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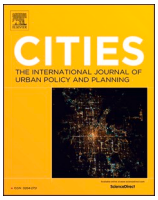

Inclusive climate resilient transport challenges in Africa

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ABSTRACT

Delivering sustainable and inclusive low-carbon transport is a critical to reducing greenhouse gas emissions and achieving the United Nations Sustainable Development Goals. Yet transport infrastructure is vulnerable to the effects of climate change in low-income countries in Africa. This paper explores the status of inclusive mobility and climate-resilient transportation in Africa, focusing on the perceptions and importance amongst key stakeholders, their incorporation into existing practices, and the priority given to making transport more inclusive and climate resilient. A nested scale approach was used that included an online continental survey of 136 respondents from 17 African countries; 2 country-level Focus Group Discussions in Uganda and Zambia; and city-level semi-structured interviews with key stakeholders in Lusaka and Kampala using the Delphi method. In addition, an online spatial questionnaire (Maptionnaire) was used to locate where infrastructure improvements were needed, and two city workshops held in Lusaka and Kampala. Providing more active travel infrastructure was a priority for both government and non-governmental groups. This is not connected to climate resilience but to immediate priorities of road safety and health. Our surveys highlighted that climate resilience and inclusive mobility policies are in place, but poor implementation and lack of transparency were undermining outcomes. Upgrading existing infrastructure was more cost-effective and workable than developing new robust alternatives. Lack of knowledge exchange was limiting agencies efforts to tackle this growing challenge. The paper underscores the need to raise awareness of relevant options to improve the climate resilience of transport infrastructure and expand accessible mobility solutions to tackle issues of inclusion and equity in African cities.

1. Introduction

Mobility and access to transport are key to sustainable development in low- and middle-income countries (LMIC) in Africa. Many urban residents are from low-income households and depend on non-motorised transport (NMT), such as walking and cycling, as their daily mode of transport (Stucki, 2015; Sub-Saharan Africa Transport Policy Program (SSATP), 2005). However, African LMIC cities often lack proper roads, public transport and NMT infrastructure that meet people's travel needs (UNEP, 2019). Poor connections between modes and destinations; the high cost of fares; and concern over safety and security issues impact mobility. This is the case for low-income disadvantaged groups who live on the periphery of cities and travel to access better-paid work and services located in central or more affluent districts (Porter et al., 2020). The absence of NMT infrastructure, together with inadequate public transport, means that people in African cities choose to use motorised vehicles (cars, minibuses, taxis, motorcycle taxis) to move around the cities, whenever they can afford to do so, in particular, in unregulated and polluting second-hand vehicles (UNEP, 2020).

A changing climate and extreme weather will affect all transport modes. It is often low-income disadvantaged groups such as the old, disabled, young, and women who suffer the most from a poor transport system that does not meet their travel needs. Transport planning in Africa therefore needs to be both inclusive and climate resilient. This is important not only to protect transport infrastructure, ensure mobility and economic development but to safeguard the health and wellbeing of all urban residents.

In this paper we examine the extent to which African transport planners and decision makers consider the concepts of inclusive mobility and climate resilient transport infrastructure and address three

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interlinked questions:

1. What is the current perception amongst key African stakeholders of the importance of inclusive mobility and climate resilient transport?
2. To what extent are these issues being addressed in current practices?
3. What are the priorities for improving the linkages between inclusive mobility and climate resilient transport?

To answer these research questions, we take a hierarchical approach, first examining the issue at the regional level, and the delving into the national policies of Uganda and Zambia to understand how current African transport policy and practice considers inclusive mobility and climate resilience.

1.1. Transport and climate change in Africa

Early studies on transport and climate change have focused on reducing transport emissions because of the continued growth in passenger and freight activity outweighing gains from greenhouse gas (GHG) emission reduction measures (UNEP, 2020). The Intergovernmental Panel on Climate Change (IPCC) states that aggressive policy intervention is needed to achieve a significant decrease in fuel carbon and energy intensity of transport modes, and to lower transport activity growth where possible (Wang et al., 2020). While such efforts to reduce transport GHG emissions are needed, action is also required to adapt transport infrastructure to current and future climate-related weather events.

The 2015 United Nations (UN) Paris Agreement set out a global action plan to limit global heating to below 1.5 °C and avoid risks to health, livelihoods, food security, water supply, human security, and economic growth (Sims et al., 2015). However, even with the UN global action plan, we still expect global heating to cause rising temperatures and sea levels, altered precipitation patterns, and more severe weather events that impact the mobility of vulnerable groups such as women, children, older adults, and people with disabilities (Stucki, 2020). According to the IPCC Fifth Assessment Report (AR5) (State of the Climate in Africa, 2020), under a medium emission scenario (RCP 4.5), extensive areas in Africa are predicted to surpass a 2 °C increase in temperature by the end of this century, compared to the mean annual temperature of the late twentieth century. This means an increase in heatwaves and warm weather periods and reduced precipitation over North Africa and southwestern parts of South Africa. Climate vulnerability is the extent to which a system is sensitive to and unable to cope with adverse effects of climate change (Adger et al., 2009). The transport sector is climate sensitive, making it vulnerable to infrastructure damage and deterioration, disruptions to transport operations, and unsafe weather caused by a changing climate. In addition, in Africa, ageing infrastructure, lack of investment funding, inadequate maintenance and rapid expansion of demand have resulted in overstrained transport networks.

In African cities, walking makes up over 75 % of total daily trips made by the poor 9 and 78 % of people walk on average for 55 min daily (Walk21 Foundation, 2021). However, infrastructure supporting these active travel demands is inadequate, contributing to pedestrians making up 33 % of all African road traffic fatalities. This is high in African countries such as Ethiopia (55 %), Uganda (35 %) and Zambia (50 %) when compared to India (13 %) and China (26 %).

While a changing climate and extreme weather will affect all transport modes and African residents, it is disadvantaged groups who will endure the worst effects given their limited mobility options (Engineering for Change, n.d.). Disadvantaged groups include those from low-income communities, older people, people with disabilities, young, and women. For example, flooding because of extreme precipitation disrupts public transport, exacerbates traffic congestion, and can overwhelm active travel infrastructure. These urban flooding impacts on transport reduce individual's access to basic needs and livelihood opportunities, including healthcare, education, and employment facilities while increasing travel time, travel costs and road safety risks (Hallegatte et al., 2019). Many urban areas are expanding and require building a climate-proof transport system now while avoiding developments that increases vulnerability to future climate change.

In 2013, The United Nations Economic Commission for Europe (UNECE) called for the urgent need to gain a clear understanding of the potential climate impacts, risks, and vulnerabilities of transport, as this will be a prerequisite to the design, construction, and management of resilient infrastructure. The concept of resilience is a contested area with varying definitions depending upon disciplinary or theoretical backgrounds. The Organisation for Economic Cooperation and Development (OECD) defines climate-resilient infrastructure as one that is "planned, designed and built that expects, prepares for, and adapts to changing climate conditions" (OECD, 2018). The Rockefeller 100 Resilient Cities Initiative (Galderisi et al., 2020) defines resilient transportation system as one that "promotes safe, equitable, and inclusive accessibility by providing sustainable, integrated, flexible, and robust mobility options – during normal times and times of crisis" (Rockefeller Foundation, 2015; Zhou et al., 2019). Resilient infrastructure therefore relates to the ability for transport to function under climate-induced disruptions, and the time and resources required to restore performance (OECD, 2018). Climate resilient mobility adds to the dimensions of the users, their behaviours, and choices. To mitigate and adapt to future climate conditions, transport planning in Africa needs to be both more inclusive of disadvantaged groups mobility needs and increase consideration of climate-resilience. These changes are important to protect infrastructure, maintain mobility and support economic development safeguarding the health and well-being of all urban residents.

Transport policymaking is seen not as a rational evidence-based process, but the outcome of many interactions between policymakers and various actors. While this approach may be more pragmatic (Ansell & Geyer, 2017), the low political participation of disadvantaged groups limits their ability to influence transport policy and planning (Gorman et al., 2019). This lack of consideration makes planning robust and fair climate resilient transport plans difficult. Improving the understanding of planners of these groups mobility demands, and how they might be affected by new transport technologies (e.g. shared mobility and electric vehicles) (Behrens & Görgens, 2019; Kett et al., 2020) is required to overcome these shortfalls in decision making. New transport infrastructure (e.g. public transport, non-motorised transport or road construction) needs to deliver more fair mobility but also to withstand future climates (Bakker et al., 2019). This is a challenge as many countries have a short-term view, prioritising the needs of pro-poor basic urban services over environmental concerns (Schwanen et al., 2011; UNEP, 2019). A reluctance to act on climate adaptation is because of the perceived potential costs imposed and consequent negative economic development effects. However, transport infrastructure investments long-term nature with their resulting lock-in to particular modal choices means this approach could actually be less cost-effective in the medium term (Seto et al., 2016). The challenge, therefore, is to have a transport planning process that is inclusive, climate-resilient and low-carbon (Banister, 2011).

2. Methods

After conducting a semi-systematic literature review on the state of knowledge on inclusive mobility and climate resilient transport, we adopted a hierarchal approach. This began with an online questionnaire to assess across the African region the perception amongst key stakeholders of the importance of inclusive and climate resilient mobility. National surveys followed this and focus groups of increasing detail in two focal countries (Zambia and Uganda) at the national and capital city level (Lusaka and Kampala) to determine countrywide and city specific challenges on these topics (see Fig. 1).

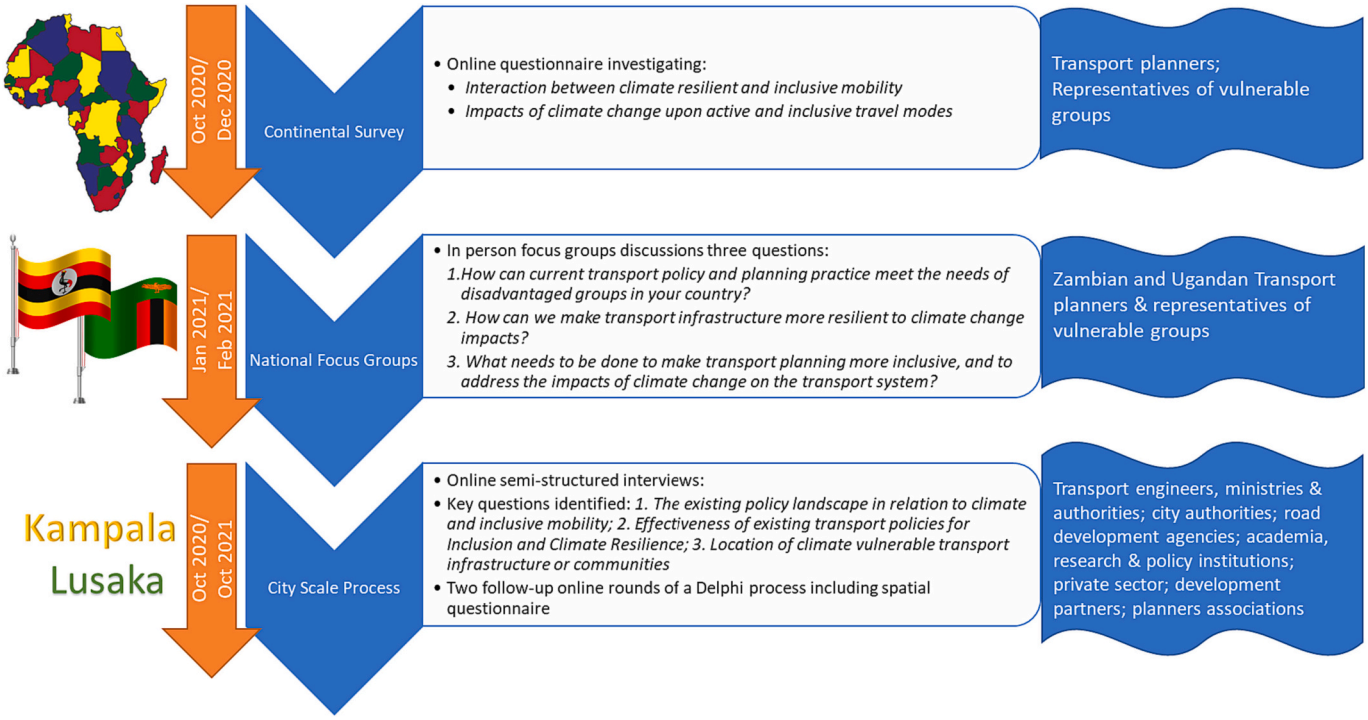

Fig. 1. Flowchart of nested scale survey processes.

2.1. Continental scale

The initial continental questions were included in a wider online survey distributed by UNEP's Share the Road Programme, who promote investing in walking and cycling policies. The survey targeted transport planners and representatives of disadvantaged groups. They were asked to respond based on their regional perspective and experience. The 15-minute survey (available in English and French) was distributed online and comprised a mix of open-and-closed questions. In relation to our research questions on inclusive climate resilient mobility; participants were asked to rank the three most important reasons that they thought people chose to walk (enablers) or not (barriers) in their region and their organisations three most important sustainability priorities. We analysed the rankings to identify key themes emerging from supporting free text justifications.

A total of 94 respondents to the survey answered questions related to climate resilience and inclusive mobility (from 135 responses overall with questions optional, hence some non-returns). The participants represented 17 countries across four African regions (see Table 1) (with only Central Africa having no respondents) with a mixture of expertise at different institutional scales (see Table 2).

Table 1
Continental survey participation rates by region (note: six respondents represented African countries but were based in the UK or Netherlands).

Regional participation	Total	Percentage	Country participation
Northern Africa	5	6 %	Algeria (3), Egypt (2)
Eastern Africa	40	45 %	Ethiopia (9), Kenya (12), Rwanda (2), Tanzania (2), Zambia (7), Zimbabwe (2)
Southern Africa	12	14 %	Namibia (5), South Africa (7)
Western Africa	31	35 %	Ivory Coast (2), Ghana (12), Niger (1), Nigeria (11), Togo (2)
TOTAL	88	100 %	

Table 2
Continental survey local or national scale participants' thematic interests (note: participants could select more than one theme and represent both scales if appropriate to their role).

Area of expertise	Local level	National level	Total
Transport	28	35	63
Land use planning	12	3	15
Sustainability	14	13	27
Environment	12	15	27
Health	8	13	21
Infrastructure	10	12	22
Other	15	13	28
Total	99	104	203

2.2. National scale

At the country scale, focus group Discussions (FGDs) were undertaken in collaboration with the UNEP Share the Road project. A semi-structured discussion was facilitated by the researchers around the key mobility themes. The 37 participants (see Table 3 for breakdown between countries) included policy makers, representatives of vulnerable stakeholders, urban planners, and academics. Participants were prompted to debate key issues around: (1) How can current transport policy and planning practice meet the needs of disadvantaged groups? (2) How can we make transport infrastructure more resilient to climate change impacts? (3) What needs to be done to make transport planning more inclusive, and to address the impacts of climate change on the

Table 3
National focus groups participant numbers and backgrounds.

Country/ City	Transport planners & decision makers	Vulnerable groups representative (NGOs)	Academic	Private sector	Total
Uganda	*7*	*7*	*1*		*15*
Zambia	*10*	*12*			*22*

transport system? Facilitated focus groups were considered the most useful method for stimulating debate on these topics between the mixture of participants. This interaction encouraging snowballing or contestation of points raised could not have occurred through individual interviews or questionnaire approaches. The contributions were recorded and transcribed with participants' identities anonymised. We qualitatively analysed the transcriptions to identify commonality and divergence in key factors on these topics between the two countries and between participants.

2.3. City scale

Finally, at the city level, assessments of city mobility, inclusion and resilience challenges were undertaken through semi-structured interviews with key stakeholders complemented by a Delphi (Rowe & Frewer, 2000) process to understand the levels of consensus in Lusaka and Kampala around these interlinked issues. Delphi is a deliberative approach that can determine views, test policy questions, and build participant consensus. The Delphi method focuses upon expert participants undertaking iterative questionnaires, followed by a sharing of anonymised collated responses (both qualitative and quantitative) to build increasing shared understanding or reveal areas of entrenched disagreement. To inform the development of the initial Delphi survey, individual semi-structured key informant interviews were undertaken with experts representing transport planners, decision-makers, and disadvantaged groups in each city (see Table 4). This was followed by two-iterations of online questionnaire and reporting with the second iteration, including a spatial component (delivered using Maptionnaire online spatial questionnaire software) to identify where it was felt infrastructure improvements were most pressing. Findings from these iterations were analysed statistically to assess levels of agreement between participants and qualitatively to identify the justifications for differing viewpoints.

3. Results

3.1. Climate resilient infrastructure

In the continent-wide survey, participants were asked to rank the three most important sustainability priorities for their work organisation (see Table 5). In relation to inclusive climate resilient transport governmental, NGOs and academia (including Private sector transport consultants) all showed that resilient infrastructure was a key focus for their organisations. It was cumulatively ranked third overall but only ranked the number one priority by 8 % of participants, showing the secondary nature of this factor in their work. Mitigating climate change was the fourth highest priority overall, but was more important to academics than government or NGOs. Overall, they ranked reducing road fatalities as the number one priority (1st ranked by 35 % of 91 respondents). This highlights the low focus upon the interactions of climate and mobility amongst key decision makers across the continent who have more immediate pressing priorities.

The overall scoring of African sustainability challenges mirrors these results (see Fig. 1) and shows the relative overall institutional priority given to these different dimensions of sustainability from the survey participants. Again, this shows the subsidiary nature of both resilience and climate change compared to immediate health and safety priorities across the continent. Interestingly, improving air quality (Zalakeviciute et al., 2020), which is a key contributor to health in urban areas 27 was ranked only 7th in the list of priorities, indicating that the indirect connection between transport emissions and respiratory disease does not appear to be a noticeable key concern.

Table 5
Participant's perception of their organisation's sustainability priorities.

Rank	Governmental	NGOs	Academia	Overall
Improve health and well-being	2	2	1	1
Reduce road fatalities	1	1	3	1
Build resilient infrastructure	3	3	3	3
Mitigate climate change (e.g. lower carbon emissions)	5	5	2	4
Redress inequalities	8	4	5	5
Reduce poverty	6	5	6	6
Improve air quality	4	7	10	7
Provide housing and sanitation	10	9	6	8
Support local economic growth (e.g. for local shops and traders)	7	8	9	9
Improve access to renewable energy	9	10	8	10

Zambian participants recognised that current transport infrastructure was not resilient. They highlighted the annual occurrence of collapsed bridges, washed away roads, overflowing drainage systems and flooded road passages during heavy rains as evidence. Active 1: They discussed how the open drainage systems easily get blocked, causing local flooding of roads and sidewalks (when present). Flooding impacts are exacerbated by the predominance of gravel-based roads that are easily damaged in heavy rain leading to potholed surfaces that undermine mobility, especially for active modes. Where tar roads are present, it was observed that they are often poorly installed. Constructors are seen to be paying awarding agencies for their contracts with the funds released for the building of infrastructure, reducing the quality and robustness of the resulting roads. Again, this led to poor surfaces that were not resilient to extreme weather. The current high costs for some transport options also limited choice for people with low income, restricting mobility and reducing resilience in the system. For example, disabled passengers were being charged an additional fare by minibuses operators to carry their wheelchair or increased fares in wet weather. In Uganda, it was felt faster progress in building resilience was needed through implementing Bus Rapid Transit (BRT) systems and railway infrastructure. The efforts of national governments to produce electric buses were praised, but the need to raise awareness of electric vehicles more widely was highlighted. Government should increase the funding of "soft" components of projects, such as monitoring and evaluation, rather than concentrating solely on funding "hard" components of infrastructure to ensure projects are meeting users' travel needs, targets and are resilient in different climatic conditions.

There was divergence at the city scale on the relative importance of reducing GHG emissions from transport versus building resilience. In Lusaka, most participants viewed building transport resilience as a higher priority than reducing emissions. Meanwhile, in Kampala, both elements were seen to work in parallel with resilient transport believed

Table 4
City scale interviews and Delphi survey participant numbers and backgrounds.

Process	City	Transport Planners & Decision Makers	Vulnerable Groups Representative (NGOs)	Academic	Private Sector	TOTAL
Semi-Structured Interviews	Kampala	10	12			22
	Lusaka	6	10			16
Delphi Round 1	Kampala	9	9		2	20
	Lusaka	7	15			22
Delphi Round 2	Kampala	5	4			9
	Lusaka	3	7			10

to be inherently lower in emissions. In both cities, there was a consensus that climate resilience needs to be integrated into planning, legislation, and implementation. Participants favoured resilience over robustness: In Lusaka, this was because of uncertainties in climate change impacts and urbanisation processes; while in Kampala the benefits of adaptability were highlighted. In Lusaka, the consensus was that the priority should adapt existing infrastructure and it was highlighted that this would require local specific solutions rather than generic fixes. Across both cities, there was agreement that decisions on adaptation must be taken now as transport infrastructure assets are long-lived and can lock-in development patterns for many decades. Taking the right decisions now could reduce long-term costs and improve infrastructure resilience. In Kampala there was also the perception that resilience could be more cost-effective to engineer than robustness and would enable transport to remain functional. Those who disagreed with this approach stressed that existing transport infrastructure is not resilient to existing challenges and therefore felt a more fundamental rethink was required to address climate change.

3.2. Inclusive transport infrastructure

Results from across the continent on the importance of inclusion were mixed. Redressing inequalities only ranked 5th cumulatively across respondents and having a low priority for governmental participants (who were drawn from departments responsible for transport). The primary focus of these agencies was on reducing road deaths and improving health linked to the impact of current transport on disadvantaged communities. This approach deals with immediate concerns, but does not address latent mobility demands.

National FGD participants' responses diverged on whether their countries' current transport policies and planning practices were meeting the needs of disadvantaged groups. In Uganda, discussants concluded that the policies and practices existed but may be inadequate or poorly implemented. Participants agreed there was a need for the Central Government to take part in implementing these policies and not leave it to local authorities and private actors. In contrast, for Zambian discussants, the reverse was observed that inadequate decentralization of responsibility on transport limited the engagement of disadvantaged groups in these processes and restricted the dissemination of information that would inform policy and practice.

Zambian planners recognised inadequate coordination between the road development agency and local authority councillors was leading to inappropriate planning outcomes that didn't meet national policy and practice goals. Lack of inclusion from disadvantaged groups was contributing to the poor design of policies and their implementation. It was felt widening inclusion of disadvantaged groups could overcome these issues especially if they could be made apolitical. In Uganda, it was recognised that disadvantaged groups should be involved in the entire planning process, including needs assessment. This was seen to require capacity building within representative groups alongside improvements in discussion forums, to effectively bring on board all stakeholders. The diverse needs of disadvantaged groups were recognised and that therefore a range of solutions are required rather than simple universal fixes. It was concluded that there should be local input into decision-making in policy formulation as opposed to the current centralised approach, which does not promote ownership of decisions. Central government should also enhance its monitoring and evaluation mechanisms to improve on effectiveness of transport planning and implementation processes. Such improvements should be made in partnership with representatives of disadvantaged groups and relevant civil society organisations to ensure their constituencies needs are met. This could help resolve recognised issues of lack of enforcement of current standards and guidelines, resulting in substandard transport infrastructure outcomes.

From all city level participants, there was a recognition of the need for better information to inform effective decision making. In Lusaka, the lack of relevant data for vulnerable groups, particularly those with disabilities, was highlighted as a key problem restricting inclusive decision making. Participants agreed that, while lack of local data was problematic, existing knowledge was poorly disseminated with different agencies operating independently and not sharing data compounding problems. The need for increasing collaboration and learning between actors was recognised if interventions were to be inclusive and have shared ownership. It was felt that the informal sector may not understand the need, or comply, with formal regulations and policies. Better awareness of informal stakeholders, improved information flows and greater knowledge exchange could overcome this issue. In Lusaka, the role of local champions in this process was recognised if climate resilient planning outcomes were to be delivered.

3.3. Combining inclusion and climate resilience

Despite the low priority given across the continent to climate change, most of the participants felt that creating a resilient infrastructure for climate-related weather events would support the active travel modes of walking and cycling (see Fig. 3). These modes are disproportionately used by disadvantaged groups across Africa, meaning actions to build climate resilience in transport could also support vulnerable populations' mobility needs. Across the continent participants ranked the most important reasons they thought people chose to walk (enablers) or not (barriers). The most selected enablers were related to affordability ("it does not cost any money") (78 %, $n = 78$) and inadequate transport systems ("lack of transport alternatives") (74 %, $n = 74$). The most selected barriers were inadequate infrastructure ("no footpaths or safe crossing points") (68 %, $n = 68$) which can be interconnected to the lack of personal safety ("feel unsafe from traffic") (58 %, $n = 58$). Weather was ranked sixth as an enabler ("Weather is good for walking") and seventh as a barrier ("weather not conducive to walking") (e.g., too hot/humid/windy). These results indicate that the impact of climate (with weather used as a proxy for potential climate change impacts) on walking is not a high current priority (nor yet a strong barrier to wider uptake of this mode) given the basic lack of safe non-motorised transport (NMT) infrastructure.

When discussing how to make transport planning both more inclusive and responsive to the effects of climate change; Ugandan participants concluded disadvantaged groups need to be better represented in the transport infrastructure planning process. It was highlighted that the draft Transport Master Plan should only be passed by the government after extensive stakeholder consultation, including those from disadvantaged groups. Almost all Zambian participants agreed that there was no inclusiveness in policy and implementation processes. Further discussion revealed that transport stakeholders did not know the boundaries for their roles in infrastructure development. The example was given of Zambian Local Councillors and Road Safety Agencies sometimes interpreting policy differently, which, in extreme cases, caused confusion in the planning process. It was also discovered that many stakeholders and transport infrastructure users were unaware of policies and implementation plans. Inadequate decentralization of the sector seemed to exacerbate poor communication with stakeholders and end users. "There appears to be few studies on transport infrastructure in Zambia to enable us to make evidence-based decisions" was one comment. This may mean that planning decisions are not leading to desired or expected transport infrastructure outcomes, undermining both inclusion and climate resilience objectives.

Between the two case cities, a critical area of disagreement was around the role and responsibility of the private sector. In Lusaka, most participants disagreed 70 % (9 participants, with 4 neutral and only one agreeing) with the statement evaluating whether building resilience depended on the private sector. In Kampala, responses were more mixed with 56 % (9) agreeing or neutral that the private sector was critical. The divergence revolved around beliefs on the role of planning legislation and its implementation. Those who disagreed highlighted the need of

government to set the agenda and regulations within which the private sector operates; however, in both cities, partnership was the preferred implementation approach for best results. To promote inclusive low-carbon mobility, in both locations there was overall agreement that this was a key priority as it will deliver a mixture of co-benefits including widening active travel use, improving urban air quality, contributing to tackling climate change and increasing transport equity.

4. Discussion

With the transition of global populations to urban living, cities are now a critical focus for building resilience to existing and upcoming climate change impacts. However, the depth of current urban inequalities brings additional challenges to delivering on SDGs ambitions, including making cities inclusive, safe, resilient, and sustainable. According to the OECD, Africa is expected d to have the fastest urban growth rate globally, with cities, especially small and medium-sized towns, projected to home an additional 950 million people by 2050 (OECD/SWAC, 2020). This transition will concentrate and magnify the effects of any lack of urban resilience, including in the transport sector.

This rapid increase in urbanisation is occurring in parallel with the emerging effects and vulnerability of African countries to climate change. Compared to the rest of the world, evaluations show Africa has the highest global vulnerability to climate change (see Fig. 4) in terms of the population's exposure, sensitivity, and existing adaptive capacity. This is the case for West, Central and East Africa regions. More worryingly, the continent also has the lowest levels of readiness to combating this risk in terms of the economy, governance, and social conditions (Chen et al., 2015; University of Notre Dame, n.d.).

Global data on how much progress different regions are making towards climate resilient transport is lacking, making comparisons of other regions to Africa problematic (Ji et al., 2022). Using the data on the investments from multi-lateral development banks in climate resilient transport shows globally transport related projects made up only 15 % of financing. The investment focus was upon low emission vehicles and mass transit systems (Bazbauers, 2021). The emphasis on these solutions was also reflected in our survey data responses from Uganda. This information indicates how development partners' funding priorities and packages can influence transport debates while ignoring specific local contextual or equity issues and not significantly tackling the broader implications of transport climate resilience and inclusive mobility. Investigating current perceptions of the importance of inclusive and climate resilient transport; our continent-wide survey results show that providing more infrastructure to support active transport was a priority for both government and non-governmental groups. However, this is connected to immediate priorities of road safety and health agendas rather than directly associated with making transport climate change resilient. Both the need to mitigate GHG emissions, that could be a co-benefit from supporting NMT, and the connection between climate change effects on environmental conditions (such as weather-related events including heatwaves, extreme rainfall, surface water flooding, etc.) that have the potential to undermine active travel in the medium term are viewed as lower priorities, or not recognised yet by the participants surveyed (see Fig. 2). These findings highlight that near-term or immediate issues are the focus of much decision making on infrastructure and policy goals. The longer-term implications of these immediate actions are currently largely not considered, or are underappreciated, at the national scale despite an emerging recognition of climate lock-in implications.

Looking at the limited evidence on transport investments in Africa indicates they are being used for road infrastructure, including improving drainage. These investments are concentrated upon capital cities with less consideration of the needs of secondary cities and towns. In relation to inclusive resilience building, improving drainage could mitigate climate change impacts, assisting in transport resilience. However, without also developing NMT infrastructure and with the geographic bias upon major cities these investments do not address inclusivity, nor the mobility demands of growing urban populations of key secondary cities. Reflecting on priorities for improving inclusive climate resilient mobility (Albert et al., 2021); our city-scale findings showed upgrading existing infrastructure was viewed as more cost effective and workable than developing or retrofitting robust alternatives. The urgency of the issue was recognised in the relative cost-effectiveness of investing in long-lasting effective infrastructure now to avoid leaving legacy resources that did not meet future needs or conditions. Lack of information was problematic with existing knowledge, often siloed agencies. Improving coordination and involvement of the private sector emerged as a key priority and challenge if policies and plans are to be developed.

The Rockefeller 100 cities resilience building project (Galderisi et al.,

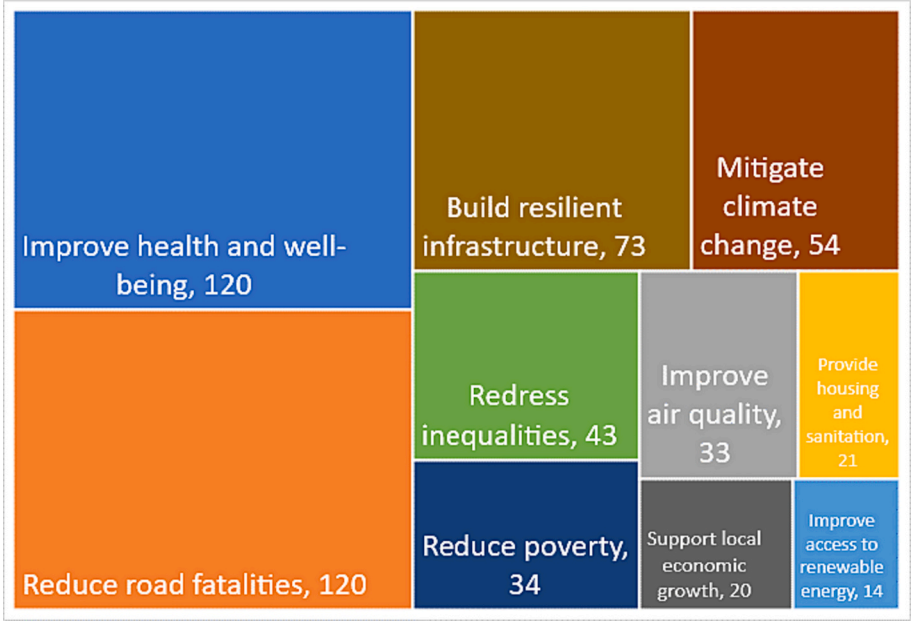

Fig. 2. Overall ranking scores of African sustainability priorities identified by all participants.

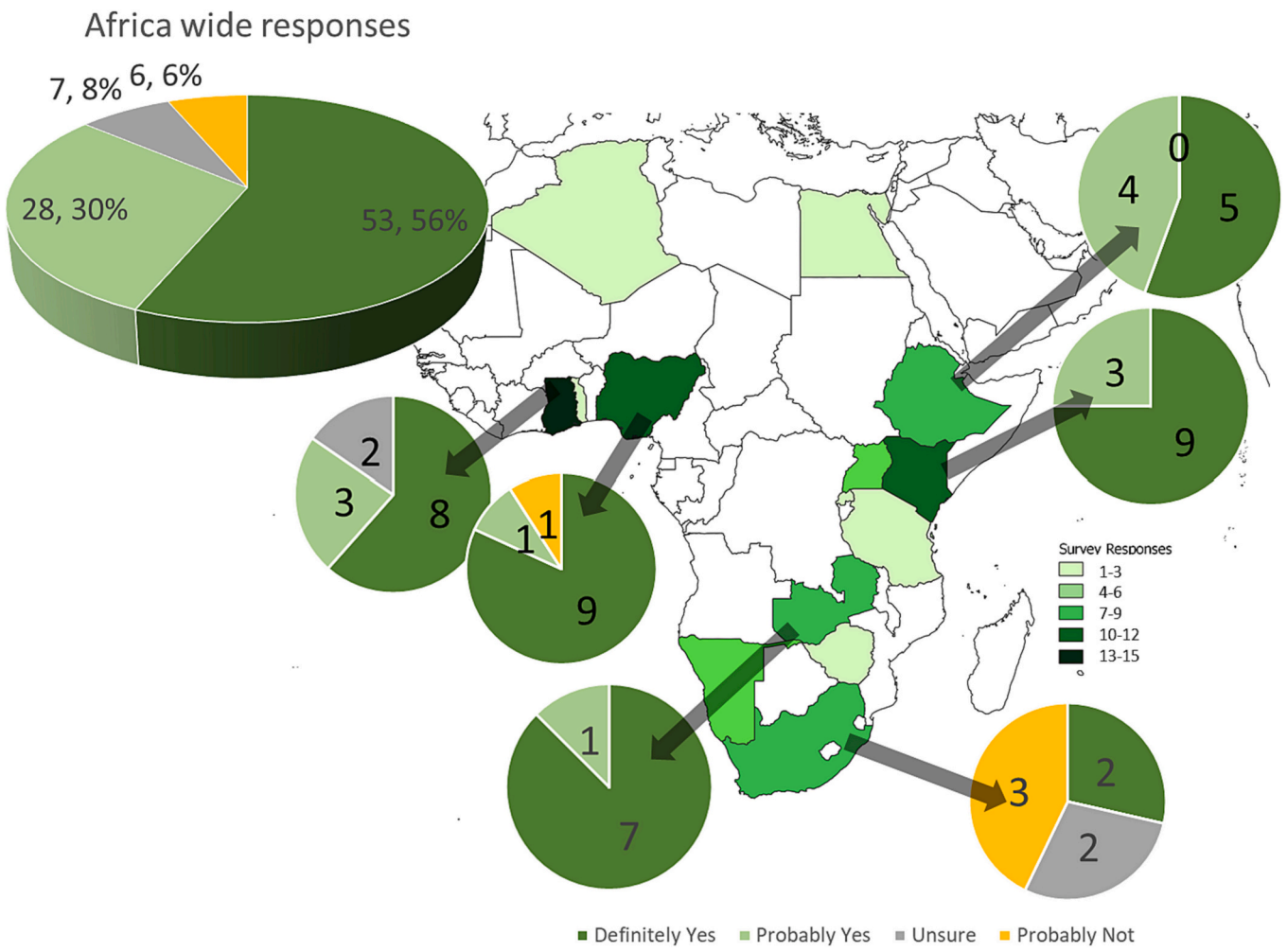

Fig. 3. Participant responses by country and the continent to the survey question "To what extent do you think creating a resilient infrastructure for climate change related weather events would help support people who walk or cycle in your community/ city/ country?"

2020) stresses the need for inclusion to be embedded in city decision-making processes to be truly effective and transformational. In relation to climate resilient urban transport, key decision makers need to recognise that mobility is a fundamental right. Regarding how these issues are being addressed in practice; at the national scale in Zambia and Uganda, our surveys highlight a variety of issues were raised in relation to implementing inclusive climate-resilient transport. In both countries, it was felt that there were policies in place in relation to these agendas, but there were issues with poor implementation, lack of enforcement undermining outcomes. There was divergence in how much this was a failing of national agencies versus miscommunication, misunderstanding or poor implementation of existing policies by local agencies undermining planning and delivery of resilient fair outcomes. Improving inclusive practices that included greater engagement and participation from representatives of disadvantaged stakeholders was identified as a possible solution, recognising that these groups have diverse needs that may not be being considered or addressed. In relation to resilience, some solutions discussed appeared more relevant to reducing GHG emissions (vehicle electrification) than improving the responsiveness and flexibility of the transport system (resilience).

Climate change impacts will affect the mobility, livelihoods and wellbeing of all urban residents but particularly vulnerable groups (Moretti & Loprencipe, 2018). In relation to the SDGs improving decision-makers understanding of the spatial and socio-economic inequalities in city and regional mobility could improve the delivery of goals linked to sustainable cities and communities (SDG 11), gender equality (SDG 5), reduced inequalities (SDG 10), and good health and well-being (SDG 3). Ultimately, tackling these interrelated issues requires considerations of land use planning, mobility infrastructure development and resilience building. This entails looking at how to overcome the existing governance barriers that are resulting in the poor implementation of current policies revealed in our surveys and how best to leverage the potential in the private sector to deliver resilient fair solutions. Canvassing a wider range of actors, including vulnerable users, in identifying solutions to the complex challenges could improve the development of city spaces and mobility options. Without wider inclusion, there is a risk of identifying exclusive solutions that do not integrate the needs of the most vulnerable. This could lead to these residents improvising dangerous mobility choices that undermine the effectiveness of infrastructure rather than enhancing its climate resilience. For example, motorised users utilising infrastructure intended for NMT or walkers using dangerous roads with no sidewalk provision to avoid climate impacts such as flooding.

Our research engaged a relatively large number of participants from across Africa at the regional scale. However, our evidence is then restricted to in-depth work in two case study countries and cities.

While these showed similarities, they also revealed key differences in the opportunities and limitations for developing inclusive climate resilient mobility solutions. This variation in local enablers and barriers shows that more extensive national and subnational studies would be beneficial to extend the knowledge base on these issues. Targeting such work in secondary cities where the greatest implementation and

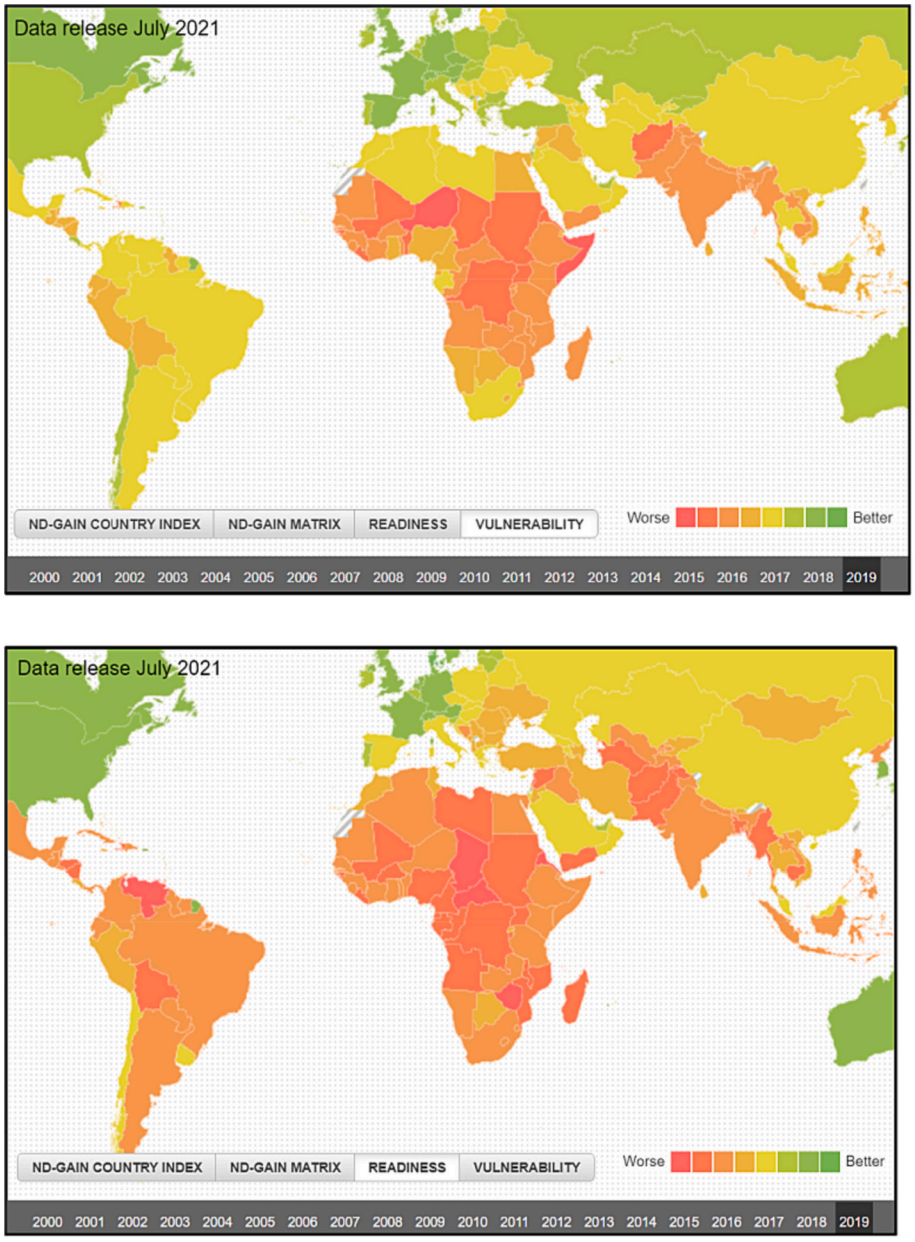

Fig. 4. ND Gain indices of vulnerability and readiness to climate change impacts (2019).
[Source Notre Dame Global Adaptation Index] (University of Notre Dame, n.d.).

investment challenges exist would be useful to overcome the bias in evidence generated in capital and major cities. Greater cross-city comparison or knowledge exchange could also benefit the development of Africa centric solutions to address the inclusive resilient mobility challenge. Additionally widening the range of participants and disciplines included in the co-creation of knowledge on this topic would generate greater shared ownership of this issue and help develop better integrated infrastructure and governance plans around the intersection of mobility, climate resilience and related policy goals such as education, poverty alleviation, gender equality and health.

5. Conclusion

This study adds to the limited existing evidence on the current state of inclusive climate resilient mobility delivery in Africa, by focusing on Uganda and Zambia. We found that providing more active travel infrastructure is a priority for both government and non-governmental groups. This is not connected to climate resilience but to immediate priorities of road safety and health. Our surveys highlighted that climate resilience and inclusive mobility policies are in place, but poor implementation and lack of transparency were undermining outcomes. Upgrading existing infrastructure was more cost-effective and workable than developing new robust alternatives. Lack of knowledge was undermining agencies efforts to tackle this growing climate challenge.

While inclusive mobility and climate resilience are recognised by key stakeholders, including planners and decision makers, the transformation in policies and processes required to deliver improved outcomes is not being delivered (Moretti & Loprencipe, 2018). We should not underestimate the urgency of such a transformation in mobility planning with high climate change vulnerability across the continent combined with booming urban populations. Our findings align with a call from other sectors on how to promote climate resilience (Sietchiping et al., 2012). The increased frequency and intensity of climate-related extreme weather events inhibits individual mobility, especially

vulnerable groups. There is a need to invest in undertaking risk assessments of transport infrastructure to understand how resilient they are to future climate change. This could include engagement with vulnerable users to make sure their mobility concerns are well understood and addressed. It also means climate proofing existing infrastructure and expanding mobility options, particularly for NMT, to build resilience. Transport infrastructure could also be used to mitigate and adapt to effects of climate change, such as urban greening and sponge surfaces to reduce flooding. Coordination and greater knowledge exchange between decision makers is required to improve planning and early warning systems.

These changes will only be delivered with strong political will and the harnessing various sectors, including private enterprise, and widening the inclusion of vulnerable groups. It will also require funding to be build inclusive climate resilient transport infrastructure. A fundamental shift in African transport policy and planning processes is therefore needed to develop sustainable, equitable and resilient transport infrastructure in a timely and cost-effective manner. This will require greater inclusion of various stakeholders including policy makers, transport planning, transport operators and vulnerable transport users as well as the consideration of future climate risk.

CRediT authorship contribution statement

Steve Cinderby: Writing – original draft, Formal analysis, Visualization. **Gary Haq:** Funding acquisition, Project administration, Conceptualization, Writing – review & editing. **Romanus Opiyo:** Investigation, Writing – review & editingthe symbol "+" after the author name "romanus opiyo" has been deleted since there was no significance found. please check and correct if necessary.. **Cassilde Muhoza:** Investigation, Formal analysis. **Amanda Ngabirano:** Investigation, Formal analysis. **Yusuf Wasike:** Investigation. **Daniel Mwamba:** Investigation. **Howard Cambridge:** Investigation.

Declaration of competing interest

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Data availability

Data will be made available on request.

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