CDC
Investment works

Evidence review

Insight

What's the impact of investing in urban infrastructure in Africa?

Practical thinking on investing for development

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Foreword

CDC is delighted to publish this evidence review on the development impact of investments in urban infrastructure. As many countries in Africa experience strong urbanisation, there is rising demand for infrastructure that can contribute to the resilience of cities against the impacts of climate change, as well as enhance productivity and wellbeing for people living in these areas.

This report contributes to the understanding of the array of development impacts created by investments in urban mobility, smart city infrastructure, water systems, solid waste management and flood protection. It highlights how to maximise impact in these sectors through private sector investments and presents an urban infrastructure impact framework, backed by evidence of economic opportunities, quality of life improvements and environmental sustainability.

The findings in this review are based on an in-depth study of 55 academic, grey literature and impact assessment reports. It draws on an evidence base for socio-economic benefits both in and beyond Africa, as assessments in this geography remain limited. To close the knowledge gap, and to further understand the impact of these investments in an African context, further research from project-level data and empirical assessments will be required.

Despite the huge need and high impact potential, there are currently limited viable private sector projects or companies in this space, which presents both opportunities and challenges. Many cities in Africa are struggling to fund urban infrastructure projects, that require more expertise and coordination to mobilise resources. The financing gap is not just owing to a shortage of private capital, but also due to a lack of public financing and capacity that makes it challenging for private investors to finance city-level projects.

We will seek to create investable opportunities in the private sector in this space as part of our next five-year strategy.

Holger Rothenbusch
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Acknowledgements

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Disclaimer

Research in the global North has revealed that cities contribute to significantly higher productivity, growth and wellbeing, but little comparable research is available for Africa. This review synthesises the available evidence. Given large evidence gaps, this is only the first step to understanding relationships and comparing impacts across sectors. The number of investments made to date is small, and the evidence on impacts is patchy. In many cases, impact assessments are conducted as part of the feasibility assessment, rather than measuring the actual impacts achieved as a result of the investment. There is a tendency to report on successful projects, likely biasing impacts upwards.

Many of the social and economic benefits have been quantified in other regions, but assessments in Africa are thin. Mitigation impacts are well understood but difficult to generalise, as the nature of the investment can lead to very different impacts. For example, investment in road infrastructure can increase or decrease carbon emissions. Impacts on climate resilience are not well studied, despite it being a major challenge to African cities. Distributional impacts of interventions have often not been assessed.

Evidence gaps by sector are provided in the last chapter of this review. All figures presented are based on a synthesis of academic and grey literature, and a review of impact assessments. As a result, methodologies for measuring costs, benefits and impacts vary across examples, and any comparison should be treated with care.

The review highlighted that impacts are highly context-specific. Impacts may vary significantly based on the location, scale, execution, and management of infrastructure investments. Findings are therefore illustrative, and assessments of opportunities are based on the information available.

Individual investment proposals should be rigorously assessed. The indicators provided in this review can form the basis for these more rigorous assessments.

Definitions

BRT	**Bus rapid transit**
SDG	**(United Nations) Sustainable Development Goal**
BCR	**Benefit cost ratio** Benefit cost ratios assess the size of costs in relation to benefits. BCR = present value of benefits / present value of costs BCR > 1 indicates the project provides net benefits
NPV	**Net present value** Net present value assesses the magnitude of benefits versus costs. NPV = present value of benefits - present value of costs NPV > 0 indicates the project provides net benefits
IRR	**Internal rate of return** Internal rates of return assess the expected return on investment for society. IRR = discount rate to set NPV to 0 IRR > social discount rate indicates positive value for money

Note: NPV, BCR and IRR figures in this review include societal (economic, social, environmental) as well as financial benefits. While informative on a per project basis, a comparison of these ratios across sectors is not appropriate as methods vary between projects.

Table 1: Definitions of terms used in the report
Source: Vivid Economics

Key findings

This evidence review presents four key findings:

1. **Strategic, high-quality urban infrastructure provision is a key development challenge in African cities.** Infrastructure investment needs in African cities are large and low levels and quality of service provision mean Sustainable Development Goals (SDGs) are not being achieved. Closing Africa's infrastructure gap could lead to a 1.7 per cent increase in annual gross domestic product (GDP) growth, with large gains in cities.
2. **Adaptation to climate change should guide infrastructure investment strategies.** Infrastructure systems can enhance or reduce the resilience of cities against the impacts of climate change. Resilient infrastructure investment strategies are built on a thorough understanding of risks, which determines what to build, where to build it, and how to ensure services can withstand the impacts of climate change. Adaptation strategies need to be developed on a city-wide level and feature across all infrastructure sectors.
3. **Bus Rapid Transit (BRT) systems have a high potential for impact.** They can have large-scale benefits on millions of people, with disproportional advantages for low-income groups. The successful implementation of large-scale BRT systems can demonstrate feasibility, develop a model that can be replicated across the continent, and attract private investment.
4. **Water and waste management investment needs are high, and commercial strategies for investment should be prioritised.** Water infrastructure faces the largest investment gap in Africa. Extending water and waste management services to low income households would dramatically improve quality of life and productivity. In many cases, these services fail to cover their costs from tariffs, and have therefore struggled to attract private financing. Successful deals – like the public private partnership for Kigali's water treatment facility – demonstrate the return on investment is feasible.

A mapping of impacts on people and planet, as shown in Figure 1A, illustrates that BRT, waste management and water can have a large positive impact.

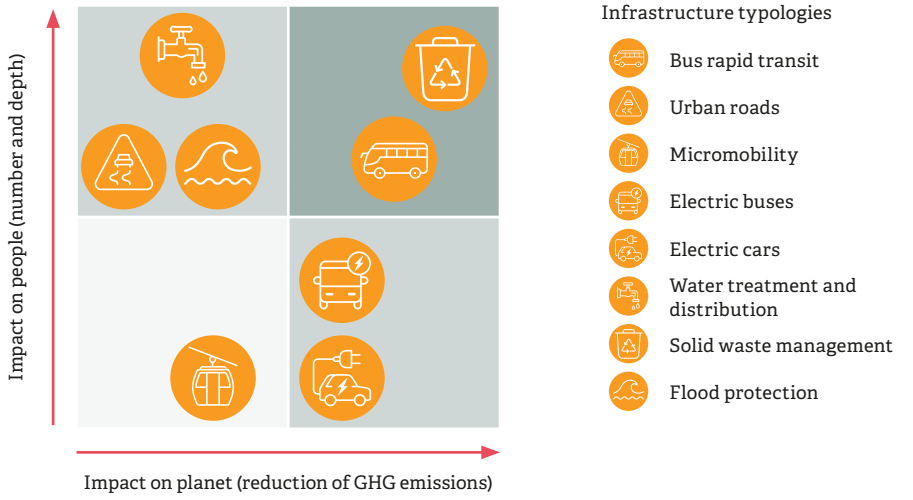

Figure 1A: Mapping impacts of investments on people and the planet
Source: Vivid Economics

Closing Africa's infrastructure gap could lead to a 1.7 per cent increase in annual gross domestic product (GDP) growth, with large gains in cities.

Infrastructure systems can enhance or reduce the resilience of cities against the impacts of climate change.

Bus rapid transit and water treatment and supply present the most significant opportunities, combining high impact and scope for private investment.

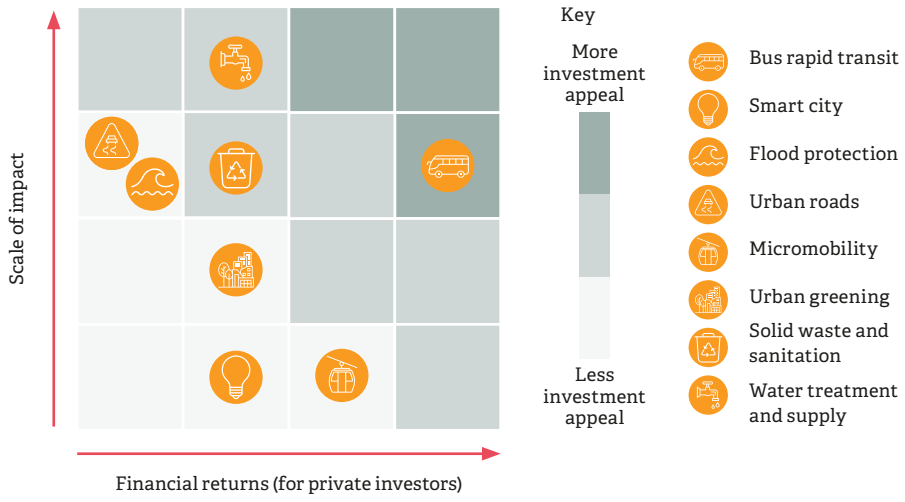

Figure 1B: Mapping impacts of investments on people and the planet
Source: Vivid Economics

A review of 25 projects illustrates the average investment opportunity and impacts of investments for five sectors (see Figure 2).

		Based on values from case studies						Impact per USD million (median)		
		Size of investment *USD million*	Impact on SDGs	Disease/ accident reduction	Particulate matter reduction	BCR	NPV in USD	CO_2 emissions avoided *yearly tons/ USD million*	Annual time saved *work years/ USD million*	Other relevant impacts
Urban mobility	Bus rapid transport *6 examples reviewed*	40-2,300	3, 8, 9, 10, 11, 13	40%-70% accident reduction (localised)	10%-30%	1.2-2.8	22 million -6.4 billion	118-589	3.8-312.5	189-5,822 daily passengers/ USD million
	Roads *8 examples reviewed*	82-932	1, 8, 9, 10	*Limited benchmarks*	Negative effect	*Limited benchmarks*	*Limited benchmarks*	Potentially negative	*Limited benchmarks*	*Limited benchmarks*
Smart city	Electric charging infrastructure *1 examples reviewed*	n/a	3, 9, 11, 13	*Limited benchmarks*	*Limited benchmarks*	*Limited benchmarks*	*Limited benchmarks*	143-333	n/a	Decrease vehicle operation cost by 25-75%. 180,000 passengers
Urban water systems	Water treatment and distribution *3 examples reviewed*	74-173	1, 3, 6, 9, 11, 13	10%-40% reduction in disease	n/a	1.1-1.2	*Limited benchmarks*	n/a	106-198	1,446-2,707 people with water access/ USD million
Waste management	Solid waste management *4 examples reviewed*	1.1-123	3, 6, 11, 12, 13	*Limited benchmarks*	n/a	3-7	*Limited benchmarks*	1,286-19,181	n/a	USD 0.89/ usd health benefit
Climate adaptation	Flood protection *3 examples reviewed*	9.7-220	1, 3, 8, 9, 11, 13, 15	Significant reduction in flood deaths	n/a	1.4-3.3	*Limited benchmarks*	n/a	n/a	*Limited benchmarks*

Note: NPV and BCR are explained in the Definitions section. A detailed overview of SDG targets supported by each investment is provided in the full report.

Figure 2: Summary of findings from reviewed investments
Source: Vivid Economics from various sources (see References section).

Impacts on low-income groups are highest for water and solid waste management but exist across most of the example projects (see Figure 3).

Sector	Infrastructure	Country/region	Project	Outcomes by income quintile				
				1	2	3	4	5
				Lowest income				Highest income
Transport	BRT	Colombia	TransMilenio					
	BRT	Turkey	Metrobüs					
	BRT	Mexico	Metrobús					
	BRT	South Africa	ReaVaya					
	Electric cars	Africa	Electric cars					
	Electric cars	Africa	Electric cars					
	Urban roads	Africa	Urban Roads					
	Micromobility	Colombia	MetroCable					
Water	Water treatment and distribution	Burkina Faso	Urban water project					
Solid waste management	Solid waste management	Africa	Solid waste management					

Income quintiles group earners into five equally sized groups along the distribution of income. Each group covers 20% of earners – quintile 1 describes the lowest 20% of earners and quintile 5 describes the highest 20% of earners. Ranges of income for each group vary by country or region.
The scale of outcomes is assessed based on quantitative and qualitative evidence.

Large gain | Moderate gain | Moderate loss | No significant effect

Figure 3: Overview of distributional impacts by investment
Source: Vivid Economics from various sources (see References section)

CDC's risk-adjusted capital and value-add can provide a range of impacts on people and the planet, as shown in Figure 4. The following chapters describe each impact channel in more detail and provide an overview of the evidence available.

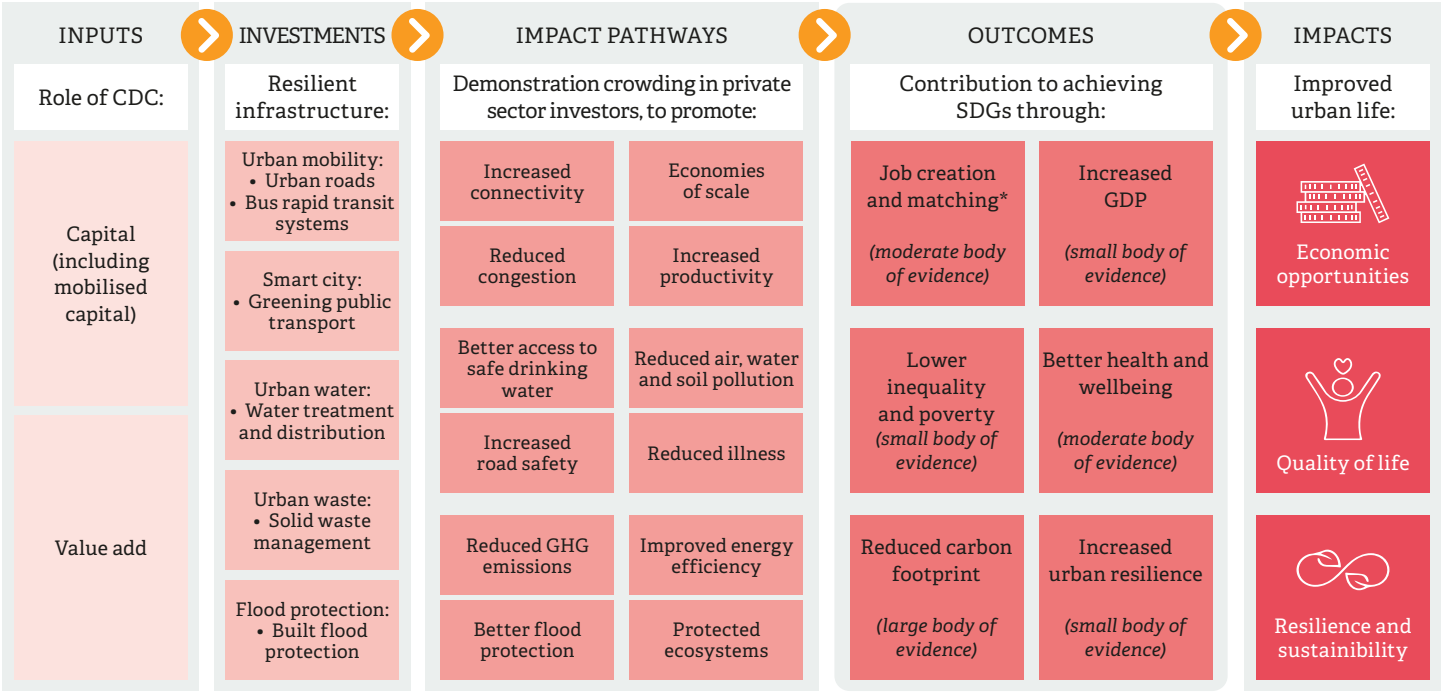

Figure 4: Urban infrastructure impact framework for CDC
Source: Vivid Economics

01

Climate resilience across the infrastructure system

African cities face high and rapidly increasing climate risks, amplified by population growth and uncoordinated urbanisation patterns. Their inability to withstand disasters has severe implications for people and the economy, inhibiting inclusive economic development and the achievement of SDGs. To combat this, climate-resilient infrastructure systems are planned, designed, built and operated in a way that anticipates, prepares for, and adapts to changing climate risks.

Infrastructure systems play an important role in determining resilience. This includes infrastructure for adaptation and the adaptation of infrastructure. Infrastructure for adaptation means investments are deliberately designed to address climate change risks. They also protect assets, people and the economy from hazards such as floods, storms or droughts. Adaptation of infrastructure means that investments across all sectors consider what to build, where to build it, and how to ensure services are climate resilient. Infrastructure assets are typically long-lived and investment decisions aim to lock-in technological choices for several decades. Climate risks are inherently uncertain and improving the resilience of poorly-specified systems is costly. Therefore, eliminating uncertainty, and building in flexibility, are both essential for resilient infrastructure systems.[1]

Climate resilience requires a system-wide approach that accounts for the downstream impacts of disasters on service delivery and livelihoods. Across all sectors covered in this review, resilience should be considered carefully by designing assets that are resilient to climate change and building infrastructure that supports city-wide resilience strategies.

African cities face high and rapidly increasing climate risks.

1 OECD (2018): Climate-resilient Infrastructure, OECD Environment Policy Paper No. 14; Asian Development Bank (2021): A System-Wide Approach for Infrastructure Resilience: Technical Note.

02

Urban mobility

Investment in urban bus rapid transit

The investment opportunity in BRT systems is significant. It offers large-scale impact on urban populations and provides additionality by demonstrating successful investment and management practices that draw in private finance. A summary of evidence is provided in Figure 5.

	Impact		How does investment intersect with...	Direction and quantity of evidence
Bus Rapid Transit	Macro	Job creation	improving access to and creating jobs?	●
		Economic equality	reducing economic inequality?	●
	Micro	Congestion	reducing congestion and saving time?	●
		Land values	increasing land values through land use changes?	●
		Road safety	reducing road accidents?	●
		Travel cost	reducing the cost of travel?	●
	Social	Health outcomes	reducing illness and death from air pollution?	●
	Environmental	GHG emissions	the reduction of GHG emissions?	●

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 5: An evidence review of BRT in the developing world
Source: Vivid Economics from various sources (see References section)

Africa's cities have lower population densities than cities in developed countries, making BRT the most feasible mass transit option available. BRT requires only 2,500 to 7,500 passengers per km² to be cost-effective, compared to 25,000 passengers per km² for commuter rail.[2] Population densities of African cities are expected to increase over the next 30 years, and BRT systems can be a good foundation to accommodate this – trunk infrastructure can be upgraded, as and when necessary, to move to more high-capacity infrastructures such as light rail. The main benefits of BRT systems are time savings, which are maximised by measures that reduce wait and boarding time, such as exclusive, segregated BRT lanes and punctual schedules.[3]

The main benefits of BRT systems are time savings, which are maximised by measures that reduce wait and boarding time, such as exclusive, segregated BRT lanes and punctual schedules.

BRT users tend to be in the lower- and middle-income groups. BRT projects can be used to facilitate formalisation of an informal public transport industry (for example, in Bogota, Mexico City, and Johannesburg) and simultaneously improve complementary urban services (such as in Johannesburg). The few existing BRT systems in Africa have demonstrated positive economic benefits and the scope for rolling them out more broadly is significant. BRT systems in South Africa, Tanzania and Nigeria span 120km in total, and carry almost half a million people per day. By comparison, 45 Asian cities have BRT systems, and 9.5 million riders use these systems daily. Latin America sees almost 21 million BRT users in 56 cities.[4] African cities have high transport costs, relatively dispersed urban areas and limited resources. BRT could be a useful solution in this context, and a successful, large-scale, BRT system in Africa could be the catalyst for its export across other African cities.[5]

BRT systems in South Africa, Tanzania and Nigeria span 120km in total, and carry almost half a million people per day.

The impact dashboard presented in Figure 6 shows investment in BRT can drive economic growth, reduce inequality and poverty, and provide positive health benefits. The numbers presented are based on an analysis of six case studies of BRT projects across China, Colombia, Turkey, Mexico, South Africa, and Nigeria.

WHAT	**Impact**	8 DECENT WORK AND ECONOMIC GROWTH; 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE Improved connectivity and lower transport costs support productive activities, stimulate innovation and formalise jobs, especially for lower income groups **(SDG 8.1, 8.5)**. BRT systems are sustainable transport modes with increased resource-use efficiency **(SDG 9.4)**.		13 CLIMATE ACTION Combatting climate change and its impacts by reducing carbon emissions **(SDG 13.2)**.
HOW	**Primary**	**Economic enabler:** Develop, finance and manage bus rapid transit systems to reduce travel costs and congestion while increasing access to services and jobs.		**Direct:** Avoid carbon emissions from motorised vehicles.
	Secondary	**Catalytic:** Provide patient capital for project development of BRT projects that, otherwise, would not occur and demonstrate a viable commercial model BRT in African cities. Potential for exporting a successful model across Africa.		
WHO	**Stakeholder**	Employees	Consumers	Planet
	Geography	Africa		
	Characteristics	Urban with a focus on lower income earners (lowest 40% of earners have annual salary between USD 5,000 and USD 10,000, depending on the country)		n/a
HOW MUCH	**Scale**	NPV of reviewed examples between USD 22 million - 6.4 billion BCR of reviewed examples between 1.2 and 1.8 Number of passengers per investment 40,000 - 1.6 million		n/a
	Depth/duration	The benefits of existing BRT systems accrue disproportionally to those earning between the 20th and 40th percentile. The jobless benefit comparitively less since they do not travel regularly.		100-600 yearly tons of CO_2 equivalent reduction per USD million

Figure 6: An impact dashboard for BRT in the developing world
Source: Vivid Economics from various sources (see References section)

2 Lall, et al. (2017): Africa's cities: opening doors.

3 Carrigan, et al. EMBARQ (2013): Bus rapid transit case studies.

4 BRT data (accessed 2021).

5 Lall, et al. (2017), Africa's cities: opening doors.

Investment in urban roads

Roads offer large developmental benefits, especially where the road network is small, or existing roads are undermaintained. Figure 7 provides an overview of the available evidence.

Impact			How does investment intersect with...	Direction and quantity of evidence
Roads	Macro	GDP growth	economic growth?	
		Jobs and labour market	job access and creation?	
		Poverty reduction and equality	reducing inequality and poverty?	
		Productivity and innovation	increasing innovation and business productivity?	
	Micro	Congestion	reducing congestion and saving time?	
		Land values	increasing land values through land use changes?	
	Social	Health outcomes	reducing illness and death from air pollution?	
	Environmental	GHG emissions	the reduction of GHG emissions?	
		Climate resilience	reducing risks associated with climate events?	

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 7: An evidence review of urban roads in Africa
Source: Vivid Economics from various sources (see References section)

Sub-Saharan Africa is the only region in the world where road density declined between 1990 and 2011 (latest available data). This reflects poor maintenance and the failure of governments to invest in upgrading road networks in the wake of urbanisation.[6] African cities allocate less land to roads compared with global benchmarks. Cities such as Kigali, Addis Ababa, Dar es Salaam and Nairobi all have low road density (16 per cent of land versus more than 20 per cent in developed countries) and high motorised transport costs.[7] Any markets that are dislocated from job opportunities, health care and education suffer. Studies in India, Uganda and Tanzania have found that road infrastructure delivers significant returns, lifting more people out of poverty compared with most other public expenditure, but the transport sector in Africa is characterised by underinvestment.[8] Fuel taxes and other user charges recover only a fraction of the maintenance costs of roads. In particular, the maintenance and upgrade of existing major roads will continue to be extremely important for African cities. Improving urban planning, regulatory frameworks and institutions are all vital for ensuring investments in roads are maximised.

6 Calderon, C., Cantu, C. and Chuhan-Pole, P., (2018). Infrastructure development in Sub-Saharan Africa: a scorecard. World Bank Policy Research Working Paper, (8425).

7 African Development Bank (2019): Creating Liveable Cities: Regional Perspectives; Bernard, L., Bird, J. and Venables, A.J., (2016): Transport in a congested city: A computable equilibrium model applied to Kampala City.

8 Quium (2019): Transport Corridors for Wider Socio–Economic Development; Otunola (2019): The BRT and the danfo: a case study of Lagos' transport reforms from 1999-2019.

Road investments consistently deliver significant internal rates of return across countries in Africa, as shown in Figure 8. The relationship between paved road investment in African cities and population density, growth in economic activity and industrial land use, has been shown to be positive.[9] While there is strong evidence that roads are important for economic growth, and some evidence roads can reduce economic inequality, they can also induce significant amounts of traffic. This has negative implications for greenhouse gas emissions and health. Income increases, reductions in cost of living and congestion have been estimated for Kampala's highway bypass. For an investment of around $82 million, a net economic benefit to residents is estimated at $15-$35 million per year, with the largest benefits for high-skilled residents.[10,11]

The relationship between paved road investment in African cities and population density, growth in economic activity and industrial land use, has been shown to be positive.

WHAT	**Impact**	Improve access to jobs and services, reducing unemployment and poverty. Enhancing connectivity, contributing to productivity gains and economic growth **(SDGs 1.1, 8.1, 8.2)**.	Improve quality and resilience of road infrastructure, promote sustainable public economic development **(SDG 9.1)**.
HOW	**Primary**	**Economic enabler:** Build, widen and rehabilitate roads to facilitate trade and productivity gains through reduced travel costs and increasing access to services and jobs.	**Economic enabler:** Build, widen and rehabilitate roads to facilitate trade. This decreases transport costs for firms and increases the range of available goods for customers.
WHO	**Stakeholder**	Employees	Distributors, suppliers, consumers
	Geography	Africa	
	Characteristics	Variable	
HOW MUCH	**Scale**	An aditional USD 1 billion spend on roads could increase GDP by between 0.25%-0.5% in the average Sub-Saharan country. This increases to 0.75%-1.25% for the 10% poorest countries. Impacts on emissions can be negative if road investment induces extra traffic. Roads can induce land use change with negative impacts on resilience	
	Depth/duration	Improving road infrastructure could meaningfully reduce inequality. GINI coefficients would reduce between 0.02 and 0.10. The benefits of roads reach people of all ages and incomes, but accrue most to middle-income earners whose access to infrastructure is, on average, lower than high-income earners. The poorest people in a population usually do not use roads and benefit comparitively less from their associated benefits.	

Figure 8: An impact dashboard for for urban roads in Africa
Source: Vivid Economics from various sources (see References section)

Road investments should consider how road space is allocated. If more roads are built and space is only allocated for car traffic, congestion and pollution are likely to increase. If road space is allocated to mass transit and non-motorised transport, environmental and social impacts can be enhanced.

Roads need to be designed for future climate scenarios. The impact of investment in roads – on exposure and vulnerability to climate hazards – has to be assessed for each project. This includes understanding current and future risks for roads themselves, but also for people and firms that are likely to locate near strategic transport routes. In this context, it is important to understand the potential impact of harming ecosystems and taking away the services they provide as barriers or buffers for people, firms and infrastructure assets.

9 Lall, S.V., Henderson, J.V. and Venables, A.J., (2017): Africa's cities: Opening doors to the world. The World Bank.

10 en.starafrica.com (2015): "Ugandan leader commissions EU-funded Northern By-Pass highway".

11 Bernard, L., Bird, J. and Venables, A.J., (2016): Transport in a congested city: A computable equilibrium model applied to Kampala City. University of Oxford (40pp).

The efficacy of road investment varies by country. Table 2 summarises how a 20 per cent increase in road investments is expected to increase household income and GDP in a set of African countries. These figures are modelled cross-country comparisons and show how impacts can vary across countries. The interconnection between roads and the economic spaces they occupy makes comparing these investments with other, often more discrete investments difficult. Road investments also play a crucial role in rolling out BRT systems, making them an important pre-requisite for this and other infrastructure.[12]

Investment	Positive impact	Benin	Mali	Senegal	Tanzania	Uganda	Cameroon	Average
Road investment	Household income	0.74%	0.87%	1.01%	0.55%	0.84%	1.07%	**0.85%**
	Gross domestic product	0.69%	0.84%	1.03%	0.81%	0.84%	0.70%	**0.82%**

Table 2: Sensitivities of sectors and countries to an increase in infrastructure spending
Source: Etasche, et al. (2012).

Road investments are complex investments, and context matters. Where the stock of road infrastructure is low, more roads likely have a larger positive effect, unless they induce congestion. Where road quality is low, maintenance should be prioritised. Where roads are necessary as a pre-requisite for public transit strategies, their full benefits are likely larger. The economic make-up of an economy matters in assessing the impacts of roads, and how best to finance them.

2.3 Investment in micromobility

Micromobility describes transport options over short distances, which for this assessment includes (electric) scooters, public bikes, and cable cars.

Given low densities and a lack of formal public transport systems in African cities, the additional economic and social impacts of micromobility investments are expected to be quite small. Micromobility projects should therefore be screened carefully and are less likely to be an investment priority. Examples for micromobility projects in African cities are scarce, with few (planned) pilot projects. In 2016, to coincide with Marrakech hosting the United Nations Climate Change Conference (COP 22), Morocco launched the continent's first shared bike scheme. The initiative featured 310 bikes in ten shared bike stations, but an expansion of the scheme has not followed. Cable car projects are in the pipeline but have not started construction, including the Likoni Cable express in Kenya and the Lagos cable car project (Cape Town's cable car to Table Mountain is used for tourism rather than urban mobility).

Evidence in dense cities outside of Africa suggest it is important to build alternate paths for mobility alongside mass transit. Where populations are dense, modal choices can balance peaks and avoid congestion. Outside of Africa, disproportionate impacts on women and workers have been demonstrated. Micromobility options are more accessible to lower-income groups than road infrastructure, which requires a car and is expensive in congested cities. In Medellín, Colombia, the cable car system provides improved connectivity and security. These positive impacts are more relevant for women, who face more severe personal safety concerns and high rates of harassment in crowded public transit systems. In addition, improved safe transport options are shown to increase female labour force participation. Wherever transport provides opportunities for workers, these workers can expect positive effects. However, the most vulnerable in society tend to hold no or highly informal jobs where commuting is not a daily activity. Therefore, for more vulnerable people, the positive impacts from better connectivity are likely to be indirect.[13]

12 Estache, A., Perrault, J.F. and Savard, L., (2012). The impact of infrastructure spending in Sub-Saharan Africa: A CGE modeling approach. Economics Research International.

13 Yañez-Pagans, et al. (2018): Urban Transport Systems in Latin America and the Caribbean: Challenges and Lessons Learned World Bank (2021): Water Overview.

03

Smart cities

Investment in electric vehicles and 'greening' public transit

The impacts of electric vehicles and mass transit are documented in several studies and are largely positive, but often not tested in African cities (see Figure 9). Electric vehicles have been shown to improve health, climate and economic outcomes in the global North, but high upfront costs and low grid capacity present barriers to uptake in African cities. Unlike in more developed markets, charging infrastructure is not the key barrier to implementation, and would therefore not be sufficient to achieve large-scale adoption.

Electric vehicles have been shown to improve health, climate and economic outcomes in the global North, but high upfront costs and low grid capacity present barriers to uptake in African cities.

Impact			How does investment intersect with...	Direction and quantity of evidence
Electric passenger vehicles and mass transit	Macro	GDP growth	economic growth?	●
		Jobs and labour market	job creation?	●
		Productivity and innovation	increasing innovation and business productivity?	●
	Micro	Lifetime costs	reducing operating costs and overall lifetime costs of the vehicle?	●
		Affordable transport	reducing passenger fares through lower operating costs?	●
		Congestion	reducing congestion and saving time?	●
		Land prices	increasing land values through land use changes?	●
	Social	Health outcomes	reducing illness and death from air pollution?	●
	Environmental	GHG emissions	avoiding or reducing GHG emissions by replacing ICE vehicles?	●
		Local e-waste pollution	increasing e-waste?	●

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 9: An evidence review of electric vehicles and buses in Africa
Source: Vivid Economics from various sources (see References section)

Electric buses and two- and three-wheelers offer an opportunity to achieve benefits – if financing models and grid reliability in key locations is ensured. However, this would require complementary investments in smart grids and municipal large-scale battery facilities. Electric buses could form part of a wider investment in urban transport and energy systems, requiring close collaboration with local stakeholders and large development finance institutions or donors to finance and facilitate complementary investments. Electric two- and three-wheelers may offer lower-cost opportunities to improve air quality, reduce noise and reduce greenhouse gas emissions. Evidence on the impact on people and the planet is documented in Figure 10.

Electric two- and three-wheelers may offer lower-cost opportunities to improve air quality, reduce noise and reduce greenhouse gas emissions.

WHAT	**Impact**	Provide access to safe, affordable, accessible and sustainable transport systems **(SDG 11.2)**. Reduce the number of deaths and illnesses from air pollution **(SDG 3.9)**. **These impacts are not expected in the short term.**		Combat climate change and its impacts by reducing carbon emissions **(SDG 13)**.
HOW	**Primary**	**Economic enabler:** Finance and electric fleets to reduce travel costs and air pollution, while increasing access to services and jobs.		**Direct:** Avoid carbon emissions from motorised vehicles.
	Secondary	**Catalytic:** Provide patient capital for project development of charging infrastructure and demonstrate a viable model of green transport in African cities.		
WHO	**Stakeholder**	Employees	Consumers	Planet
	Geography	Africa		
	Characteristics	Benefits supporting electric vehicle roll-out would benefit highest earners due to high upfront costs. Health and climate outcomes would accrue to all, especially children and the elderly who are most impacted by air pollution.		n/a
HOW MUCH	**Scale**	The scale of deployment and market development is limited. Global electric vehicle demand is low (global market penetration of 2.8% of light-vehicle sales) and upfront costs are still prohibitive. Battery cost reductions can mean that electric buses become a feasible option. A reliable grid is a prerequisite for an electric vehicle or bus roll-out. EV uptake in Africa could support 180,000 passengers.		n/a
	Depth/duration	Green public transport can improve long-term health outcomes, enhance quality of life and improve productivity.		300 yearly tons of CO_2 equivalent avoided per USD million.

Figure 10: An impact dashboard for electric vehicles and buses in Africa
Source: Vivid Economics from various sources (see References section)

04

Urban water systems

Water treatment and distribution

Investment in water infrastructure is essential for nutrition, health and productivity in Africa (see Figure 11). These benefits disproportionally apply to lower income groups, given low levels of access to clean and safe water.

	Impact		How does investment intersect with...	Direction and quantity of evidence
Water treatment and distribution	Macro	GDP growth	economic growth?	●
		Productivity	increasing economic productivity?	●
	Micro	Land values	increasing land values through land use changes?	●
	Social	Health outcomes	reducing illness and death from disease?	●
	Environmental	Pollution	the reduction of air, water and soil pollution?	●

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 11: An evidence review of urban water systems in Africa
Source: Vivid Economics from various sources (see References section)

Water investments offer large benefits for African cities, as shown in Figure 12. According to the World Bank, some regions could see economic growth reduce as much as 6 per cent due to water-related losses in agriculture, health, income and prosperity.[14] In the developing world, water utilities struggle to connect households to water systems, and systems frequently fail. Access to clean running water is vital to health and productivity. Breakdowns in supply therefore have consequences beyond water-borne illness. These include the spread of other infectious diseases (such as COVID-19), distortion in the time use of women, and lost economic activity.

14 World Bank (2021): Water Overview.

Access to clean running water is vital to health and productivity. Breakdowns in supply therefore have consequences beyond water-borne illness. These include the spread of other infectious diseases (such as COVID-19), distortion in the time use of women, and lost economic activity.

Women and girls bear disproportionate costs from water collection in Africa. This reduces their productivity and access to education, reinforces gender roles and can have serious health implications. It is estimated that more than 65 per cent of the population in sub-Saharan Africa must leave their home to collect water. Among households spending more than 30 minutes collecting water, women are the primary collectors. In the Ivory Coast, women collect water 90 per cent of the time. Although adults generally collect water for households, girls are much more likely to collect water than boys (62 per cent versus 38 per cent). Load carrying has implications for school attendance and performance, women's time budgets and gender relations, and health and wellbeing. Head loading may be associated with negative energy balance, chronic musculoskeletal symptoms, risk of acute injury, compromised reproductive outcomes, and pains and associated distress.[15]

Climate change impacts put pressure on access to clean and safe drinking water. An increase in extreme weather events, flooding and rising temperatures mean water resources are expected to become scarcer and will make distribution systems more vulnerable to disruptions. This puts pressure on access to clean and safe drinking water, presenting risks for population health and wellbeing. The challenges are intensified by population growth and under-provision of water services in informal settlements. Strategic investments in the resilience of urban water systems are essential for urban populations and economies.[16]

Strategic investments in the resilience of urban water systems are essential for urban populations and economies.

WHAT	**Impact**	3 GOOD HEALTH AND WELL-BEING; 6 CLEAN WATER AND SANITATION — Improve access to safe and affordable drinking water, reduce deaths and illnesses attributed to waterborne diseases and strengthen resilience to climate-related disasters, which improves quality and length of life **(SDGs 6.3, 6.1, 6.4, 3.3)**.	15 LIFE ON LAND — Water treatment can protect the integrity of ecosystems **(SDG 15.5)**.
HOW	**Primary**	**Economic enabler:** Develop, finance and construct water treatment plants to improve the availability, reliability and quality of water in Africa, thereby improving quality of life, providing greater resilience to the current and predicted impacts of climate change.	**Direct:** Protect ecosystems by treating wastewater
	Secondary	**Catalytic:** Provide patient capital for project development to enable water projects to happen that otherwise would not and demonstrate a viable commercial model for water provision in Africa.	
WHO	**Stakeholder**	Consumers	Planet
	Geography	Africa	
	Characteristics	Urban/peri-urban with a focus on lower income (40th percentile) earners and women/girls	n/a
HOW MUCH	**Scale**	The scale of water-related health impacts is extensive. Even a small increase in water disruption increases the incidence of diarrhea and typhoid in African cities. The World Bank estimates that some regions could see economic growth reduce as much as 6% due to water-related losses. Water projects typically reach hundreds of thousands of people.	n/a
	Depth/duration	Consumers (especially women and girls) suffering from unreliable or limited access to water and high levels of poverty will benefit most from water investments. Women and children are at higher risk to climate shock-related water insecurity.	300 yearly tons of CO_2 equivalent avoided per USD million.

Figure 12: An impact dashboard for urban water systems in Africa
Source: Vivid Economics from various sources (see References section)

15 Graham, J.P., Hirai, M. and Kim, S.S., (2016): An Analysis of Water Collection Labor among Women and Children in 24 Sub-Saharan African Countries, PloS one, (11(6), p.e0155981).; Porter, G., Hampshire, K., Dunn, C., Hall, R., Levesley, M., Burton, K., Robson, S., Abane, A., Blell, M. and Panther, J., (2013): Health impacts of pedestrian head-loading: A review of the evidence with particular reference to women and children in sub-Saharan Africa. Social Science & Medicine (88, pp.90-97).

16 World Resources Institute. Africa Urban Water Resilience Initiative.

The water infrastructure gap is the largest of any infrastructure sector in Africa, at $56-$66 billion per year.[17] Despite the funding need, the private sector has not been able to invest in many projects, due to high perceived risk. Public private partnerships may provide a route to consistent revenue streams for private investors who share the high costs of capital and commercial risk with governments, and these can sometimes provide significant financial returns. Raising water tariffs to cost-recovery levels could raise around $5 billion a year in sub-Saharan Africa, and ensure proper maintenance, preventing the deterioration of infrastructure and ultimately resulting in a more sustainable model.[18]

Water utilities in Africa often rely on government subsidies, but there are important exceptions. Experiences in some African cities highlight that reliable and profitable water services can be provided. Well-managed utilities can recover operating costs and some capital costs under the right conditions. In Kigali, Rwanda, a successful public-private partnership for a large-scale water treatment facility has demonstrated that private financing can be leveraged successfully. The investment focused on water treatment and reduced risk by arranging offtake agreements with the local water utility.[19] The largest investment gap in water, however, is in rehabilitating distribution systems, which is less attractive for private financing as returns are risky. CDC can play a role in exploring financing models and risk management, and demonstrate how private sector financing can help support the achievement of SDG 6: Clean Water and Sanitation.

Experience has shown that it is possible to significantly improve the performance of water utilities in Africa. Case studies in Burkina Faso[20] and Rwanda demonstrate that, in the right context, water investments can be profitable, but these cases are still outliers in Africa.[21] Where political will exists, operational efficiency is possible and economic factors align, models to stimulate private investment in water infrastructure in Africa should be explored.

In Kigali, Rwanda, a successful public-private partnership for a large-scale water treatment facility has demonstrated that private financing can be leveraged successfully. The investment focused on water treatment and reduced risk by arranging offtake agreements with the local water utility.

17 Infrastructure Consortium for Africa (2018): Infrastructure Financing Trends in Africa, 2018.

18 Foster, V. and Briceño-Garmendia, C., (2010): Africa's infrastructure: a time for transformation. World Bank.

19 World Bank (2018): Kigali Water: Lessons from one of sub-Saharan Africa's first water PPPs.

20 World Bank (2020): Report No: ICR00004934; African Development Bank (2011): Ouagadougou Drinking Water Supply Project – PCR.

21 International Finance Corporation (2015): Rwanda: Kigali Bulk Water Project.

05

Urban solid waste management

Investment in solid waste management

Waste management systems can include: landfill; recycling; organic waste composting and biogas; and waste-to-energy mechanisms. Strategies that adopt circular economy principles (recycling, composting, waste-to-energy) have a bigger impact on people and the planet. However, the evidence for circular economy examples in African cities is limited. This chapter therefore discusses improved urban waste management more broadly. The evidence on impacts on people and the planet is summarised in Figure 13.

	Impact		How does investment intersect with...	Direction and quantity of evidence
Solid waste management	Macro	GDP growth	economic growth?	●
		Productivity	increasing economic productivity?	●
	Micro	Land values	increasing land values through land use changes?	●
	Social	Health outcomes	reducing illness and death from disease?	●
	Environmental	Pollution	the reduction of air, water and soil pollution?	●

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 13: An evidence review of solid waste management in Africa
Source: Vivid Economics from various sources (see References section)

Solid waste management has important implications for health and productivity in Africa, especially for lower-income groups, as summarised in Figure 14. Most African cities lack the infrastructure facilities and appropriate land use planning to meet the demands posed by the urban growth rate, especially in informal settlements. Unsystematic dumping of refuse into isolated places and water bodies exacerbates the already low sanitation level in most African countries.[22] Often, the lack of effective governance frameworks around waste management, including barriers for private companies, leads to illegal dumping.[23] Strategic urban plans incorporating and enforcing waste management regulations, while keeping costs low, require significant political will and technical expertise. Africa produces 170,000 tons of waste daily, the lowest of any region in the world, but almost all waste is dumped or sent to landfills (between 90 per cent and 100 per cent). A high proportion of this waste is mismanaged and risks entering the environment and causing pollution.[24] Waste prevention, re-use and recycling are not well-established in African cities. Between 80 per cent and 90 per cent of the waste produced in Africa is recyclable, but more than 90 per cent is dumped. The low recycling rate in Africa suggests opportunities to develop a secondary resources economy are still largely unexplored.[25]

Africa produces 170,000 tons of waste daily, the lowest of any region in the world, but almost all waste is dumped or sent to landfills (between 90 per cent and 100 per cent).

WHAT	**Impact**	Improve health by reducing disease outbreaks and spread. **(SDG 3.3)** Ensure availability and sustainable management of water management by reducing groundwater pollution and improving sanitation. **(SDG 6.2, 6.3)**	Combat climate change and its impacts, by reducing carbon emissions **[SDG 13.2]**
HOW	**Primary**	**Economic enabler:** Develop, finance, construct and/or manage waste management projects that improve health and productivity in the face of urbanisation and climate change.	**Direct:** Avoid carbon emissions related to waste
	Secondary	**Catalytic:** Provide patient capital for project development to enable waste management projects to reach conclusion that otherwise would not. Demonstrate a model for waste management projects that can be exported.	
WHO	**Stakeholder**	Consumers	Planet
	Geography	Africa	
	Characteristics	Urban population	n/a
HOW MUCH	**Scale**	The health benefits of improved waste management systems are significant but not well explored in Africa.	n/a
	Depth/duration	Consumers (especially children) living in informal settlements are often low-income. They are particularly vulnerable to disease and its spread and are most negatively affected by poor waste management.	1,200 – 19,000 yearly tons of CO_2 equivalent avoided per USD million.

Figure 14: An impact dashboard for solid waste management in Africa
Source: Vivid Economics from various sources (see References section)

22 Ferronato, N. and Torretta, V., (2019): Waste Mismanagement in Developing Countries: A Review of Global Issues. International Journal of Environmental Research and Public Health (16(6), p.1060).

23 Ibid.

24 Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F., (2018). What a Waste 2.0: a Global Snapshot of Solid Waste Management to 2050. World Bank Publications.

25 Godfrey, L., Ahmed, M.T., Gebremedhin, K.G., Katima, J.H., Oelofse, S., Osibanjo, O., Richter, U.H. and Yonli, A.H., (2019): Solid Waste Management in Africa: Governance Failure or Development Opportunity? Regional Development in Africa (p.235).

Some African cities have privatised waste collection, with improved coverage but no demonstrated improvements in efficiency or reliability.[26] Redirecting waste away from dumpsites towards reuse, recycling and recovery could inject an additional $8 billion every year into the African economy.[27] Integrating informal reclaimers into future waste management activities is key to unlocking these opportunities, while also ensuring improved livelihoods. Informal waste pickers fill a gap in Accra, Ghana (and in other African cities), and they could play an important role in improving waste management in African cities.[28] Examples from Brazil and India show how waste pickers can be successfully integrated into a waste system. In Maputo, Mozambique, waste pickers were registered as cooperatives – and integrated into the formal collection service – with great success. Almost half a million citizens now have waste collection services, where before they had none, and full-time employment was garnered for 250 people.[29]

Cost recovery for waste management in Africa is low. Adding a product charge for waste-producing products could capture the cost of managing waste more effectively. This charge can be progressive by applying a higher tariff for luxury products. Waste collection markets are often monopolies, preventing innovative and improved business models from succeeding; regulation to increase competition may be more effective than privatisation of services.[30] Significant effort is required in re-organising the waste management system before roles for private sector providers can be identified. This could present a strategic area to work on with donor partners. The state of waste systems means that Africa is suited to a combination of decentralised initiatives at small scale and expensive, large-scale interventions; low-technology and low-cost solutions such as cargo bicycles, motor tricycles or donkey carts may be good alternatives to waste collection trucks for waste collection, particularly where access is constrained.

Redirecting waste away from dumpsites towards reuse, recycling and recovery could inject an additional $8 billion every year into the African economy.

26 O'Keefe, M., Lüthi, C., Tumwebaze, I.K. and Tobias, R., (2015): Opportunities and limits to market-driven sanitation services: evidence from urban informal settlements in East Africa.; Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F., (2018): What a Waste 2.0: a Global Snapshot of Solid Waste Management to 2050. World Bank Publications.

27 Godfrey, L., Ahmed, M.T., Gebremedhin, K.G., Katima, J.H., Oelofse, S., Osibanjo, O., Richter, U.H. and Yonli, A.H., (2019): Solid Waste Management in Africa: Governance Failure or Development Opportunity? Regional Development in Africa (p.235).

28 Oteng-Ababio, M., Arguello, J.E.M. and Gabbay, O., (2013): Solid waste management in African cities: Sorting the facts from the fads in Accra, Ghana. Habitat International (39, pp.96-104).

29 Buque, L.I.B. and Ribeiro, H., (2015): Overview of the selective waste collection with pickers in Maputo municipality, Mozambique: challenges and perspectives. Saúde e Sociedade (24, pp.298-307).

30 Kaza, S., Yao, L., Bhada-Tata, P. and Van Woerden, F., (2018). What a Waste 2.0: a Global Snapshot of Solid Waste Management to 2050. World Bank Publications.

06

Urban flood protection

Investment in built flood protection

Floods are the greatest natural hazard to Africans. The potential severity of flood impacts has been illustrated by the 2018–2019 South-West Indian Ocean cyclone season, which resulted in a level of flood damage previously unseen in Africa. Flood risk is likely to increase over the next decades. Climate change contributes to higher frequency and intensity of floods occurring, while increasing population density and unplanned spatial expansion exposes more infrastructure and people to flooding. Integrating flood protection into urban infrastructure investments, and planning infrastructure expansions in a way that avoids putting assets or people at risk, will be a critical task for African cities.[31]

Flood protection can be provided by built solutions, sometimes referred to as 'grey' infrastructure, or by nature-based solutions that act as buffer zones, often referred to as 'green' solutions. Nature-based solutions are generally most effective in rural or peri-urban areas, where large swaths of land can be rehabilitated. To date, there is limited evidence of urban projects in Africa which focus on nature-based urban flood protection. As a result, the evidence review in this chapter, summarised in Figure 15, is focused on built solutions. When considering investments in flood protection, preference should be given to nature-based solutions where they are feasible and effective, due to their impact on avoiding carbon emissions.

Climate change contributes to higher frequency and intensity of floods occurring, while increasing population density and unplanned spatial expansion exposes more infrastructure and people to flooding.

31 Grasham, et al. (2019): On considering climate resilience in urban water security: A review of the vulnerability of the urban poor in sub-Saharan Africa; Lumbroso, D., (2020): Flood risk management in Africa. Journal of Flood Risk Management (13(3)); Global Facility for Disaster Reduction and Recovery (2020): Knowledge Note: Upscaling Nature-based Flood Protection In Mozambique's Cities

Impact			How does investment intersect with...	Direction and quantity of evidence
Flood protection	Macro	Jobs and labour market	job preservation?	
		Poverty reduction	reducing poverty?	
		Productivity	increasing or protecting productivity in cities?	
	Micro	Land values	increasing land values by protecting land against floods?	
	Social	Health outcomes	preventing loss of life and encouraging physical activity?	
	Environmental	GHG emissions	the reduction of net GHG emissions?	
		Urban resilience	increasing the resilience of urban areas to floods, disease and other disasters	

Key

Direction of findings

- Significant positive impact or relationship
- Mixed findings or not significant
- Significant negative or null relationship

Quality of evidence

- Well documented
- Moderate body of evidence
- Small body of evidence

Figure 15. An evidence review of built flood protection in Africa
Source: Vivid Economics from various sources (see References section)

Most cities in Africa are flood disaster risk hotspots, and examples have demonstrated that flood protection measures yield high social benefits, as shown in Figure 16. Rapid urbanisation in Africa over the past 20 years has led to a significant increase in flood risk, especially for those 238 million people in sub-Saharan Africa living in informal settlements. Unplanned development, competition for space and environmental degradation can mean that floodplains and natural catchment areas of rivers and coastal zones are destroyed. During Cyclone Idai, an estimated 29 per cent of Mozambique's national road network was damaged, and 20 bridges were destroyed.[32]

Rapid urbanisation in Africa over the past 20 years has led to a significant increase in flood risk, especially for those 238 million people in sub-Saharan Africa living in informal settlements.

32 World Bank (2019): Mozambique: Cyclone Idai & Kenneth Emergency Recovery and Resilience Project (P171040).

WHAT	**Impact**	Reduce deaths and the direct economic losses caused by water-related disasters by increasing urban resilience **(SDG 11.5)**. Reduce the incidence of waterborne diseases resulting from flooding and pollution, reducing injuries and loss of life **(SDG 3.3)**.		Flood protection improves resilience to climate-related hazards **(SDG 13.1)**.
HOW	**Primary**	**Economic enabler:** Develop, finance, construct and/or flood protection infrastructure, such as levees, canals and reservoirs, that protect the urban population located in high-risk areas.		**Direct:** Protect protect urban firms, institutions and infrastructure assets from flood damage.
WHO	**Stakeholder**	Employees	Consumers	Planet
	Geography	Africa		
	Characteristics	Urban with a focus on populations living in informal settlements, women and children.		Urban with a focus on flood-prone areas.
HOW MUCH	**Scale**	Flood protection infrastructure can have significant economic benefits. The value of flood protection interventions ranged widely. In parts of Africa, the net present value of flood protection may run into billions of dollars.		
	Depth/duration	Unplanned settlements are commonly built on marginal land including flood prone areas. Thus, the benefits from flood protection accrue largely to these marginalized communities. Women and children typically lack access to coping resources for floods.		Flood risk is likely to increase in many cities, making investments more important.

Figure 16: An impact dashboard for built flood protection in Africa
Source: Vivid Economics from various sources (see References section)

Flood protection measures are highly socially desirable, and require a detailed assessment of risks and investment options. Effective flood protection measures should entail: flood risk modelling; an assessment of potential humanitarian and economic costs of flooding (to prioritise where interventions should take place); an understanding the co-benefits of each intervention; the development of a strategic, long-term flood risk management strategy; and appropriate financing models that provide returns and risk profiles attractive to the private sector.[33]

33 Hallegatte, S., Rentschler, J. and Rozenberg, J., (2019): Lifelines: The resilient infrastructure opportunity. The World Bank.

07

Areas for future research

Robust project-level data and empirical assessments of impacts for the African context are scarce.

- Evidence gaps for resilience of infrastructure assets: evidence on the impact of investment in resilience, including humanitarian catastrophes and damage avoided, for the African context.
- Evidence gaps for BRT: evidence on the distribution of benefits from BRT infrastructure; testing theoretical explanations in African cities; and understanding of city-wide or national impacts in Africa.
- Evidence gaps for urban roads: understanding the relationship between improvements in transport infrastructure and local economic activity and growth, especially for small-scale projects; measuring impacts on different types of firms or groups of people; return on investment from transport investments for health, education and agriculture in the African context; and impacts for vulnerable populations, especially youth and older people, in African contexts.
- Evidence gaps for electric vehicles and greening public transit networks: economic benefits for African cities have not been quantified; feasibility assessments for electric buses, two- and three-wheelers are missing.
- Evidence gaps for urban water systems: lack of good data for water treatment and distribution in African cities (many water initiatives have failed due to inadequate information with which to make investment decisions); impact of water sector investments on land values in African cities; evidence on the relationship between water sector investments and growth of GDP or economic productivity.

- Evidence gaps for waste management: inconsistencies in definitions, data collection and methodologies in African waste management; empirical assessment of waste infrastructure on land values in African cities; literature on health impacts of solid waste is weak due to a lack of longitudinal studies, uncertain exposure metrics and the lack of controls for confounders; evidence on the relationship between waste management investments and growth of GDP or economic productivity; testing strategies that adopt circular economy principles in African cities.
- Evidence gaps for flood protection: empirical research on economic benefits of urban flood protection in Africa; evidence on the distribution of benefits across demographics; research of flood risk and nature-based solutions in African cities; impact of flood protection infrastructure on land values in Africa.

References used in data sheet and impact dashboards by section

Key findings data sheet

Aerts, J. (2018): A review of cost estimates for flood adaptation. Water, 1646.; African Development Bank data portal, project documents (2019, 2020); Carrigan, et al. (2013). Social, environmental and economic impacts of BRT systems: bus rapid transit case studies from around the world. World Resources Institute, EMBARQ.; Calderón, C. and Servén, L., (2014): Infrastructure, growth, and inequality: an overview.; Calderón, C. and Servén, L., (2010): Infrastructure and economic development in Sub-Saharan Africa. Journal of African Economies, 19(suppl_1), pp.i113-i87. CCAP (2012); Collier, et al. (2016): Urban infrastructure for development.; Estache, A. and Garsous, G., (2012): The impact of infrastructure on growth in developing countries. IFC Economics Notes, 1.; Foster, et al. (2010): Africa's Infrastructure: A Time for Transformation.; Hudson, et al., (2019): Cost–benefit analysis of flood-zoning policies: A review of current practice.; Kim, et al., (2016): Effect of urban green spaces and flooded area type on flooding probability; Kodongo & Ojah (2015): Infrastructure and Economic Growth in Sub-Saharan Africa.; Kull, et al. (2013): Probabilistic cost-benefit analysis of disaster risk management in a development context; Lall, et al. (2017): Africa's cities: Opening doors to the world; Mobereola (2009): Lagos Bus Rapid Transit.; USE (accessed 2021) use.metropolis.org.; Levinson, et al. (2013): A bus rapid transit line case study: Istanbul's Metrobüs system; Ncube & Leyeka Lufumpa (2017): Infrastructure in Africa: Lessons for future development; Ogun (2010): Infrastructure and poverty reduction: Implications for urban development in Nigeria.; Parnell & Simon (2014): National urbanisation and urban strategies: necessary but absent policy instruments in Africa.; Pieterse, E. (2014): Filling the void: an agenda for tackling African urbanisation.; Pirie, G. (2014): Transport pressures in urban Africa: practices, policies, perspectives.; Quium, A.S. (2019): Transport Corridors for Wider Socio–Economic Development.; Smit & Pieterse (2014): Decentralisation and institutional reconfiguration in urban Africa.; Turok, I. (2014): Linking urbanisation and development in Africa's economic revival.; Turok, I. (2016): Getting urbanization to work in Africa: the role of the urban land-infrastructure-finance nexus.; Walmsley & Hardy (2009): Who benefits from flood management policies?; Yañez-Pagans, et al. (2019): Urban transport systems in Latin America and the Caribbean: lessons and challenges.; Matsuyuki (2020); Likoni Cable Express (2018); Clean Technology Fund (2020); Lagos cable car project.; Heinrichs and Bernet (2014): Public Transport and Accessibility in Informal Settlements: Aerial Cable Cars in Medellín, Colombia, Centre for public impact (accessed 2021).; Shang, W.L., Chen, Y., Li, X. and Ochieng, W.Y., (2020): Resilience Analysis of Urban Road Networks Based on Adaptive Signal Controls.; Van den Berg, C. and Danilenko, A., (2017): Performance of water utilities in Africa.

Investment in bus rapid transit impact framework

Carrigan, et al., EMBARQ (2013): Bus rapid transit case studies.; Lall, et al. (2017): Africa's cities: opening doors.; Mobereola (2009): Lagos Bus Rapid Transit.; CCAP (2012).; USE (accessed 2021) use.metropolis.org.; Levinson, et al. (2013): A bus rapid transit line case study: Istanbul's Metrobüs system.

Investment in urban roads impact framework

Lall, et al. (2017): Africa's cities: Opening doors to the world. The World Bank.; Ugandan leader commissions EU-funded Northern By-Pass highway. En. starafrica.com (archived from the original on 25 February 2015, retrieved 12 November 2015).; Bernard, L., Bird, J. and Venables, A.J., (2016): Transport in a congested city: A computable equilibrium model applied to Kampala City. University of Oxford (40pp).; Estache, A., Perrault, J.F. and Savard, L., (2012): The impact of infrastructure spending in Sub-Saharan Africa: A CGE modeling approach. Economics Research International.; Bernard, L., Bird, J. and Venables, A.J., (2016): Transport in a congested city: A computable equilibrium model applied to Kampala City. University of Oxford (40pp).; Estache, A., Perrault, J.F. and Savard, L., (2012): The impact of infrastructure spending in Sub-Saharan Africa: A CGE modeling approach. Economics Research International.

Investment in micromobility impact framework
Morten (3IE:2020). ; Quium (Sustainability:2019).; Otunola, et al. (IGC:2019).; Bernard, et al. (Oxford Uni.:2016).; Matsuyuki, et al. (WCTR:2019).; Likoni cable express website (accessed 2021).; CTF (African Development Bank:2020).; Edriss & Chiunda (JSER:2017).; ICA (2018).

Investment in electric vehicles and greening public transit impact framework
Yañez-Pagans, et al. (2019): Urban transport systems in Latin America and the Caribbean: lessons and challenges.; Matsuyuki (2020): Clean Technology Fund (2020).; IEA (2020): Global EV Outlook 2020; Deloitte UK (2019): Hurry up and… wait – the opportunities around electic vehicle charging points in the UK.

Investment in water treatment and distribution impact framework
Lall, et al. (World Bank:2017).; Carrigan, et al. (Environment and Urbanization:2015).; O'Keefe (3IE:2020).; World Bank (Burkina Faso - Urban Water Sector Project:2020).; Edwards (WHO/IWA:2011).; Oteng-Ababio, et al. (Habitat International:2013).; Zurbrugg (WCTR:2002).; ICA (2018).; World Bank (2020), Report No: ICR00004934; African Development Bank (2011), Ouagadougou Drinking Water Supply Project – PCR; International Finance Corporation (2015) Rwanda: Kigali Bulk Water Project.

Investment in solid waste management impact framework
Bello, et al. (2016).; Hossain, et al. (2011): Waste management.; Hoornweg & Bhada-Tata (2012).; Vivid Economics (2018): SWM Kano case study.; Ellen MacArthur Foundation (2020): Cape Town: Afirca's first industrial symbiosis programme.; O'Keefe, M., Lüthi, C., Tumwebaze, I.K. and Tobias, R., (2015): Opportunities and limits to market-driven sanitation services: evidence from urban informal settlements in East Africa. Environment and Urbanization (27(2), pp.421-440).; Zurbrugg, C., (2002): Urban solid waste management in low-income countries of Asia - how to cope with the garbage crisis. Presented for: Scientific Committee on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session, Durban, South Africa (pp.1-13); Oteng-Ababio, M., Arguello, J.E.M. and Gabbay, O., (2013): Solid waste management in African cities: Sorting the facts from the fads in Accra, Ghana. Habitat International (39, pp.96-104).; Vivid Economics (2018): SWM Kano case study.; Ellen MacArthur Foundation (2020): Cape Town: Afirca's first industrial symbiosis programme.;. Hoornweg & Bhada-Tata (2012): What a Waste. World Bank.

Investment in built flood protection impact framework
Lall, et al. (World Bank:2017).; Carrigan, et al. (WRI:2013).; Walmsley, et al. (Flood Risk Management Research and Practice:2020).; Hudson & Botzen (Water:2019).; Ward, et al. (Nature:2017).; Cartwright (NCE working paper:2015).; Kull, et al. (Disasters:2013).; ICA (2018); Lucas, B., (2020). Urban Flood Risk Management in Africa.; Aerts (2019). A Review of Cost Estimates for Flood Adaptation.

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