful change. In complex systems, such as those that exist in cities, there are many interesting and dynamic reasons why it is difficult to shift toward desired futures. Even if these visions are widely agreed to be better than the status quo, there are many barriers, constraints and path dependencies. It is important to get a clear sense of what is blocking progress toward this future, what is perpetuating the status quo, etc.

The sorts of barriers that might be identified could include things like:

- Policy or institutional issues (such as conflicting regulations or tensions between departmental mandates);
- Social or political constraints (such as the acceptability of particular infrastructural technologies);
- Fiscal or financial issues (such as weak revenue-generation, sub-national borrowing limits, etc.)

3.2.5 Identification: What is needed to address constraints and intervene in the problem?

Understanding the problem, the desired future, and the challenges and blockages the system faces in reaching this future, provides a sound foundation for identifying viable entry points to address or change the system.

In this phase it is important to ask: Given where we are, where we want to go, and what is stopping us, what do we need to do? This should lead to a long list of necessary system interventions. This list should be refined by asking: Which of these issues can this group intervene in? This shorter list forms the basis

for the entry points for action. The entry points for action are developed based on a sound understanding of the changes needed in the system and the capacity of the Core Partners network to intervene in meaningful ways.

3.2.6 Programmes of actions (action plans)

For each entry point, programmes of action need to be developed. For these programmes to be meaningful, they need to be developed with the idea that such programmes will be taken forward by strong coalitions of actors within the lab network and decision-making space.

These programmes of action should include the following:

- Developing of a clear problem statement for the sub-issue;
- Development of a work plan for filling gaps in knowledge necessary for effecting change;
- Development and strengthening of a coalition of actors to take this work forward. This could include actors outside of the original city-lab grouping;
- Development of an action plan (the group may decide to apply for other funding to support particular action plans or particular actions)

As these plans are being developed, the Convening Partner needs to hold the lab space. This includes keeping up the network, ensuring that those leading the development of plans are supported, and ensuring that the development of plans for intervention speak to one another and reflect a systems understanding of the issues at hand. Where necessary, the Strategic Partner can support the Convening Partner in maintaining the framing, conceptualising, and feeding-in of learnings from other lab processes. Implementing action plans will each take on their own timelines.

3.3 Institutionalisation and reflection

Labs, as structured processes, require closure and evaluation. They are meant to initiate different activities, ways of thinking, and ways of working. However, the lab itself is an incubator and must eventually allow for such work to be institutionalised. At the close of the lab, it is important to reflect on what worked and did not work, as well as how best insights and relationships can be taken forward into the future.

3.3.1 Institutionalisation

Depending on what the lab set out to do, institutionalisation of the lab processes will differ. However, the goal is that the new knowledge, plans, and practices generated through the lab process become embedded in the decision-making space. In other words, they become streamlined into existing institutional processes and no longer exist in the ‘grey space’ created by the lab for experimentation.

One of the ways to do this is to ensure that the action plans have been taken forward by a coalition of actors within the decision-making space. These actors have taken ownership of addressing the issue and are either institutionalising the lessons learned or operationalising the plan that has been developed.

3.3.2 Coming together and closure

Labs generally run for several years (often between two and four). After this period, the intensive work of the lab comes to an end and the process must be integrated into the operations of the decision-making space. At the close of the lab, it is important to ensure that everything is documented and shared. Sharing the learnings from the lab both locally and internationally is important to ensuring that the ideas and lessons can be integrated and extended. The design of this process should be specific to the needs of the lab partners.

Table 6: Actors' roles in Institutionalisation and Reflection phase

Actor	Role	Key Assumptions
SP	Assist with institutionalising the lab process; Draw high-level insights from across the lab processes.	Institutionalisation can take different forms, including new established working norms, a policy, or a plan.
CP	Work closely with the decision-making partner to institutionalise lab insights and plans; Document what has been done and what has worked/did not work.	The CP may elect to continue with specific lab outcomes post-project closure.
DMP	Identify pathways to institutionalise lab insights; Actively assist in driving this process.	The form and extent of institutionalisation will vary between cities.
Network	Take forward specific action plans for implementation.	The emphasis will be on identifying feasibly implementable actions.

3.3.3 Evaluation and monitoring

The activities of the city-lab will need to be monitored and evaluated to reflect on learnings and impact. Evaluation processes will vary, depending on the lab's design. Planning up front for evaluation of the lab's process and impacts is important, and one of the most important things to track is the lab's long-term impacts.

(Credit: Liza Rose Cirolia)

4. AFRICAN CITIES: CLIMATE, INFRASTRUCTURE & GOVERNANCE

Our framework for understanding what a city-lab is (and is not) is grounded in a keen understanding of the historical and contemporary dynamics of African cities. It reflects a curated narration of the critical contextual challenges and opportunities in African cities. It takes as a starting place that common assumptions about Africa informed by Western development discourse hamper the transformative potential of change processes and require fundamental revision.

4.1 African urban patterns and projections

It is vital to begin any process of transformation and change from an understanding of what is happening in African cities – the processes under way and the historical developments which have informed the contemporary moment. Despite incredible diversity across the continent, there are some common dynamics and trends, which shape cities in particular and similar ways. These are fundamental for city-lab development.

4.1.1 Urbanisation

It is important to understand the nature and substance of Africa's urban growth patterns. Africa is rapidly urbanising. Year on year, a higher proportion of Africa's population can be found in cities. This urbanisation is driven by both movement to cities from rural areas, as well as from natural urban growth. This population growth is matched by simultaneous densification of existing areas and sprawling or peripheral areas.

This urban growth has unique patterns and prospects, affecting both larger and smaller urban agglomerations. The primacy of capital cities – wherein the metropolitan urban agglomerations are magnitudes larger than the next largest towns and cities – shapes the development opportunities and challenges on the continent. For larger metropolitan areas, the strategic significance within the national and regional context, and the sprawling fabrics and material networks (which often span several local jurisdictions), provide unique challenges.

At the same time, smaller towns and cities are experiencing exponential growth rates (albeit off very low bases), often with very little investment (Roberts, 2014; OECD/SWAC, 2020). For smaller towns, the governance and material conditions will need significant intervention over the next decade to accommodate (and get ahead of) rapid growth. It is against this backdrop of urban diversity (and rapid urban growth) that key issues of governance and development must contend.

4.1.2 Demographic transition

In addition to urbanisation, a demographic transition is under way, resulting in cities largely populated by young people. In 2019 almost 60% of Africa's population was under the age of 25, making Africa the world's youngest continent (Mo Ibrahim Foundation, 2019). This has implications for the future of infrastructure and the economy.

In the very near future, these young people will need jobs or work. Mechanisation, digitisation, and globalisation are shaping these possibilities. The growth in industrial zones and parks, while important, are unlikely to absorb most of the growing workforce. These daunting (global and local) processes must be read in relation to the other technological and economic disruptions that are changing urban economies in fundamental ways, reducing the scope for formal working opportunities, and driving gig and informal economies.

4.1.3 Informality

One of the defining features of African cities is informality. Informality is not just exhibited in the economy (e.g. informal work, discussed above) but across a range of domains. Informal housing/settlement, land administration, governance systems, service delivery, and their supporting institutional forms are all prevalent in African cities.

A common feature, with particular implications for infrastructure and climate risks, is that settlement often takes place before the provision of basic services and trunk infrastructure. Service provision thus takes place retroactively – often in incremental ways. Planning with and for these processes remains a challenge, owing to the rapid pace of development, limited resources, and challenges around coordination. This would be a very demanding context for governments anywhere in the world, but especially so in Africa, given uneven decentralisation, silos, and limited fiscal capacity.

4.1.4 Urban governance

The patterns and processes of urban growth, demographic change, and informality – among other important processes in African cities – map onto a complex governance landscape. One of the most challenging issues in the context of urban Africa is the contested and transforming nature of urban governance. This reality does not just apply to African cities, but is exacerbated by the often contemporary nature of multi-level government reforms and decentralisation programmes (OECD/UCLG, 2019).

What is the difference between urban governance and urban government?

- Urban governance: Urban governance refers to all the actors and stakeholders involved in governing city spaces and systems. This could include state actors, such as local governments, regional governments, utility companies, etc. It can also include non-state actors who wield power and hold legitimacy, for example faith-based groups, gangs, or powerful NGOs
- Urban local government: Within a multi-level government (MLG) system, urban local government refers to the lowest level of government at the urban scale. In the African context, urban local governments often have limited powers, functions, and fiscal resources, despite their importance in managing Africa's growing urban areas

Many African countries developed their multi-level government systems in the past 30 years. While these programmes were intended to decentralise power to local government, in reality most countries experienced partial decentralisation, limited fiscal autonomy for sub-national levels, and complex power struggles (especially where national opposition parties are in power locally) (Cirolia, 2020). This partial decentralisation has direct implications for urban management, as control over key urban infrastructures is spread between agencies and levels of government. Additionally, the responsibility for addressing climate risks and hazards is often held by yet other organisations.

Given this reality the following section explores, in more detail, the common ways that key urban infrastructures are provided in many African city contexts. These trends have direct and indirect implications for how climate issues and infrastructure systems intersect in African cities.

4.2 Infrastructure of African cities

It is widely recognised that African cities need infrastructure investment. This investment is needed not only to attend to existing deficits, such as undermaintained networks. It must also respond to emerging needs brought about by a multitude of processes, such as urban population growth, technological transformations, and climate imperatives. Defining the infrastructure investment priorities in African cities requires scoping what is meant by 'infrastructure' in the first place. Notably, there is no universal definition capable of capturing 'infrastructure' in simple terms.

In the context of this framework, the concept of 'urban infrastructure' is used to mean the physical or material structures and facilities that underpin or enable flows of resources, and thereby the provision of urban services. This functional definition is used because it enables a focus on the investment programmes of urban authorities (city governments, urban utility companies, etc.) and foregrounds the importance of delivering urban services. This frame does not reduce infrastructure to water pipes or solar power. Instead, it works to understand how infrastructure is:

- Multi-scalar and part of long and complex value chains;
- Embedded in social, cultural, and political systems;
- A mixture of fixed investment and fluid flows;
- Shaped by complex institutional and regulatory structures;
- Fundamental to urban economies, including being linked to questions of work and labour;
- Core to addressing poverty, inequality, and dignity, and therefore must be affordable and accessible

This framing of infrastructure provides a valuable scaffold to understand the utility and functionality of infrastructure in urban contexts in Africa.

4.2.1 Infrastructural services

In African cities, people, firms, and industries do not need infrastructure for its own sake. Instead, infrastructure is needed for the services and uses which it enables. From washing dishes to getting to work or school, the utility of infrastructure rests in its ability to be converted into productive value.

In many cities globally, these service-delivery systems are underpinned by large networks. These services include energy services for cooking and lighting, mobility systems that move people and goods, waste collection and disposal, water and sanitation provision and treatment, and ICT enabled by large-scale investments in multi-scalar networks. These network investments allow for cross-subsidisation of different user groups and amortisation of bulking capacity costs over several generations. These networked services are delivered through all manner of institutional arrangements, from concessions granted by national government to utilities (e.g. energy in Uganda), to corporatised water companies operating at arm's length from local governments (e.g. water and sanitation in Kenya).

There are additional urban services, such as safety, parks and recreation, urban health, and many others, that are not linked to large-scale infrastructure investment, but are also essential to urban functionality. Notably, important urban systems that intersect and are embedded in the above services are vital to city functioning. For example, urban food systems and urban housing systems operate at the interface between these important services. They also require functioning land administration and management, a foundational piece of the urban question.

4.2.2 'Hybrid' service-delivery systems

Owing to complex colonial histories in African cities, many key urban infrastructures (discussed in the previous section) are not delivered through large centralised networks controlled by capacitated local authorities. While these networks do exist in many cities, they may only serve small parts of cities, such as older CBDs, wealthier suburbs, or industrial areas. Where they do exist, they are often patchy and over-extended, having been planned for much smaller populations and under-maintained over decades. For example, even where there are energy or water networks, there may be rolling blackouts or dry taps. Compounding the colonial legacy, over the past 30 years global finance for infrastructure has often been focussed on urban mega-projects, such as major highways, large wastewater treatment plants, or augmenting energy-generation capacity. Significantly less investment has been made into distribution and operating systems that connect these large investments to urban everyday life.

The limits of the central network have required supplemental provision, such as on-site energy generators or water tanks. In many cases whole industries have evolved to provide these services, with various degrees of formality, safety, affordability, and environmental impact. The outcome is that African city infrastructure is not uniform: it is hybrid and heterogeneous (Jaglin, 2014; 2017). What this means is that there are a diversity of intersecting ways that service-delivery is achieved. This is not just a case of

informal and formal, but also on/off-grid, large/small systems, public/private, etc. Overall, African cities experience hybrid service-delivery systems. Informal, small-scale, and off-grid technologies 'fill the gaps' left by the centralised network. Users generally pay significantly more to use distributed infrastructure technologies, holding additional risks, such as that of repair or disposal. Hybrid services are challenging to govern, creating particular issues when city governments want to address climate imperatives.

From an infrastructure and service-delivery perspective, key socio-technical infrastructure transitions are under way in Africa that cannot be ignored. From digital innovations in mobility to the proliferation of independent power producers, technological shifts are rapidly changing how services are delivered. Leapfrogging and disruption may be possible, and African cities can skip over now-obsolete configurations. However, the pathways through which potential technological shifts are achieved remain contested, with many unknowns, and potential for new sites of extraction, fragmentation, and exploitation. While African cities stand to gain from these technological shifts (particularly toward green and distributed systems), there are also many risks and costs.

4.3 Impacts of a changing climate and a net-zero carbon transition

It is now indisputable that the world is experiencing rapid and unprecedented changes in the climate. CO_2 emissions are the major driver. International policy actors are placing pressure on national governments all over the world to reduce the emission of greenhouse gases that are driving changes in the climate. The focus is on trying to remain as close to a 1.5 degrees Celsius global temperature increase as possible, by reducing emissions to net-zero by 2050.

In Africa, national governments, in an effort to align with international commitments to the Paris Agreement and the SDGs, are placing pressure on cities. Pressure to take climate action at the urban scale is also coming from international networking organisations like the C40 Cities Climate Leadership Group, the international NGO ICLEI (Local Governments for Sustainability), and others.

However, as pointed out in recent Intergovernmental Panel on Climate Change (IPCC) reports, colonisation and other structural processes underpin the uneven economic processes which have driven the climate crisis. In reality, African cities contribute very little to climate emissions. They have also been the victims of colonisation, and stand to lose significantly more as coal mining is replaced with renewable energy generation.

Despite contributing very little to the global climate crisis, African cities experience the effects, and hold the risks, of this global crisis. Cities – both their governance and material systems – will need to adapt in the face of the consequences and attend to the uncertainty. At the same time there are growing calls for cities to seize the climate opportunity, an opportunity to leverage new technologies, new markets, new sources of funding for infrastructure (e.g. green finance), and new political capital.

4.3.1 Physical changes in Africa's climate

The climate is rapidly changing, resulting in physical changes including but not limited to changing temperatures, changes in rainfall, sea level rise, salinisation of water sources, and decreases in vegetation and biodiversity.

According to an IPCC Assessment Report[2], all African regions' mean temperatures and hot extremes (including heatwaves) have emerged above natural variability, relative to the 1850–1900 period, and the rate of surface-temperature increase has been more rapid across Africa than the global average. Increases in mean and extreme temperatures are projected to continue throughout the 21st century (with the rate of increase dependent on the extent of global reductions in greenhouse gases).

Projections suggest that the frequency and intensity of heavy rainfall events (including those associated with tropical cyclones) are likely to increase in most parts of Africa, with additional global warming further increasing already widespread and costly impacts from urban flooding. Changes in mean and total annual precipitation are much more varied across the continent. Increases in precipitation have been observed over much of the West African Monsoon region, while decreases in mean precipitation have been observed over Southern, Central, and North Eastern Africa regions. Most regions, though, are experiencing increases in aridity and droughts, with projections suggesting further increases in droughts driven by ongoing climate change.

In addition to land-based impacts on cities, marine heatwaves have also become more frequent, and are projected to increase around Africa. Relative sea level has increased around Africa over the past three decades, at a higher rate than global mean sea level.

4.3.2 Climate vulnerabilities and hazards

Physical changes resulting in heatwaves, droughts, intense rainfall events, cyclones, and sea storm surges, overlay on existing vulnerabilities, creating hazards that exacerbate risks. How these physical changes are experienced in African cities differs. Sea level rise, for example, creates hazards and risks felt most acutely in coastal towns. This rise will continue, contributing to increases in the frequency and severity of coastal flooding and erosion along extensive stretches of the African coast, putting many coastal towns and cities at further risk of infrastructure damage and livelihood losses. Matriline heatwaves negatively impact marine ecosystems that the fisheries and eco-tourism sectors rely on in many African cities and towns. Changes in rainfall impact most acutely on water-scarce regions.

2 IPCC Sixth Assessment Report, Working Group 1, Regional Fact Sheet - Africa, URL: https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Africa.pdf

These vulnerabilities are not hypothetical. Climate-related changes, and the associated risks and hazards, are already considerable and cause costly damages within most African cities. As the recent IPCC report points out, the highest levels of vulnerability and risks are felt in informal settlements and smaller towns.

These vulnerabilities are attributable to a lack of infrastructure and governance capacity. As one example, Tropical Cyclone Idai, which made landfall near Beira City in Mozambique in 2019, bringing high winds and widespread flooding, led to the deaths of more than 1,300 people, affected over three million more, destroyed more than 240,000 homes, 20 bridges, and severely damaged road, electricity, water, telecommunications, health, and education infrastructure. Increases in temperature, rainfall intensity, and dry-spell duration impacts on hydropower production and thus electricity availability and prices, and causes damage to road networks, undermining key economic sectors in African cities.

How regional climate trends translate into the climate patterns and associated impacts experienced or anticipated within specific towns and cities across the continent requires further downscaling of risk assessments to the city-scale (Giugni et al., 2015; Jack et al., 2019; Taylor et al., 2021). There is severely limited scientific infrastructure and capacity across the continent to produce and update detailed climate-risk assessments that are decision-relevant, requiring considerable investment.

4.3.3 Net-zero carbon transitions

African cities are not only directly impacted by climate hazards, but also face risks and potential opportunities associated with low-carbon or net-zero carbon transitions being promoted globally, focussed primarily on shifting energy sources away from fossil fuels in the electricity and transport sectors.

African countries and urban areas on the whole (outside of South Africa) still contribute relatively little to global emissions of greenhouse gases. However, there is growing international pressure to decarbonise economies and societies, especially focused on developing and industrialising along less carbon-intensive trajectories than European countries, which continue to reinforce relationships of colonial legacy dependence and asymmetrical development in the region.

The ‘low-carbon transition’ is the policy umbrella under which global greenhouse gas emission-reduction efforts are gathered. While this has historically been managed at a national policy level, over the past decade opportunities to decarbonise, especially electricity and transport at a subnational level, has picked up momentum. The policy debates driving this change are still largely focused on the global North, and disconnected from the realities of developing contexts, and this certainly extends to African cities and towns.

The low-carbon transition is now widely accepted to not only require massive investment, but also to generate a just distribution of costs, benefits, and risks. A recent analysis of national contributions (between 1850 and 2015) to cumulative CO_2 emissions in excess of 350ppm atmospheric CO_2 concentration found that the US is responsible for 40% of excess global CO_2 emissions, the European Union 29%, the G8 nations 85%, and the countries classified by the UN Framework Convention on Climate

Change as Most Industrialised Countries (i.e. Annex 1 countries) were responsible for 90% of excess emissions (Hickel, 2020). The costs and risks that African nations face are not congruent with the benefits historically accrued from carbon-intensive development. This is sometimes characterised as 'transition risk'.

Risks to African cities and economies associated with these transitions include reducing demand and prices for fossil fuels, notably coal and oil. Infrastructure built around fossil fuel industries, including rail, power plants or ports, may have to be replaced or retired early. There is growing concern over widespread job and income losses associated with a rapid shift away from fossil fuels, and the consequences this might have on poverty levels and urbanisation rates. African cities are not only disproportionately exposed to climate crises which they have not caused, but are also subject to substantial transition risks. These risks need to be addressed within a context in which local government actors face a range of challenges related to their mandates, position within multi-level governance systems, political power, revenues, and access to finance. While calls for a 'just transition' were initially focussed on the rights and vulnerability of workers (initially in the global North) as industries were forced to align with environmental policy, this agenda has been broadened to consider a just and fair distribution of risks, costs, and benefits from the low-carbon transition at multiple scales. This includes calls for developed countries and those contributing disproportionately to greenhouse emissions to carry the greatest share of the cost of addressing the crisis they have created.

Opportunities created by these low-carbon transitions include the rapidly decreasing costs and increasing availability and performance of renewable energy technologies. The potential for more distributed, small-scale, locally-owned and -operated energy systems present exciting opportunities within African cities. Clearly, the low-carbon transition shifts both the risk and opportunity context for cities and their various mandates, functions, development plans, and financing arrangements. These contexts are dynamic, and depend on how many possible and plausible technology, market and policy scenarios play out. The position and agency of African city governments must be properly understood within national, regional, and international political and investor relations and power dynamics.

The required investment to decarbonise energy systems (notably for power generation and transport) have been scoped at a country level, in the Nationally Determined Contributions (NDCs), and therefore aligned to the Paris Agreement. Despite initial concerns about African governments prioritising short-term development needs over climate commitments as a result of the COVID-19 pandemic and its economic impacts, several have updated their NDCs.

Estimates suggest that the climate-investment requirements for the region stand at $377 billion for climate-change mitigation and $222 billion for building climate resilience (UNU-INRA, 2021). Currently, levels of available funding and appropriate finance instruments are alarmingly low. Of the $100 billion per annum by 2020 committed by developed countries for developing countries, only around $20 billion has been provided to Africa during the 2016 to 2019 period (Bhattacharya, 2022).

Nonetheless, if climate finance and other development funding can be mobilised, there are opportunities to drive locally relevant infrastructure investment in locally appropriate ways. Since the finance comes from outside the country, the funding may be tied to conditionalities that do not align to local priorities. Thus, even the emerging opportunities are risk-laden. Supporting local stakeholders to better engage with these opportunities so that the terms and priorities can be set locally and contextually is a good start. The Covenant of Mayors in Sub-Saharan Africa has since 2019 made unlocking climate finance a primary focus of the network.

4.4 Investing in climate-resilient, low-carbon urban infrastructure

Many towns and cities across Africa are growing rapidly. Local governments and urban service authorities, already struggling to adequately service all existing residents and enterprises, will need to service many more, including many who are and will be living and working in places, structures and ways that are not planned, registered, and regulated. The risks associated with temperature, rainfall, wind- and sea-level patterns are considerably increased due to the lack of well-maintained infrastructure and affordable services designed to moderate climate impacts in most African cities.

A severe deficit in buildings compliant with safety standards, drainage infrastructure, water treatment and reticulation infrastructure, road infrastructure, sewage infrastructure, public health services, insurance services and the like, means that many city governments, residents, and businesses operating in African towns and cities suffer considerable losses and costly damages when heatwaves, droughts, storms, and heavy rainfall events occur.

(Credit: Liza Rose Cirolia)

Table 7: Climate risks and hazards across sectors

Sector	Urban services and related infrastructure	Climate intersection examples
Energy	Energy services for cooking, lighting, heating, powering appliances, etc.	Generation contributes to carbon-decarb agenda, distributed technologies (decentralised gov).
Mobility	Movement for people and goods (commuting and logistics). Supported by investment in road, rail, public transport systems.	Contributes to carbon emissions; costs pegged to energy cost; risks of damage to fixed infrastructure from hazards. Linked to energy, mobility; requires either liquid fuel (fossil or bio), or electricity.
Waste	Waste collection, recycling, disposal, and landfill management.	Pollution, landfills, contribution to carbon emissions.
Water	Management of water services. This includes water provision for consumption (drinking, cleaning, etc.), as well as drainage and runoff management.	Drought, malaria risk related to rainfall and flooding, natural source/ecosystem depletion.
Sanitation	Sanitation services, including removal and treatment of septic waste.	Heavy rainfall impacts on pollution, waterborne disease and health risk, on-site alternatives.
ICT	Internet access, data collection and management, etc.	Contributes to carbon emissions; risks of damage to telecom infrastructure from fires/flooding, etc.

In developing the infrastructures necessary to attend to urban and demographic pressures, cities have choices. Cities can continue along the status quo, developing resource-intensive, capital-intensive, and inflexible investments, or they can consider the need for adaptive capacity, responsiveness, ecological resilience, and carbon neutrality. Not only is more infrastructure needed to address existing and growing needs, but the type, design and maintenance of infrastructure being invested in must be considered in light of altered climate conditions – especially increasing heat, droughts, storms and floods – and the net-zero carbon imperative.

This points to infrastructure choices and investments that are affordable, flexible, and scalable to respond to local needs and changing conditions. Infrastructure for solar and wind power, flood attenuation, water purification, stormwater harvesting, groundwater recharge, coastal protection, passive cooling, public and non-motorised transport, wastewater and faecal sludge treatment and reuse, eco-toilets, solid waste management and beneficiation, plastic reuse in building materials, and monitoring and early-warning systems will be part of the picture. Moving forward, how infrastructure is retrofitted, designed, and delivered will determine its resilience and adaptability in the face of uncertain climate and environmental futures.

- Climate change means that African governments must operate under conditions of extreme uncertainty and dynamic risk. The implications are that the way in which urban infrastructure is planned, financed, built, and managed needs to reflect this context of mounting uncertainty
- Efforts are needed to ensure that infrastructure models and choices do not lock African cities, countries, and regions into unsustainable development pathways

In the face of this uncertainty, there is a need to consider how infrastructural investments can be more:

- Flexible to respond to changing dynamics;
- Modular and incremental so that course-correction is possible;
- Interoperable with future systems (which might not yet exist or be affordable)

Working out the appropriate mix and distribution of infrastructures in a specific city, reducing trade-offs and maximising synergies across sectors requires much more collaborative and forward-looking forms of governance than are currently prevalent. The city-labs approach is designed to support and foster the engagements and thinking needed to underpin climate-compatible infrastructure planning and investments.

5. CONCLUSION

It is important that cities develop adaptive and sustainable responses to the risks and impacts which climate change creates or exacerbates in relation to urban infrastructure and service-delivery systems. In the African context, this is a challenge. Not only do city authorities have limited mandates and resources, but the cities' needs are tremendous – and future trends and transitions have uncertain and diverse implications. It is therefore necessary to deploy innovative approaches to solving complex urban problems. These approaches must involve developing capacity to think and act differently, and breaking silos between sectors, spheres of government, and the state and urban citizens.

ANNEX 1:

PRE-WORK FOR CLIMATE AND INFRASTRUCTURE CITY-LABS

Note: Critical content necessary for understanding and populating this table can be found in the earlier parts of this paper. Please read them carefully.

5.1 Basic overview

This section should provide the basic information needed about the city to aid understanding of the tables below. The following are some suggested things to include in this summary. Please ensure that all information is referenced and that, wherever possible, the most-up-to-date statistics are used. For this section, please use official documentation and sources as much as possible.

- Population
- Growth rate
- Additional demographic information
- Include a map of the city, including administrative boundaries and spatial footprint
- Other key information

5.2 Mapping stakeholders: City context

5.2.1 Locating local government in MLG systems

This section should provide a high-level overview of the formal structures that govern the city. We have used the frame of 'multi-level government' (MLG), to situate local government within higher levels of government. If the levels of governments (spheres/tiers) are not accurately described, if others exist, or if some are not needed in your city, please adjust the table accordingly. It is most important that this table* provides a clear understanding of the local government context, with the other levels of government attended to more generally.

(Credit: Liza Rose Cirolia)

ANNEX 1:

TABLE 1: LOCATING LOCAL GOVERNMENT IN MLG SYSTEMS

	Responsible actor	Roles in urban development	Institutional political structure
Local gov/municipal			
How does local government fit within the following systems:			
Metropolitan region (e.g. city region)			
Regional (e.g. province, district, states)			
National			
International			

Governance questions:

- In the MLG systems, what are the most important horizontal relationships (e.g. between local government and other levels of government)? What are the key areas of alignment and dissonance?
- In the MLG systems, what are the most important vertical relationships? What are the key areas of alignment and dissonance?
- Are there any notable changes or transitions on the horizon for the governance system (e.g. decentralisation reforms, elections, etc.)?
- Are there key political issues that need to be clarified?

5.2.2 Key non-state actors active in the city

This section should provide a high-level overview of the non-state actors operating in the city. Attention should be given to those actors who work on issues of governance, urban infrastructure, or climate responses. As this table will be used as the basis to discuss possible 'convening partners' for the lab, detailed attention should be given to the academic departments and individuals involved in these conversations. The other categories can be addressed more superficially at this stage.

Potential for involvement in city-labs:

- Which actors from the above list are most active in conversations related to climate change and infrastructure?
- What fora or institutional arrangements exist to support or convene these actors?
- Which actors might have the most appetite or incentive to be part of a lab process?
- What contemporary issues (local, national, or global) might shape interest or capacity to be involved?

(Credit: Liza Rose Cirolia)

TABLE 2: KEY NON-STATE ACTORS

Additional actors	Names of actors	Areas of work	Specific projects in the climate infrastructure space, or specific people working on related issues
Academic (e.g. departments, centres, units, individuals)			
NGOs/INGOs			
Private sector (e.g. developers, management consulting companies, etc.)			
Lenders/donors			
Civic groups (e.g. youth groups, unions, FBOs, etc.)			
Others			

5.3 Urban infrastructure overview

5.3.1 High-level overview of the state of urban infrastructure

This section aims to provide a high-level overview of the state of urban infrastructure in the city. It aims to outline the key infrastructure systems and the challenges they face. These challenges could be internal to the systems (e.g. system cannot be extended) or could relate to other systems (e.g. social issues created by the infrastructure)

5.3.2 Local government's roles in urban infrastructure

This section aims to understand the relationship between key urban infrastructures and local government. This could include, for example, direct responsibilities, risks, impacts, consequences, etc.

TABLE 3: URBAN INFRASTRUCTURE OVERVIEW

City infra-structure	Description of existing networks & service delivery options	Key challenges related to this infrastructure (quality, consistency, affordability, etc.)	In-progress projects/plans (such as plans for upgrading roads, last mile delivery programmes, etc.)
Energy			
Water			
Sanitation			
Waste			
Mobility/transport			
ICT			
Land and planning			
Others			

TABLE 4: LOCAL GOVERNMENT'S ROLES

City infrastructure	Local government role in each infrastructure
Energy	
Water	
Sanitation	
Waste	
Mobility/transport	
ICT	
Land and planning	
Others	

5.3.3 Other actors' roles in urban infrastructure

This table outlines the other actors involved in urban infrastructure, e.g. higher levels of government (national and regional), international actors such as donors, lenders and INGOs, private companies, NGOs, or the informal sector. Please list their roles and key functions.

'Making sense' of infrastructure pressures

- From the perspective of the local government, what are the most pressing infrastructure challenges?
- From the perspective of the city system, what are the most urgent developmental, economic, and environmental/ecological pressures facing urban areas?
- How have different actors framed these issues? How are these issues/pressures part of historicised, current, and speculative pathways?

Intervening in infrastructure challenges

- Who are the key actors in creating, managing, or intervening in these pressures?
- What are the dominant policy paradigms that frame existing activities to respond to these pressures, and who formed part of developing and sustaining these paradigms?

TABLE 5: OTHER ACTORS' ROLES

City infrastructure	Involvements of other key actors in urban infrastructure
Energy	
Water	
Sanitation	
Waste	
Mobility/transport	
ICT	
Land and planning	
Others	

5.4 Climate and transition changes affecting the city

5.4.1 Identifying climate changes and related hazards

This section helps understand the climate changes impacting the city. Climate change leads to a range of physical changes, such as changes in temperature or rainfall. These physical changes can contribute to the increased incidence of hazards in urban contexts. The space below is provided to allow for any relevant data collected by national or international bodies to be captured and referenced. The information should preferably include any official data gathered at the national or subnational level, supplemented, where necessary (e.g. old data) with key stakeholder perceptions, noted as such.

5.4.2 City-specific climate hazards and their impacts

This section looks at the specific climate hazards arising from the climate changes identified in the previous table. The specific hazards for this city should be used to populate the rows of the table. Please include at least four. This section further explores the impact of these hazards on infrastructure systems. Impact refers to the potential effects of hazards on human or natural assets and systems. These potential effects, which are determined by both exposure and sensitivity, may be beneficial or harmful.

5.4.3 Identifying transition changes

This section looks at the transition changes and their impacts. Transition changes are those urban scale changes that are linked to the transformation toward a low-carbon economy. Given how national governments, donors, and other actors are aiming to address climate change through 'sustainable' or 'low-carbon' transition interventions, this section seeks to understand how those transition changes currently under way play out at the city scale. For example, the availability of conditional climate finance may influence urban infrastructure decisions, such as procurement of solar street lighting. We have identified some transition changes below. Please populate the relevant changes with city-specific information regarding the implications.

TABLE 6: IDENTIFYING CLIMATE CHANGES/HAZARDS

Physical changes	Relevant data evidence on this change in city context (provide references)	Related hazards affecting cities
Increase/decrease in temperatures		*e.g. storm events, heatwaves, forest fires, etc.*
Increase/decrease in rainfall		*e.g. drought, flooding, erosion*
Sea-level rise		*e.g. coastal flooding, erosion, damage to property, salinity changes, loss of wetlands*
Increase in salinisation		*e.g. changes in water quality, groundwater contamination, desertification*
Decrease in vegetation cover		*e.g. desertification, loss of biodiversity*

5.4.4 City-specific transition changes and their impacts

This section looks at the implications and effects of the transition changes at the city scale. These transition changes should be taken from the above table, specifically tailored to the city context and issues. Please identify at least four.

TABLE 7: CITY-SPECIFIC HAZARDS/IMPACTS

Hazards arising from climate changes	Description of hazard in city context	Infra-structure impacted	Other impacts	Are the incidents of this hazard likely to increase/ decrease?
e.g. flooding				
e.g. drought				

5.5 Identifying city-driven innovations

This section focuses on the innovations and responses at the city scale, particularly driven by local governments. Cities are responding in creative ways to the infrastructure challenges posed by climate change and transitions. In the following table, please indicate what sorts of innovations are currently being developed, trialled, or implemented at city scale. Please include at least four.

Reflections on innovative projects or programmes:

- Do any of these projects challenge or disrupt the 'status quo' way of working/thinking in the city?
- Do they change roles, resources, relationships, and how climate is understood?
- Are there any signs of success? What, if anything, has gone wrong?

5.6 Synthesis of lab options

5.6.1 City problems

Based on the above information, what problems would be suitable for a lab to focus on? These need to be issues which meet particular criteria, including:

- Complex issues, implicating multiple sectors and actors
- Potential to make an impact within the timespan of the lab
- Have a central role for local/city government
- If addressed, will impact on marginalised and vulnerable people

TABLE 8: TRANSITION CHANGES

Transition changes	Specific city transition changes Related hazards affecting cities
National policy commitments to decarbonisation	
Availability of climate and other funding/ finance	
Climate or related conditions for infrastructure funding/finance	
Availability of climate-related advisory and capacity-building services	
New resource-efficient technologies are available	
Economic or industrial changes (e.g. new businesses like solar equipment sales)	

TABLE 9: CITY PROBLEMS

Key issue	Description of the issue	Approach/method
e.g. flooding in informal settlements		
e.g. management of e-waste		

5.6.2 Potential Convening Partners

This section aims to identify possible Convening Partners (e.g. academics, NGOs, etc. who might be able to lead). This could include a group working together. The Convening Partner should be the 'neutral' party who can host the lab space and invite a wide range of actors to join the conversation. Please include details of the rationale, including, for example, previous experience, resources, and skills.

TABLE 10: POTENTIAL CONVENING PARTNERS

Description \ of lead (including institutional home)	Rationale	Potential limitations
e.g. Academic department X		
e.g. Established NGO X		

5.6.3 Overall readiness prognosis (to be completed with Strategic Partner)

The following three tables will be populated together with the Strategic Partner and, if necessary the Decision Making Partner.

(Credit: Liza Rose Cirolia)

TABLE 11: OVERALL READINESS PROGNOSIS

Platform
• Is there sufficient political stability to convene actors? • Can the strategic partner identify the climate infrastructure and governance issues (and how they intersect)? • At these intersections, there are stakeholders… (apathetic, resistant, curious, excited, mobilised?) • Is there understanding among stakeholders that intersectional problems exist that are not being adequately addressed? Is there agreement among stakeholders? • Is there sufficient capacity distributed among stakeholders to significantly address challenges at the urban scale? Describe this capacity
Convening Partner
• Are there possible Convening Partners who would be able to co-develop and co-implement a lab? • Do identified Convening Partners: • have significant convening power across stakeholder groups? • have working relationships at decision-making nodes? • operate as a generalist or in niche areas? • have adequate facilitation capacity? Or the capacity to procure or develop this? • have the capacity to manage resources and make contractual agreements as necessary?
Decision space
• Are the relevant formal and informal decision-making nodes clearly identifiable? • Are there champions at the decision-making nodes? • Is there a recognition at decision-making spaces that the current responses at the climate and infrastructure interface are not working? • Are nodes of decision-making functionally connected?

(Credit: Liza Rose Cirolia)

ANNEX 2:

AFRICAN CITY-LAB EXAMPLES

One of the earliest examples of city-labs in Africa was the African Centre for Cities' (ACC) City-Lab programme, established in Cape Town, South Africa, in 2008. In 2010, the ACC became part of Mistra Urban Futures (MUF), which developed city-labs in Sweden, the United Kingdom, and Kenya. As part of this, the Mistra Urban Futures Knowledge Transfer Programme (KTP) was an exchange partnership between the City of Cape Town and the ACC, which demonstrated how deeper university-city knowledge and learning can be fostered through temporarily embedding academics into local government, and officials into universities. Building on the ACC experience, the Gauteng City-Region Observatory (GCRO), in Johannesburg, South Africa, adopted the City-Lab approach in 2014 to explore and develop knowledge around implementing a green infrastructure approach in Gauteng (Culwick et al., 2019).

TABLE 12: EXAMPLES OF CITY-LABS IN AFRICA

Name	City	Dates
Human Settlements City-Lab	Cape Town, South Africa	2012-2016
Urban Flooding City-Lab	Cape Town, South Africa	2008-2012
Philippi Area City-Lab	Cape Town, South Africa	2008-2015
Urban Ecology City-Lab	Cape Town, South Africa	2010-2014
Urban Violence City-Lab	Cape Town, South Africa	2014-2016
FRACTAL Climate Lab	Lusaka, Zambia	2016-2021
FRACTAL Climate Lab	Windhoek, Namibia	2016-2021
Tanzanian Urbanisation Laboratory (TULab)	Dar es Salaam, Tanzania	2017-2019
Kiandutu City-Lab project	Nairobi, Kenya	2017-2019

Sources: Simon et al., 2018; Marrengane & Croese, 2021; Tanzania Urbanisation Laboratory (TULab), 2019. Ad

Beyond South Africa, the ACC supported the development of several city-lab programmes. In 2016 "City learning labs" were set up in several cities across southern Africa as part of the Future Resilience of African Cities and Lands (FRACTAL) project. In 2017 the ACC further established an urbanisation laboratory in Tanzania (TULab), as part of a Coalition on Urban Transitions (CUT) project, which applied the same approach to issues of sustainability at a national scale. Also in 2017, the ACC supported the Ford Foundation in initiating city-labs using the African Urban Research Initiative.

Table 14 below shows examples of specific city-labs in Africa: four city-labs from the ACC's City-Lab programme in Cape Town (the Sustainable Human Settlements City-Lab, Urban Flooding City-Lab, Philippi City-Lab, and Urban Ecology City-Lab); two FRACTAL Climate City-Labs (in Lusaka and Windhoek); the TULab in Tanzania; and the Kiandutu City-Lab.

Convening Partner	Funding	Strategic Partner
ACC	Western Cape Government, Dept of Policy and Research	MUF
ACC	Western Cape Government, International Development Research Centre	MUF
ACC	City of Cape Town	MUF
ACC	Western Cape Government, International Development Research Centre	MUF
ACC	GIZ	GIZ
University of Zambia	FCDO and NERC	FRACTAL
University of Namibia	FCDO and NERC	FRACTAL
Economic and Social Research Foundation (ESRF)	Coalition for Urban Transitions	ACC
University of Nairobi, Centre for Urban Research Innovations (CURI)	Ford Foundation	ACC

ditional information drawn from FRACTAL.

ANNEX 3:

EXAMPLES OF CITY-LAB ACTIVITIES

Activity	Description
Seminars or workshops	Running seminar series workshops that reflect a range of experiences and views from academics, officials, and civil society around a particular topic can contribute to a better understanding of the various dimensions of the issue among participants. It can help legitimate marginalised perspectives and types of knowledge family.
Distillation processes	Distillation sessions are a particular type of workshop/seminar for interrogating scientific data and information in relation to the common issue being explored.
Field trips	Undertaking field trips to specific geographic areas, specific projects, or specific organisations of relevance to the topic is a useful complement to seminars and workshops. Field trips bring the issues to life in a very tangible way, create a shared experience and set of reference points among participants, and are a good way for different stakeholders to interact more informally than they normally would.
Collaborative research	Undertaking collaborative research involves co-designing research processes, and ensuring that the insights are collectively agreed on. This can create new knowledge and can help build the research and analysis capacity of all participants.
Collaborative writing	Collaborative writing processes to produce publications (books, reports, journal articles, policy briefs, etc.) that reflect a range of experiences and views from academics, officials, and civil society.

Example
The Urban Flooding City-Lab had a series of 10 seminars with presentations by academic researchers, local government officials, and NGOs, on various aspects related to flooding in Cape Town. Through these seminars, participants developed a more holistic understanding of flooding in Cape Town, and the complex interactions between water, people, and infrastructure. The Human Settlements City-Lab workshops brought together activists and officials in a series of workshops to discuss the different understandings of the role of the state in providing housing. This provided a foundation for understanding the fundamentally different objectives and drivers that these actors faced. The Kiandutu City-Lab held a series of three City-Lab workshops targeting Kiandutu informal-settlement residents in Thika town, which were organised to discuss land sharing.
In FRACTAL, climate information distillation sessions were used to generate integrated understandings. All discussions provided ample time and space for participants to interrogate the scientific information and ask questions about the process of producing the information, particularly the assumptions that were made by climate scientists along the way.
The Philippi City-Lab took academics and policy makers to Philippi to explore the different types of projects undertaken in the area, for example housing projects and NGOs. Part of this process also included having people engage with the spatial development framework for the city in the local area. In FRACTAL, Learning Lab participants in Lusaka visited the Kafue Gorge Hydropower Station, the site of one of the largest production boreholes supplying groundwater to the city (Shaft 5 in Lilayi), the Iolanda water treatment plant, and an informal settlement to see community-led drainage, eco-toilets, and water supply projects.
The Urban Flooding City-Lab used collaborative research methods to understand residents' experiences of flooding in informal settlements. It included ethnographic fieldwork in a number of informal settlements, GIS mapping, and unpacking of stakeholder perspectives of the problem and solutions.
The Sustainable Human Settlements City-Lab brought together participants from government, civil society, academia, and the private sector to co-write chapters for a book entitled Upgrading informal settlements in South Africa: A partnership-based approach. The Urban Voice City-Lab developed a four-day training course for local government officials and other practitioners aimed at enhancing their knowledge concerning effective methodologies and approaches for improving safety through upgrading. In addition, four journal articles were jointly published.

Embedding and disembedding	Putting people into new roles and/or institutions can provide them with different experiences and inject new ways of thinking into their institutions.
City exchanges	Exchanges between cities can help foster learning between platforms in different city contexts. Exchanges generally include enabling key partners – academic, officials, activists, etc. – to travel to another city where a lab is taking place, to learn from the experiences. These exchanges can also be digital, if travel is not possible – however, the value of taking partners out of their context should not be overlooked.

	FRACTAL selected academics to be placed into government contexts. The embedded researchers provided a consistent link between academia and municipalities in cities. The embedded researcher spent much of their time in local municipalities building an understanding of the context and seeking opportunities to connect climate-related research with decision-making processes.
t	FRACTAL included several city-to-city exchanges, during which researchers and municipal representatives attended city-labs in other South African cities to share knowledge about issues in their context, as well as policies and activities implemented to respond to these. These visitors also learned about the issues and responses in the cities they visited. Mistra Urban Futures also provided city exchanges, where officials and academics from across the network (Cape Town, Kisumu, Manchester, etc.) visited one another to learn from varied experiences.

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