Climate Research for Development (CR4D)

End of Grant Workshop

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Predicting synergies and trade-offs of water related ecological infrastructure for climate adaptation in peri urban sub-Saharan Africa

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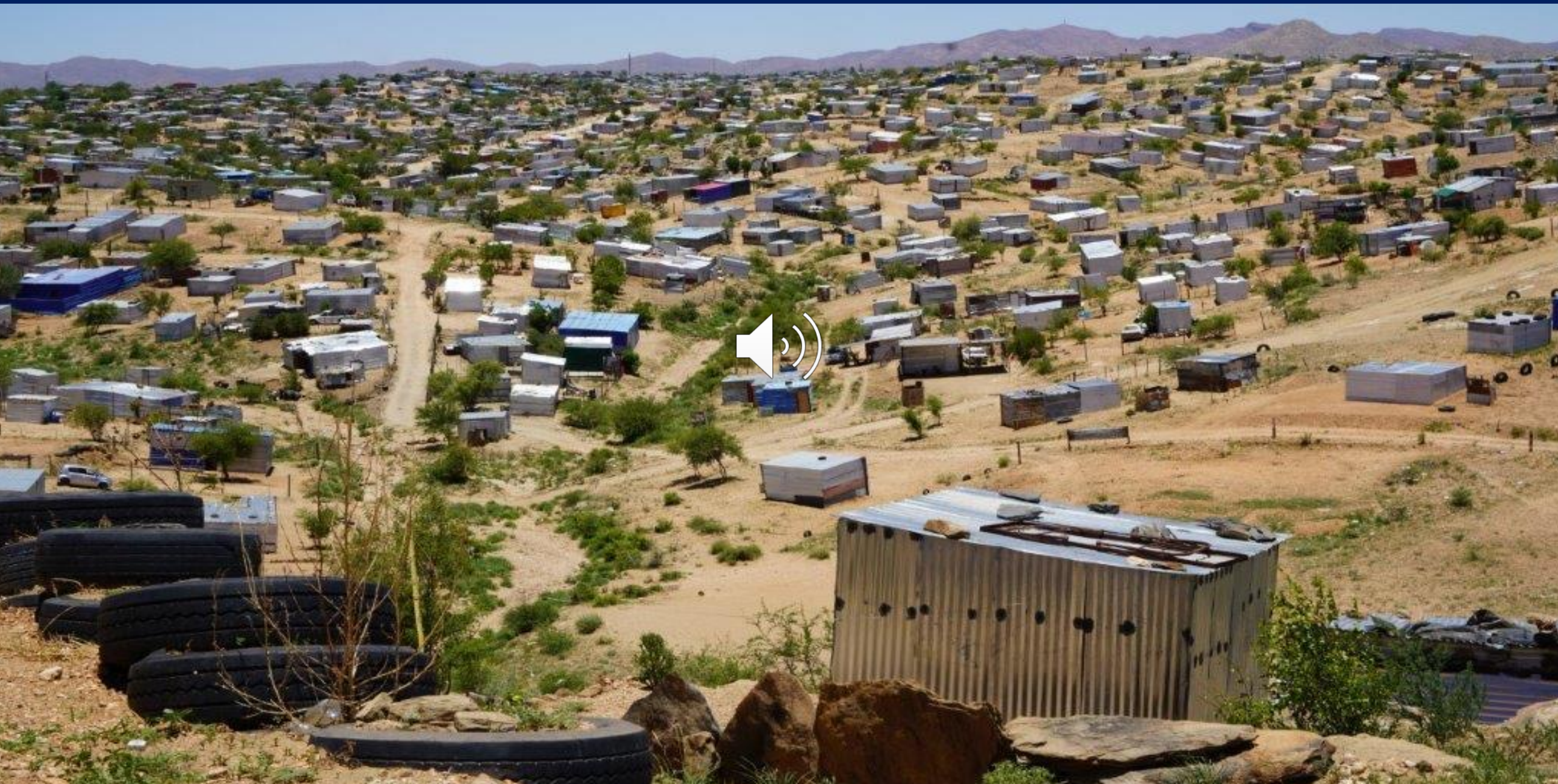
Senior Research Fellow

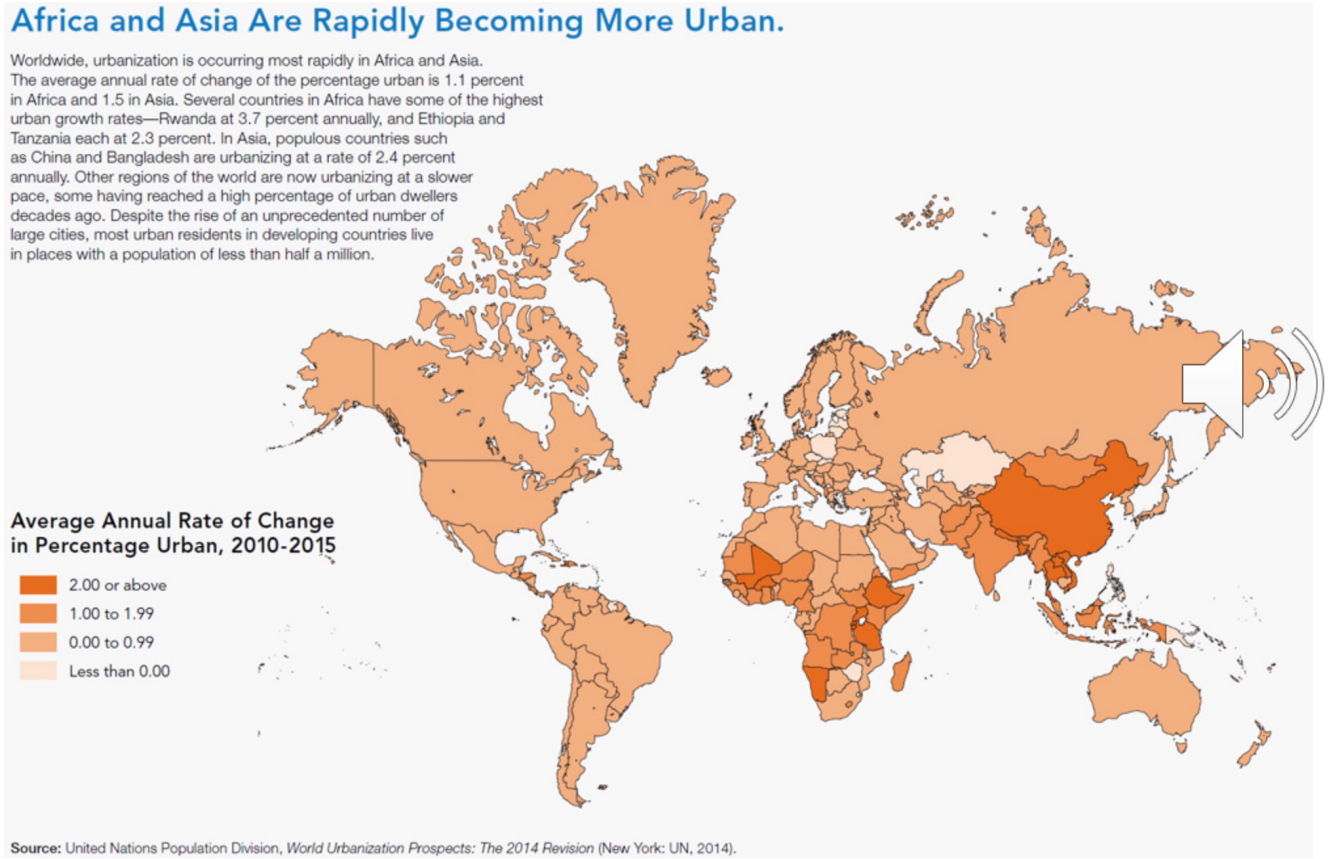
Overview

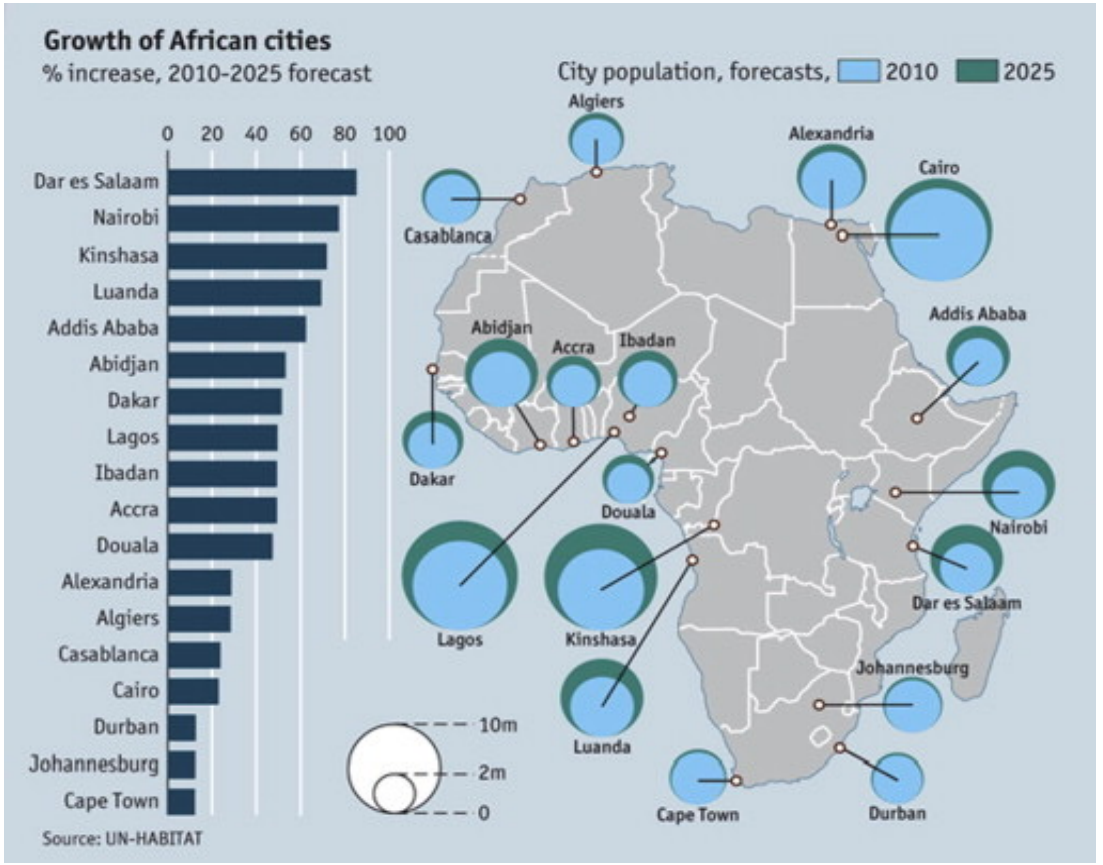
Background → Methods → Key findings → Engagement and outreach → Capacity building → Next steps

Background



Background





(Thorn et al, 2020, 2015; IPCC 2014, Dodman et al., 2017, UN Habitat 2019)

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Unique characteristics of peri urban areas

- Urban growth rate is high (3.39%/a v. 11.2% in peri-urban), but in cities development is general private. Such growth is connected to seasonal and permanent environmental migration for alternative livelihoods.
- Typically, hundreds share communal taps, many rely on open defecation without access to functioning toilets, there are raw sewerage and open drains, congestion and a lack of solid waste management
- Often settle in hazardous zones *(high water tables, slopes, landslides, flood prone, riparian, or low lying zones, under electricity beacons)* Clear all vegetation, flattening land to 'develop', Changes surface , flood patterns "ecological deserts"
- Inequalities permeate urban society
- Transient, heterogeneous context impacts investments when awaiting 'plots to come on line' , ownership of communal resources. (E.g., play parks, taps, and toilets which require good governance structures, monitoring and clearly defined roles to maintain, susceptible vandalism, theft, or privatization).

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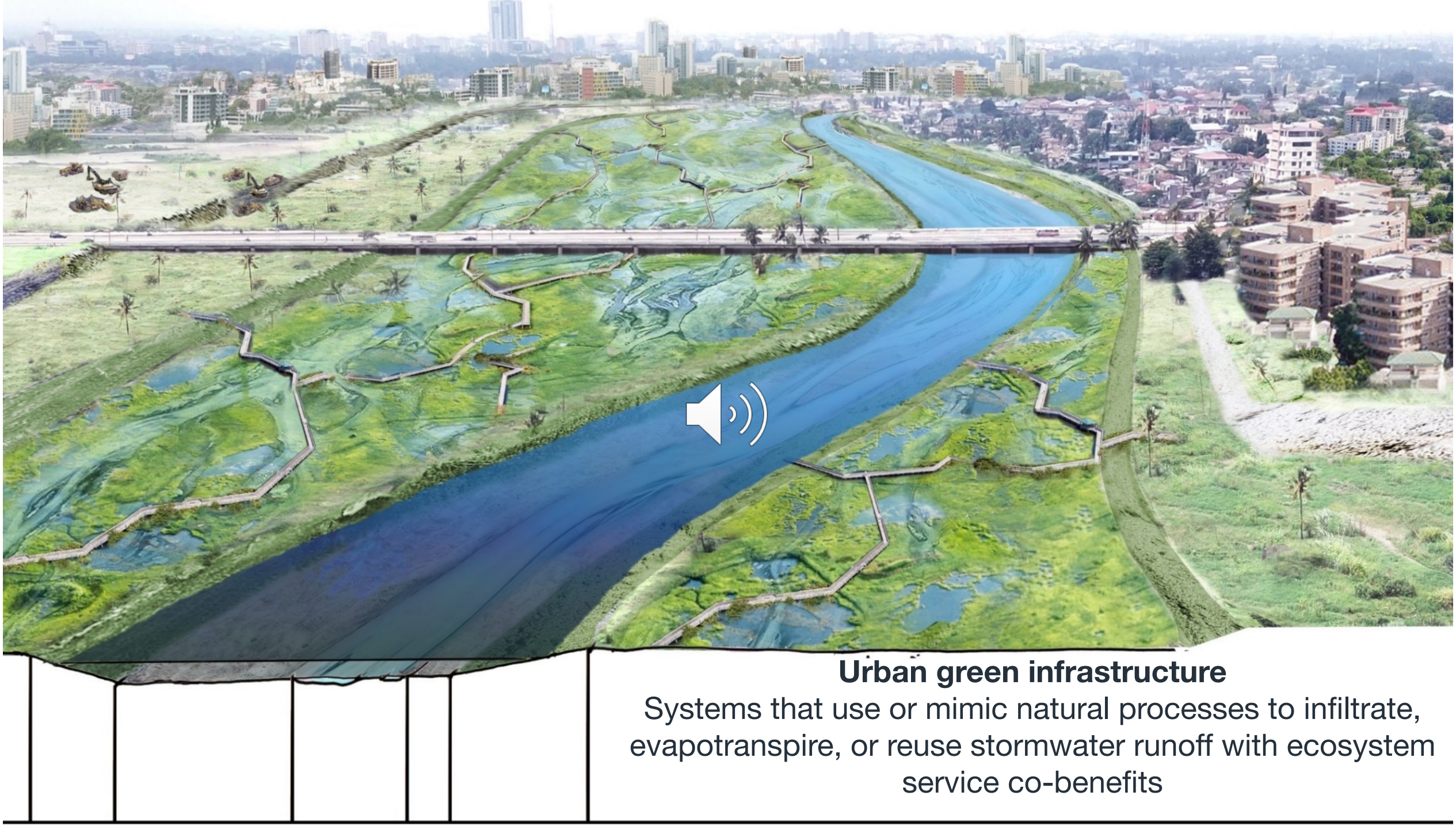
Enter green urban infrastructure

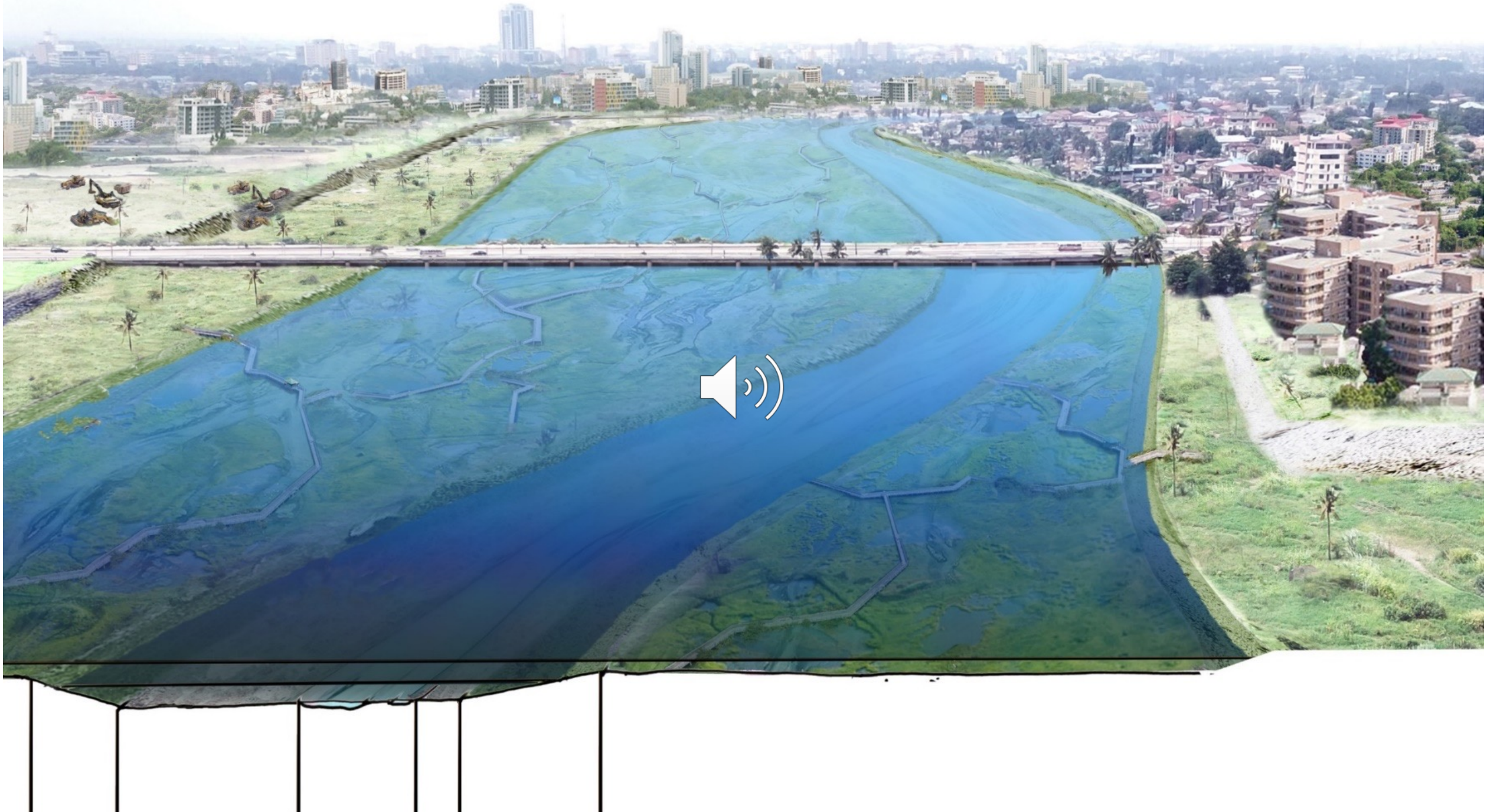
Green infrastructure (or ecological/ natural infrastructure):
'strategically planned and managed network(s) of natural lands, such as forests and wetlands, working landscapes, and other open spaces that conserves or enhances ecosystem values and functions and provides associated benefits to human populations'.
can function on its own, or incorporated within the design of grey infrastructure, resulting in hybrid infrastructure (e.g., sea walls combined with oyster reefs to protect against erosion and flooding).
Once built, infrastructure serves as the foundation for increasing aggregate economic output, deliver essential services, and create employment.

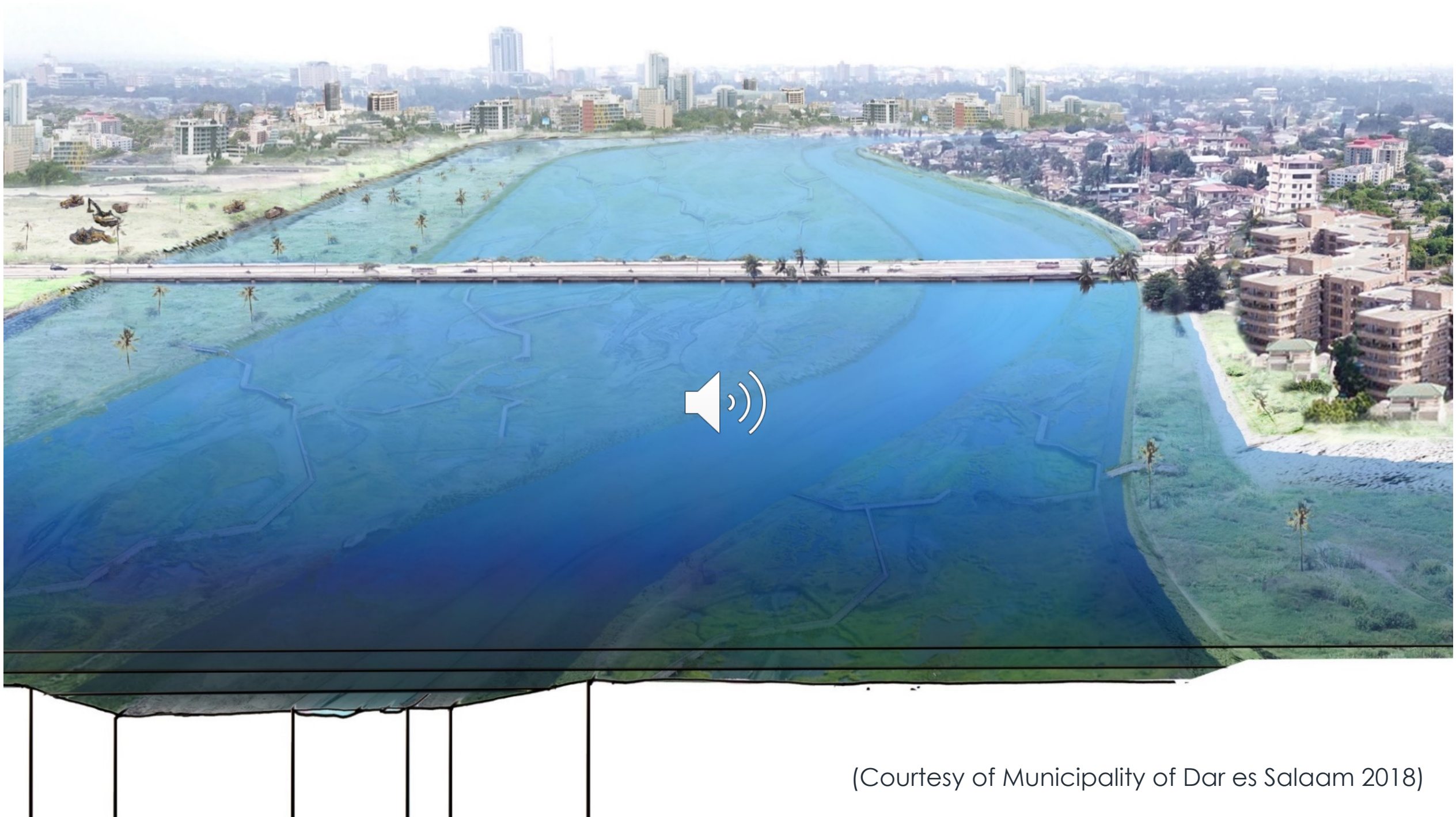
E.g., to prevent flooding of ports and road, cross-sectoral and multi-scalar solutions which might involve installing green roofs, water piping to accommodate inlets of potable water and outlets of greywater, rehabilitating interconnected green spaces, and retrofitting homes with sustainable material, all which improve business efficiency, competitiveness and avoid high costs to manage waste streams



Urban green infrastructure

Systems that use or mimic natural processes to infiltrate, evapotranspire, or reuse stormwater runoff with ecosystem service co-benefits





(Courtesy of Municipality of Dar es Salaam 2018)

Aims

- Assess the comparative impacts of water-related UGI on ecosystem service provisioning and wellbeing in peri-urban areas;
- Identify the barriers to the mainstreaming of UGI in peri-urban settlements for climate adaptation;
- Examine diverse, plausible scenarios to achieve desired futures for 2030 and 2063, using participatory scenario planning; and
- Determine the impacts of seasonal variability on water supply in rural and peri-urban areas and autonomous adaptation pathways

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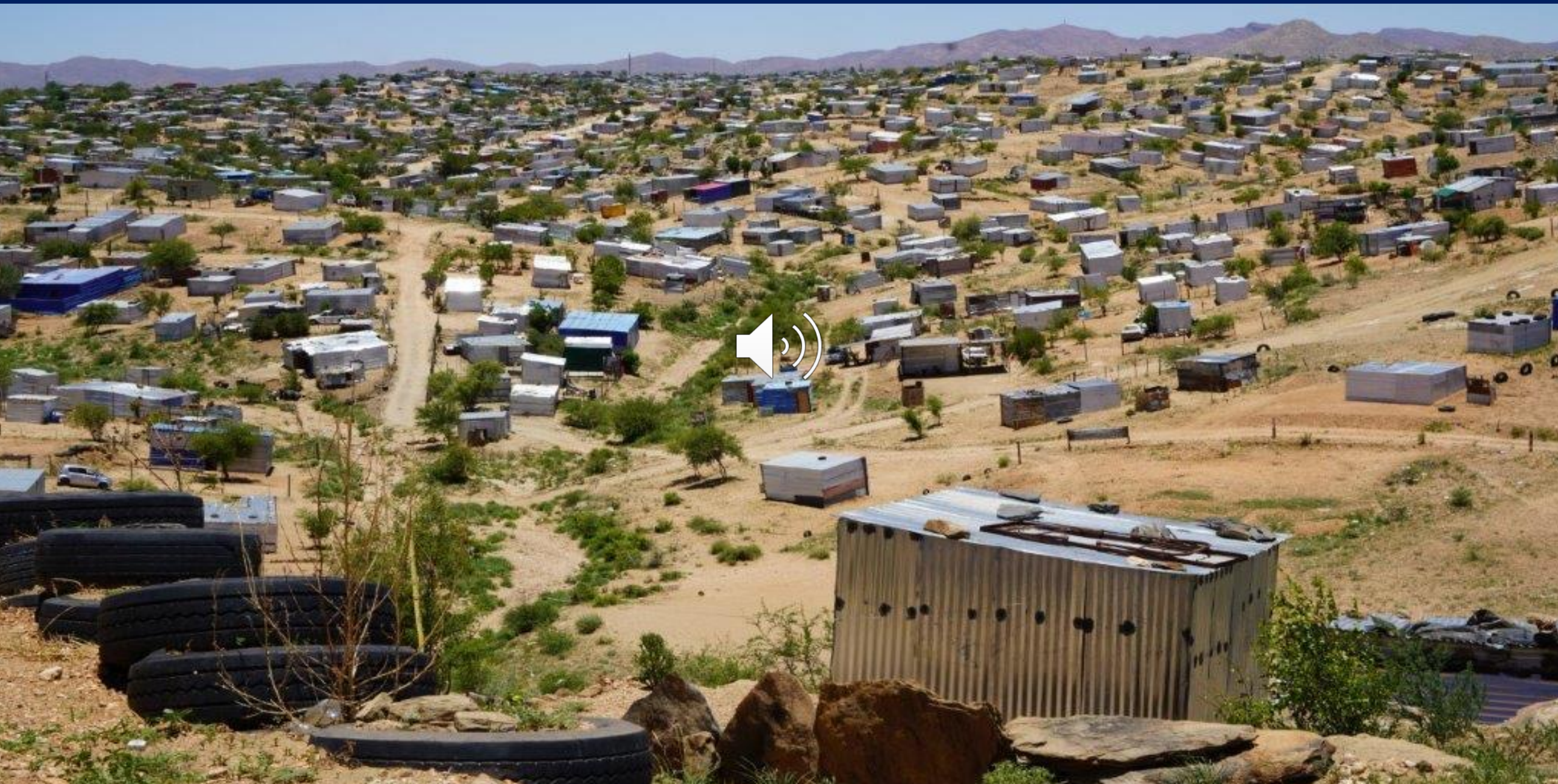
Methods



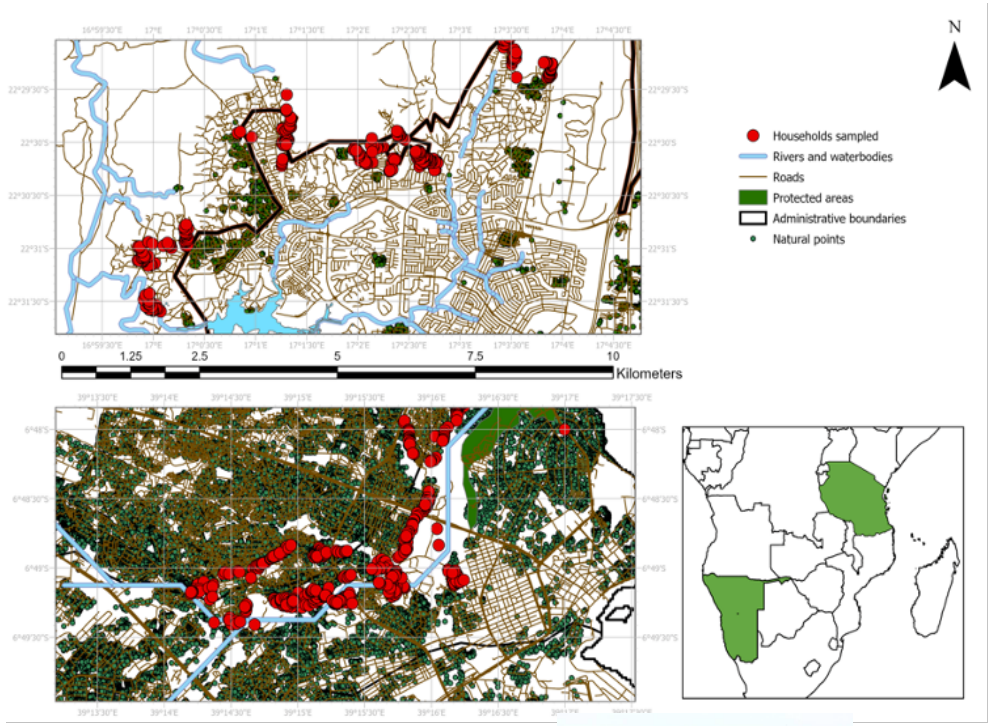
Study sites

Flood prone Dar es Salaam mega-city one of the fastest growing cities in SSA;
low-lying areas perennial flooding

Drought prone Windhoek
landing-point for rural-urban migrants from across the country, signalling the intensification of droughts and erratic rainfalls

Broad regional coverage, a range of population sizes, inland verses coastal locations, growth rates, strong local partnerships, data deficient

Irregular occupation has encroached into public spaces, ephemeral riverbeds, hilly slopes, grasslands, forests, marshlands, plantations and farms, under electricity lines, and other marginal or critical habitats



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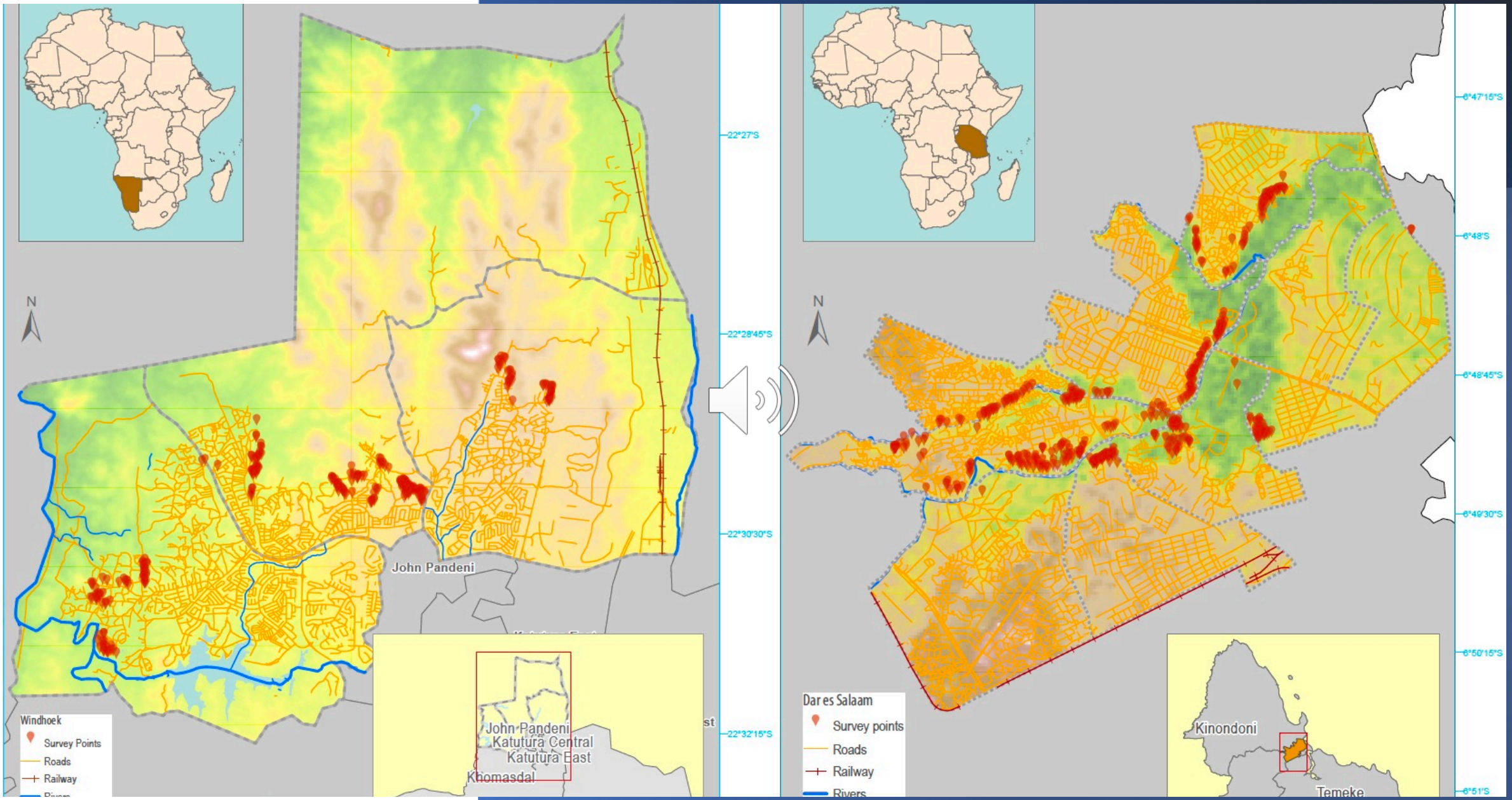
N
22°27'S
22°28'45"S
22°30'30"S
22°32'15"S
John Pandeni
Windhoek
Survey Points
Roads
Railway
John Pandeni
Katutura Central
Katutura East
Khomasdal
N
6°47'15"S
6°48'S
6°48'45"S
6°49'30"S
6°50'15"S
6°51'S
Dar es Salaam
Survey points
Roads
Railway
Rivers
Kinondoni
Temeke

Key methods

Household surveys: *n* = 832
(7 settlements, 3 constituencies – Namibia
11 settlements, 2 municipalities - Tanzania

Key informant interviews: *n* = 118
(53% male, 47% female; age = 44.6 +/- 12.7 years)

Field surveys 9 cities in two seasons

Participatory scenario planning workshops and focus groups

Trend analyses, remote sensing, ArcGIS, mass spectrometry

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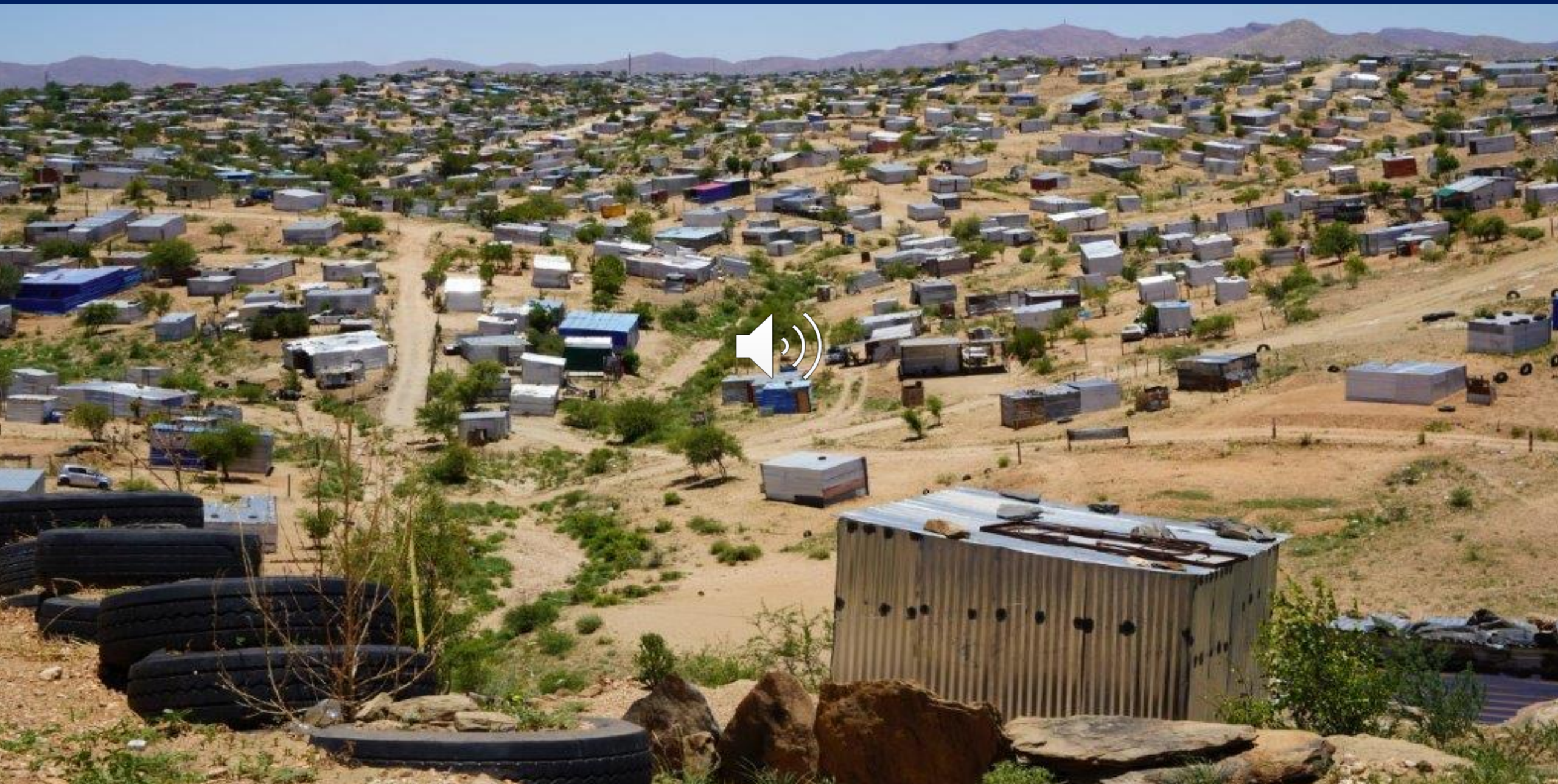
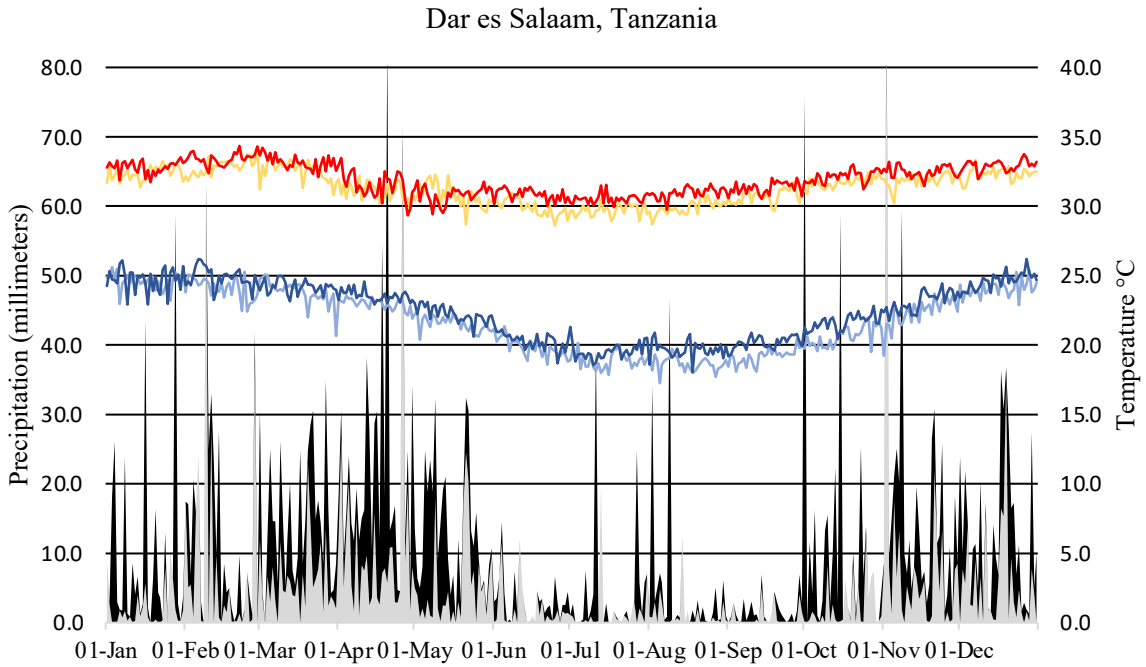
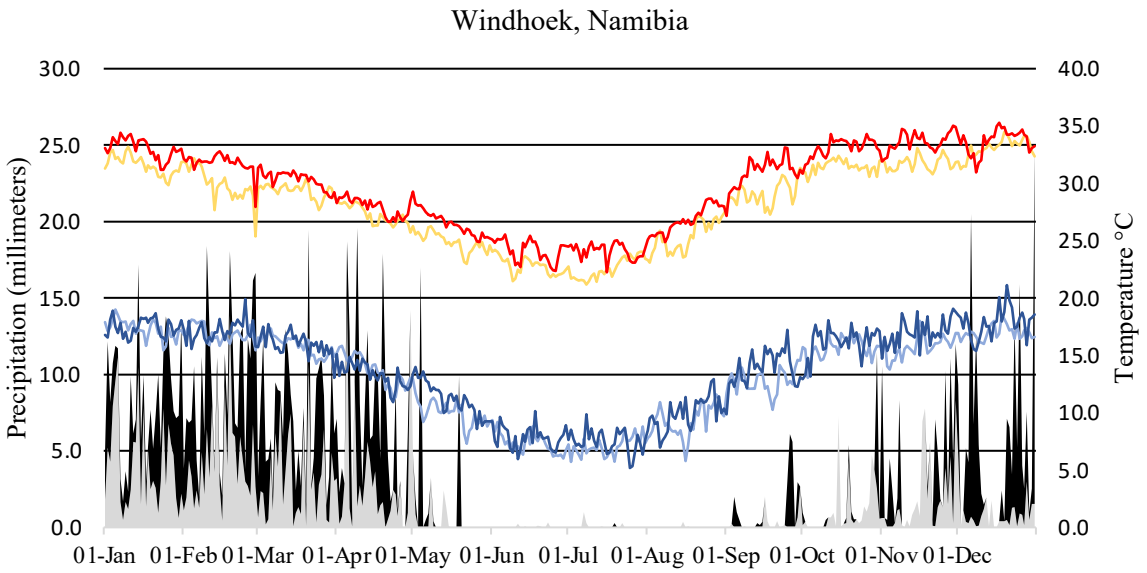
Results



Climate variability and change





In the last two decades, flood-prone Dar es Salaam, has seen a steady increase in maximum and minimum temperatures and an increase in precipitations particularly during the rainy season (March-May). While, drought-prone Windhoek has experienced an increase in temperature and an increased variability of rainfall.

In review with Ecosystem Services

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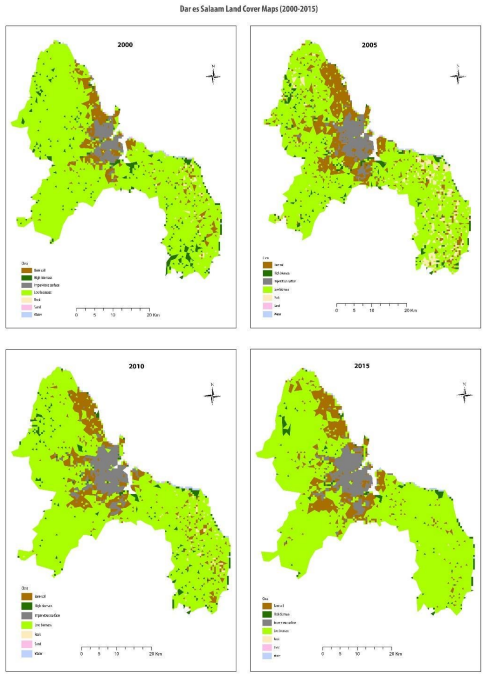
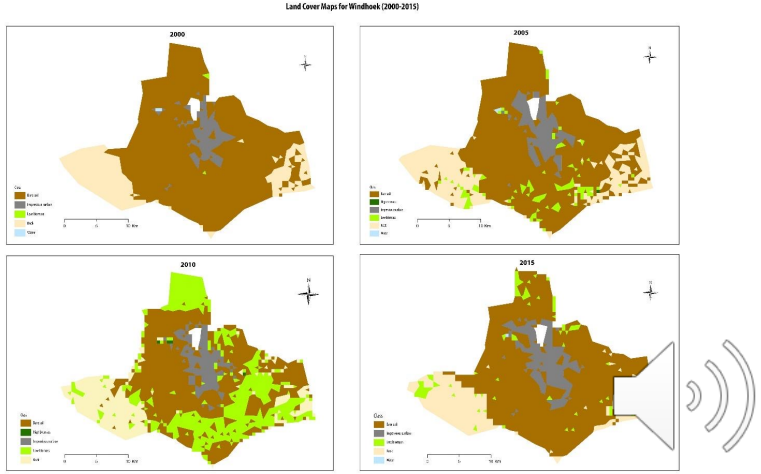
Land cover change in 2000-2020





Dar es Salaam

Land use class	Area (km²)				Percentage change (w.r.t. area)			2000-2015	
	2000	2005	2010	2015	2000-2005	2005-2010	2010-2015	Km sq.	%
Bare soil	140.2	281.8	199.9	207.5	101.1%	-29.1%	3.8%	67.35	48.1%
High biomass	77.4	65.0	55.1	36.5	-16.0%	-15.3%	-33.6%	-40.91	-52.8%
Impervious surface	72.1	107.1	122.0	125.3	48.6%	13.9%	2.6%	53.17	73.7%
Low biomass	1304.5	1063.7	1216.1	1238.6	-18.5%	14.3%	1.9%	-65.94	-5.1%
Rock	12.0	85.8	13.3	0.8	613.3%	-84.5%	-94.3%	-11.28	-93.8%
Sand	1.2	2.4	0.7	0.5	92.8%	-68.9%	-33.7%	-0.74	-60.2%
Water	5.6	6.8	7.4	5.1	20.2%	8.6%	-30.8%	-0.55	-9.7%

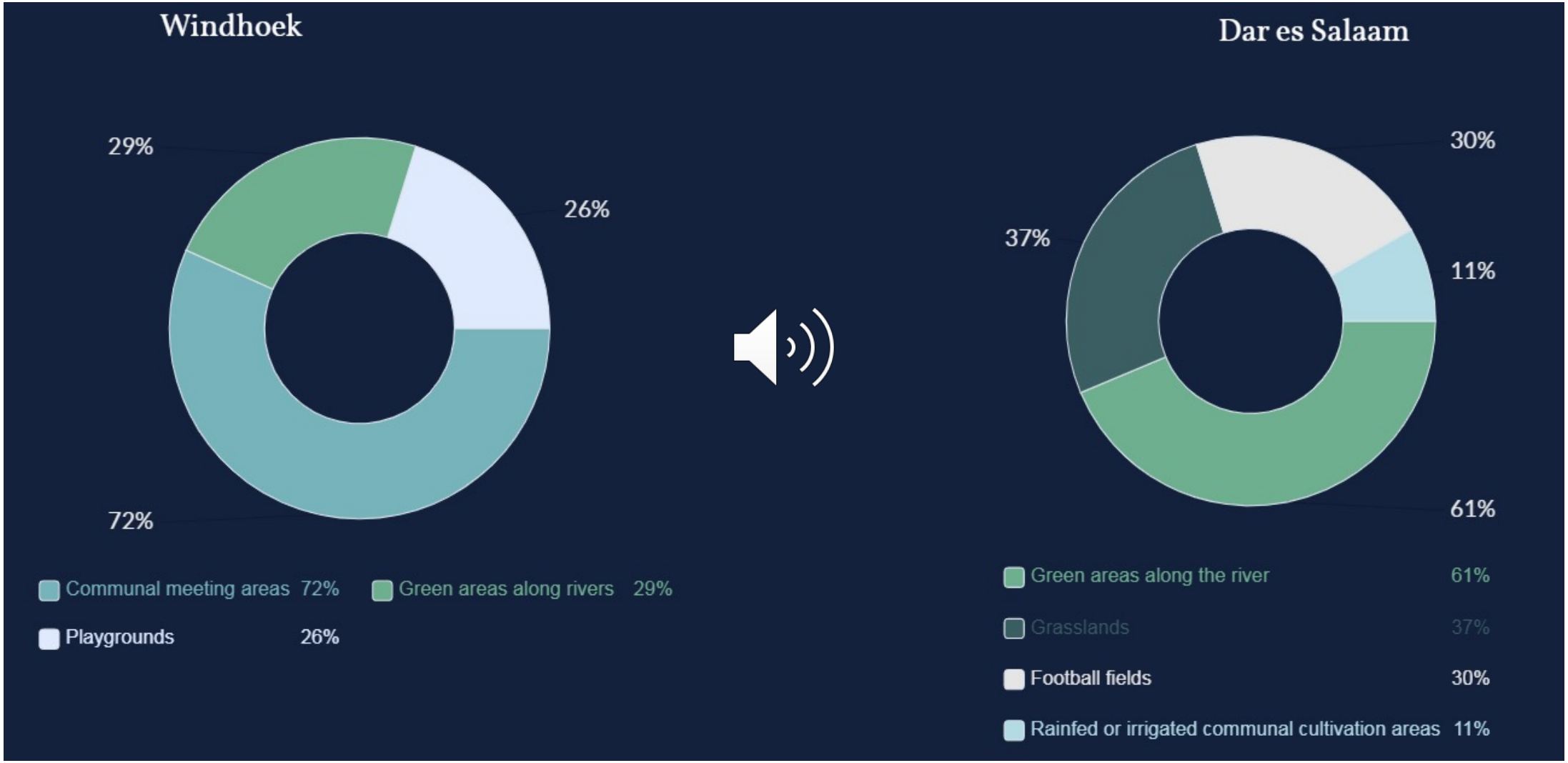
Windhoek

Land use class	Area (km²)				Percentage change (w.r.t. area)			2000-2015	
	2000	2005	2010	2015	2000-2005	2005-2010	2010-2015	Km sq.	%
Bare soil	456.0	401.7	279.8	394.5	-11.9%	-30.3%	41.0%	-61.48	-13.5%
High biomass	0.0	0.3	1.0	0.0	N/A	300.9%	-100.0%	0.00	0.0%
Impervious surface	35.7	50.1	32.4	64.0	40.4%	-35.4%	97.5%	28.31	79.3%
Low biomass	0.8	27.0	174.2	25.7	3312.2%	545.3%	-85.3%	24.87	3143.3%
Rock	105.9	118.3	97.4	113.5	11.7%	-17.7%	16.5%	7.55	7.1%
Water	0.5	0.5	0.0	0.3	4.5%	-100.0%	N/A	-0.26	-50.00%

Change analysis in Dar es Salaam showed that impervious surface class, which refers to all paved areas, concrete metal roofs and other built infrastructure had the highest relative increase from 2000 to 2015 (73.8%). A similar figure was found in Windhoek, where between 2000 and 2015 impervious surfaces had an increase of 79.3%.

In review with Ecosystem Services

What constitutes green urban infrastructure?



In review with Landscape and Urban Planning

In review with Landscape and Urban Planning

How do public spaces in peri urban settlements contribute to social-ecological resilience?

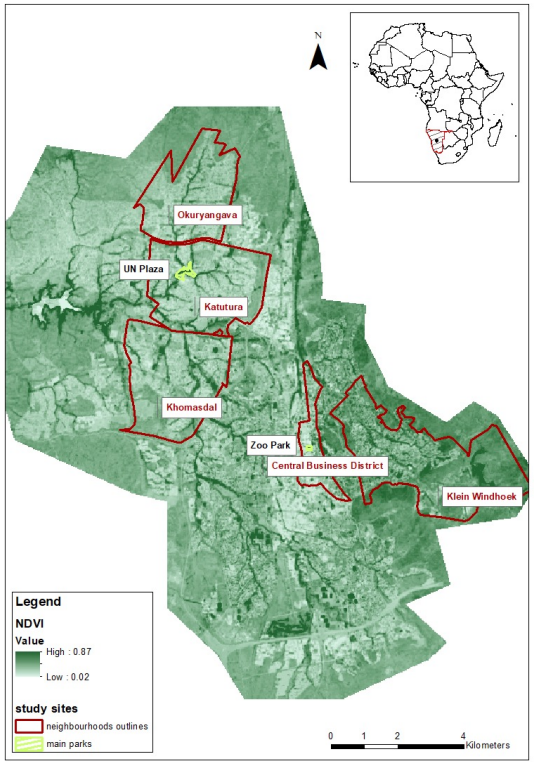
	Windhoek	Dar es Salaam
Provisioning services	**Fruits** (e.g., guava, lemon, paw paw) **(65.2%)** and **medicinal resources** (e.g., aloe ferox, moringa) **(50.3%)**	**Grass for livestock feed (48.8%), vegetables for household consumption (37.2%)** or sale (6.2%)
Regulating services	**Shade (98.5%), improve air quality (97%), carbon sequestration (79.1%),** control erosion (11.5%), reduces water velocity (8.5%)	**Improve air quality (68.3%),** control erosion (18.7%), reduces water velocity (20.3%)
Cultural services	Beautification, aesthetic value and inspiration and psychological comfort	**Beautification, aesthetic value and inspiration, recreation (35.5%), exercising (28.5%),** community organizing (5.6%)
Supporting services	**Birds (94.4%), cats (W 92.4%) and dogs (89.1%)**	**Birds (94.9%), reptiles (62.5%), snakes (24.3%),** earthworms (19.5%), sheep, goats (12.5%)

In review with Landscape and Urban Planning

Table 2. UGI and ecosystem services availability and importance in Dar es Salaam (*availability* is measured on a scale from 1 to 3 and it was drawn by expert opinion, while importance is measured in relation to the number of times an ecosystem service was mentioned by survey respondents; when locations did not provide a specific ecosystem services *"x"* is reported)

		Availability of ecosystem services derived from UGI																
	Derived ecosystem service	**Green spaces**											**Blue spaces**				**Importance**
		Green areas along a	**Playgrounds**	**Football field**	**Green areas along**	**Health clinic garden**	**School garden**	**Cemetery**	**Planted trees**	**Meeting areas**	**Communal cultivation**	**Grassland**	**Riverbeds**	**Rivers and streams**	**Wetland**	**Lakes**	**Mangroves**	
Regulating	Air quality regulation	●●●	●	●●	●●	●●	●●	●	●●●	●	●●	●	x	x	●	x	●●●	68.3%
	Carbon sequestration	●●●	●	●●	●	●●	●●	●●	●●●	●	●●	●●	x	x	●	x	●●●	7.8%
	Micro-climate regulation	●	x	x	●	●●	●●	●●	●●	●	●●	●	x	x	x	x	●●	0.0%
	Infiltration	●●●		●●●	●●	●	●●	●●	●●●	●	●●	●●	●●●	●●●	●●●	●●	x	2.6%
	Erosion prevention	●●	●	x	●●	x	x	x	●●	●	●●	●●	x	x	●●	x	●●●	18.7%
	Reduced water velocity	●●●	x	x	●●●	x	x	x	●●	x	●●●	●●●	x	x	●●	x	●●●	20.3%
	Moisture retention	●●●	●●	x	●●	●	●●	●	●●	x	●●	●●●	●●●	●●●	●●●	x	●●●	2.0%
	Reduced soil compaction	●	x	x	●●●	x	●●	●	●●	●●	●●	●●	x	x	x	x	x	2.6%
	Water purification	●●●	x	x	x	●●	x	x	x	x	●●	●●●	x	x	●●	x	●●●	0.8%
	Reduces salinity	●	x	x	x	x	x	x	x	x	●●	x	x	x	●●	x	●●●	0.0%
	Connectivity	●●●	x	x	●●●	x	x		●●		●●●	●	●●●	●●●	●●	x	●●	1.2%
	Reduces sedimentation	●●	x	x	x	x	x	x	x	x	x	●●	x	x	●●	x	x	3.8%
	Nutrient cycling	●●	●	●	●	●	●●	●●	●●	●●	●●●	●●	x	●●	●●	●●	●●	0.0%
	Water regulation and supply	x	x	x	x	x	x	x	x	x	x	x	x	●●●	●●	●●	●●	0.8%
	Reduces agricultural runoff	●●●	x	x	x	x	x	x	x	x	x	●●	x	x	x	x	x	6.0%
Provisioning s	Shade	●●●	●●●	●●	●●	●●●	●●●	●	●●●	●●●	●●	x	x	●●	x	●●	●●	19.3%
	Fuelwood	●	x	x	x	x	x	x	●●●	x	x	x	x	x	x	x	x	1.%
	Fruits	●●	x	x	x	●●	●●	x	●●●	x	●●●	x	x	x	x	x	x	4.8%
	Medicinal resources	●●	x	x	●	●●	●●	x	●●	x	●●●	x	x	x	x	x	x	0.0%
	Grass for livestock	●●●	x	●	x	x	x	x	x	x	●●	●	x	x	x	x	x	48.8%
	Vegetables for household consumption	●●●	x	x	x	●●	●●	x	x	x	●●●	x	x	x	x	x	x	37.3%
	Vegetables for sale	●●●	x	x	x	x	x	x	x	x	●●●	x	x	x	x	x	x	6.2%
Cultural	Psychological comfort	●●●	●●●	●●●	●	●●●	●●●	●●●	●●●	●●	●●●	●	●	●●	●●	●	●●●	0.2%
	Beautification aesthetics inspiration	●●●	●●●	●●	●●●	●●●	●●●	●●	●●●	●●	●●●	●	x	●●●	x	x	●●●	61.5%
	Educational	●●●	●●●	●●●	●	●●	●●●	x	●●	●●●	●●	x	x	●	●	●	●●	1.8%
	Exercising	x	●●	●●●	●●	●	●●●	x	x	x	●	●	x	●	x	x	●	28.5%
	Recreation	●	●●●	●●●	x	x	●●	x	●●	●●	x	●	x	●●●	x	x	●●	35.5%
	Community organising	●	x	●●●	x	●●	●●●	x	●●	●●●	x	x	x	x	x	x	x	5.6%
	Spiritual and religious value	●●	x	x	x	●●	●	●●●	●●	●●	●	x	x	●●	●	●	●●●	0.0%
Supporting	Habitat for species	●●	●	●	●●	●●	●	●●	●	●	●●	●	●	●●●	●●●	●●●	●●●	
	Maintenance of genetic diversity	●	x	x	●●	●●	●●	●●	●	●●	●●	●●	●	●	●●●	●●	●●●	

Access, use and perceptions of green spaces in a post-apartheid city vary along a spatial gradient of formally racially segregated neighbourhoods



Highest Greenness (NDVI)

Lowest greenness (NDVI)

NEIGHBOURHOOD	CONTEXT	SERVICES DERIVING FROM RIVERBEDS	DISSERVICES DERIVING FROM RIVERBEDS
Klein Windhoek	Wealthy and former white neighbourhood	Biodiversity observation; outdoor recreation; walking dogs	Facilitation of house robberies and mugging; diseases and foul smell from sewage manholes overflow
Khomasdal	Middle class and former coloured neighbourhood	Mental well-being: biodiversity observation, space for socializing and for children to play	Facilitation of house robberies; diseases and foul smell from sewage manholes overflow, mosquitoes and snakes, youth drinking and smoking
Katutura	Poorer-middle class and former black neighbourhood	Mental well-being; biodiversity observation, space for socializing	Facilitation of house robberies, diseases and foul smell from sewage manholes overflow, bushes behind which criminals hide, mosquitoes, youth drinking and smoking
Okuryangava	Informal settlements with limited access to services	Cooling, biomass for energy, camelthorn pods and grasses as fodder, home vegetable garden	Diseases and foul smells from sewage manholes overflow, bushes behind which criminals hide to rob or assault, mosquitoes

Accepted as Springer book chapter

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Assess seasonal variability on water access and supply

Cuvelei Etosha and Swakop River Basin

High resolution mass spec – non –targeted and targeted analysis

Develop a model to predict the pollutant exposure range of risk to guide where to target an intervention

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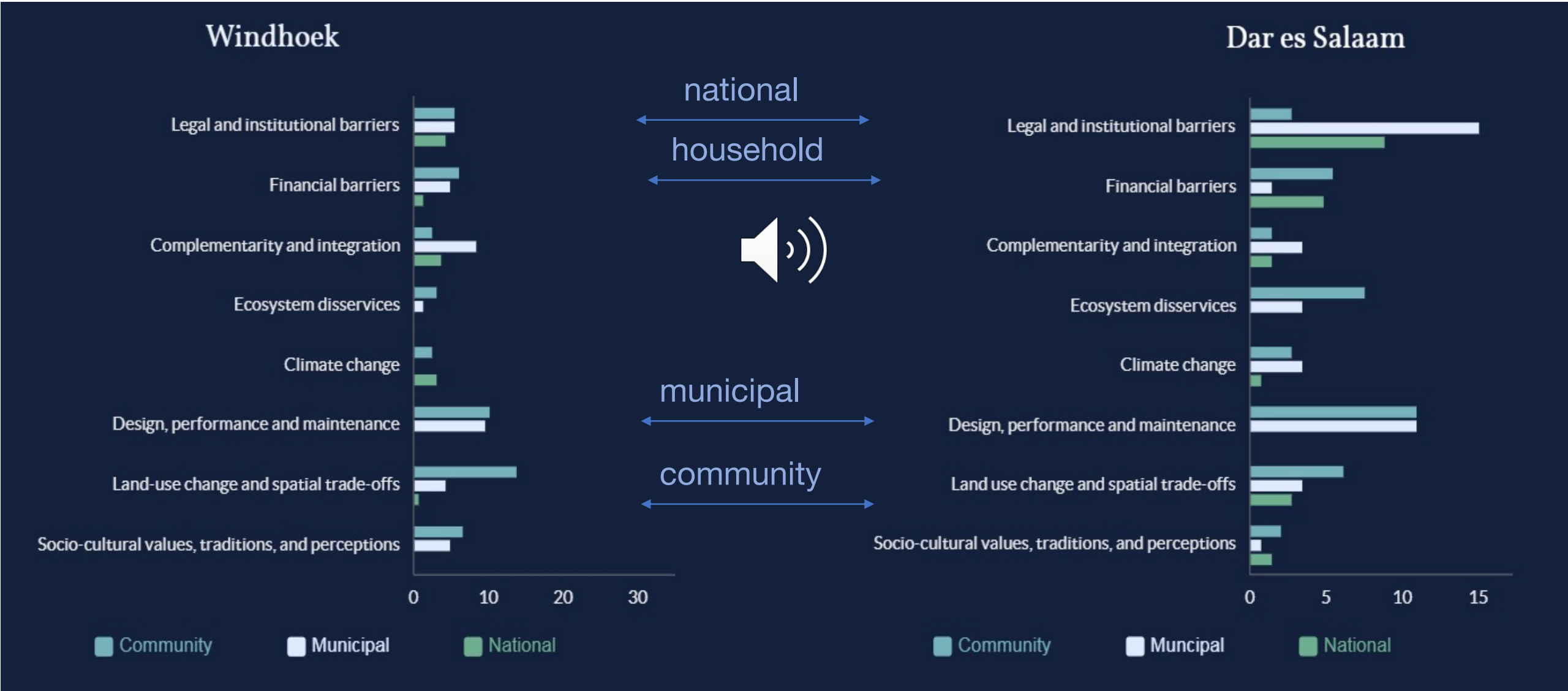
Developed eight-part framework of barriers distinct to peri urban UGI implementation

Barriers	Subcategories	References
Design, performance, and maintenance	Low data availability and lack of standardization	Abo-El-Wafa et al., 2017; Mensah, 2017; O'Donnell et al., 2017; Douglas, 2018; du Toit et al., 2018; Staddon et al., 2018
	Limited technical capacity	
	Poor long-term maintenance	
Legal and institutional barriers	Pro-grey infrastructure path dependence	Kabisch et al., 2016; van Ham and Klimmek, 2017; O'Donnell et al., 2017; Douglas, 2018; Mensah, 2017; Herslund et al., 2018; Titz and Chiotha, 2019; Davies et al., 2019
	Outdated policies and ineffective master plans	
	Land regularization and ownership rights	
	Limited social inclusion and public participation	
	Poor implementation and enforcement	
Financial barriers	Inadequate financial resources and short-term project cycles	Muredere, 2011; Pelling et al., 2015; Ampaire et al., 2016; Sarabi et al., 2019; Davies et al., 2019
	Lack of monetary and nonmonetary valuation of UGI	
	Privatisation of land and water	
	Inadequate transparent financial management	
Complementarity and integration barriers	Lack of coordination and cooperation betwe[illegible]nd within institutions	Spires et al., 2014; Ampaire et al., 2016; Dhakal and Chevalier 2016; van Ham and Klimmek, 2017; Herslund et al., 2018; Pasquini and Enqvist, 2019; Titz and Chiotha, 2019
	Absence of strong communication strategies fo[illegible] citizen engagement	
	Hindered innovation, experimentation, and forward-looking strategies	
Ecosystem disservices	Exposure to physical risks	Cilliers and Cilliers, 2015; Kabisch et al., 2016; du Toit et al., 2018; Cilliers, 2019; Pasquini and Enqvist, 2019
	Perceptions of low aesthetic value and health hazards	
Land use change and spatial trade-offs	Lack of multifunctionality and land use trade-offs	du Toit et al., 2018; Titz and Chiotha, 2019
	Land degradation	
	Biodiversity loss and limited connectivity	
Climate change	Disproportionate exposure to climate-induced hazards	Parnell and Walawege, 2014; Wang et al., 2019
Socio-cultural values, traditions, and perceptions	Lack of household awareness regarding UGI	Mensah, 2014; Cilliers and Cilliers, 2015; Pelling et al., 2015; Wangai et al., 2016; O'Donnell et al., 2017; du Toit et al., 2018; Lindley et al., 2018; Roy et al. 2018; Lange et al., 2016; Davies et al., 2019
	Cultural and religious beliefs	
	Paternalism	

Key barriers to environmental and social solutions to mainstreaming public spaces



Barriers cont.

(I) Design, performance and maintenance	Low data availability Lack of standardization Limited technical capacity Poor long-term maintenance
(II) Legal and institutional barriers	Pro-grey infrastructure path dependence Outdated policies and ineffective master plans Land regularization and ownership rights Limited social inclusion and public participation
(III) Financial barriers	Inadequate financial resources, short project cycles Lack of monetary and nonmonetary valuation Inadequate transparent financial management
(IV) Ecosystem disservices	Exposure to physical risks (wild animals) Perceptions of low aesthetic value and health hazards

In review with Landscape and Urban Planning

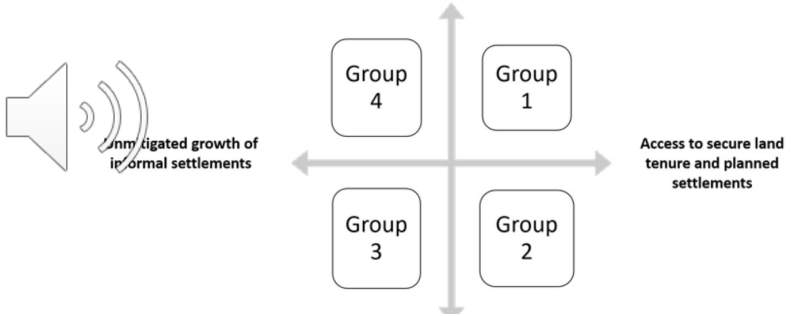
Participatory scenario planning

Shila Nawa – The good life

Zula for survival

Survival of the fittest

Embracing informality



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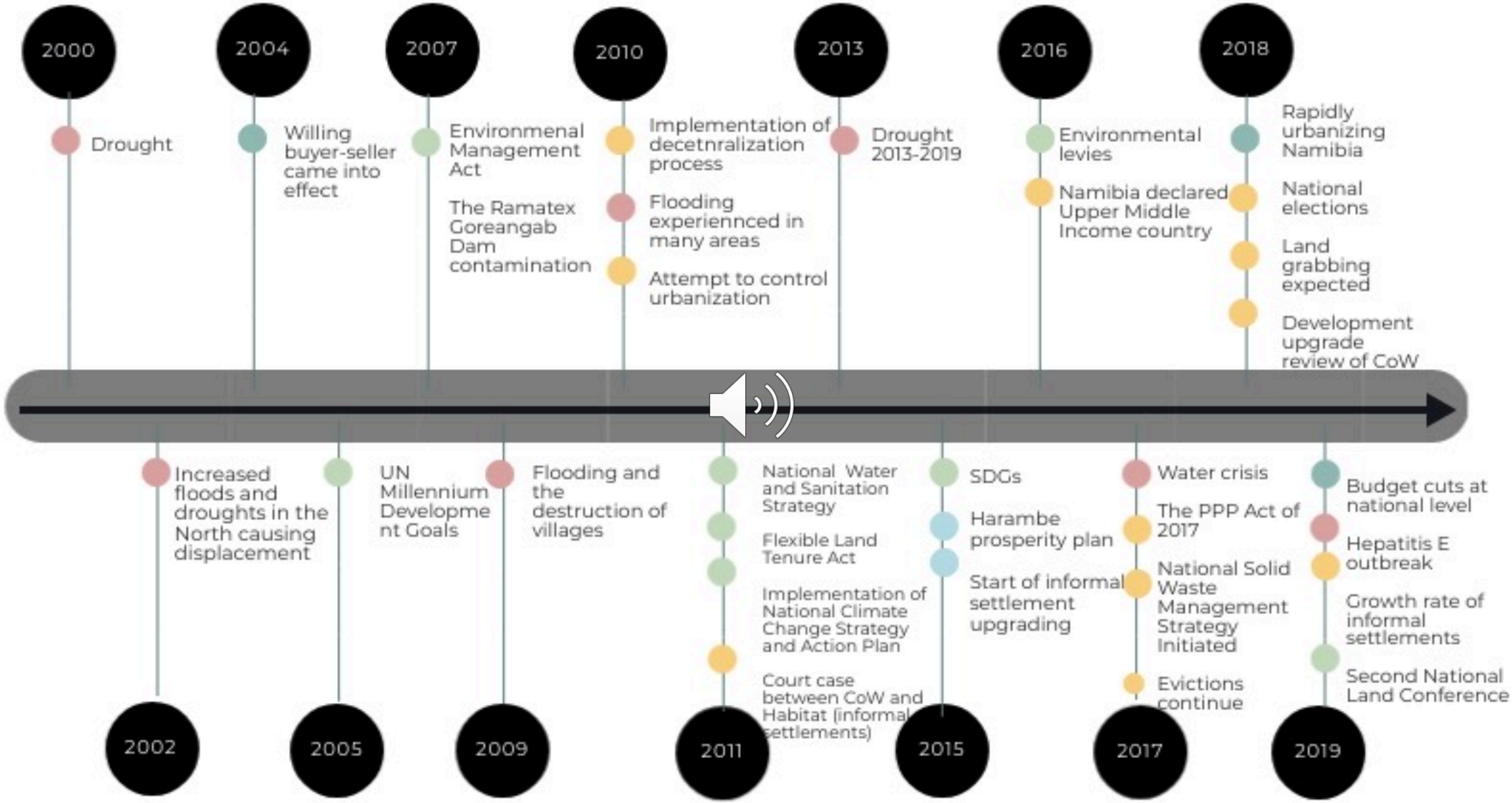
2000
Drought
2002
Increased floods and droughts in the North causing displacement
2004
Willing buyer-seller came into effect
2005
UN Millennium Developme nt Goals
2007
Environmenal Management Act
The Ramatex Goreangab Dam contamination
2009
Flooding and the destruction of villages
2010
Implementation of decetnralization process
Flooding experiennced in many areas
Attempt to control urbanization
2011
National Water and Sanitation Strategy
Flexible Land Tenure Act
Implementation of National Climate Change Strategy and Action Plan
Court case between CoW and Habitat (informal settlements)
2013
Drought 2013-2019
2015
SDGs
Harambe prosperity plan
Start of informal settlement upgrading
2016
Environmental levies
Namibia declared Upper Middle Income country
2017
Water crisis
The PPP Act of 2017
National Solid Waste Management Strategy Initiated
Evictions continue
2018
Rapidly urbanizing Namibia
National elections
Land grabbing expected
Development upgrade review of CoW
2019
Budget cuts at national level
Hepatitis E outbreak
Growth rate of informal settlements
Second National Land Conference

Animation

For many living in today's rapidly growing African cities,

urban life unfolds in poorer informal settlements amid a frenzy of ad-h
densely packed dwellings.

Here the lack of sanitation, access to water and secure tenure are everyday challenges.

Today, about 59% of the urban population in sub-Saharan Africa lives in peri-urban settlements

Storyboard

ACDI - Introduction

Animation.lk
Custom Built Films

expected to grow three-fold by 2050.

Often, these communities develop around hazardous riparian zones prone to flooding, heat stress and drought.

Yet, nature-based solutions can provide opportunities for such communities to mitigate and adapt to climate impacts.

For example, revegetating slopes along rivers can reduce erosion, filter water, and reduce downstream pollution.

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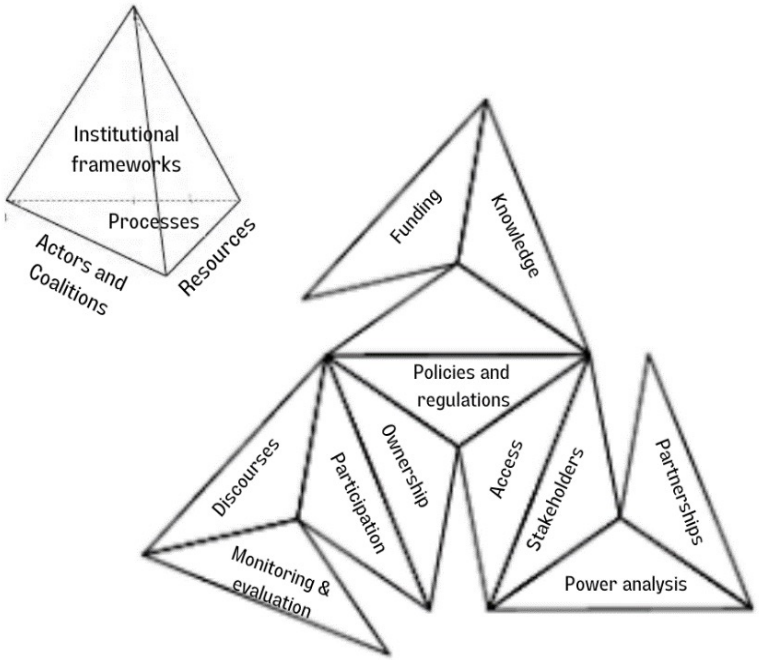
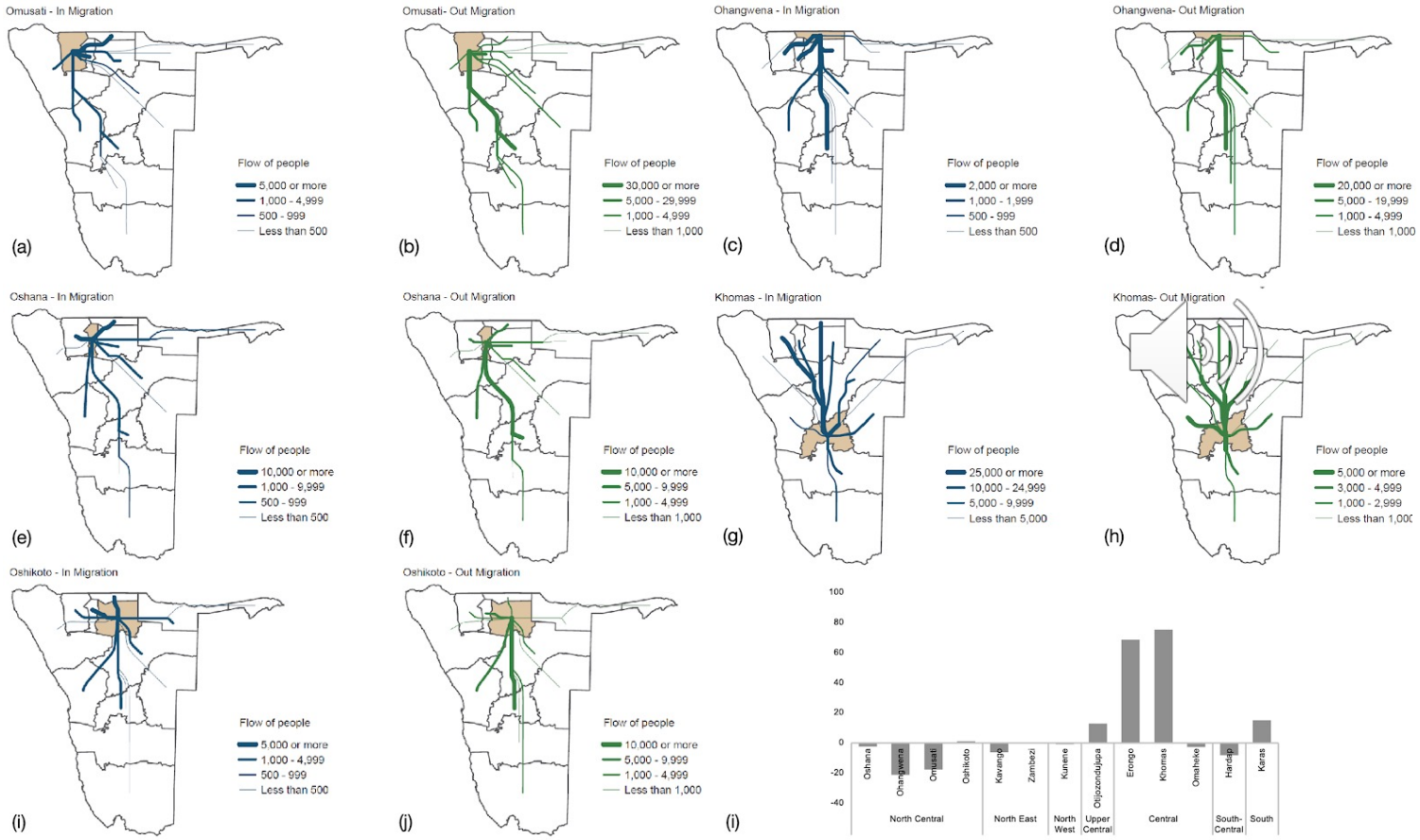
Governance of urban green infrastructure in informal settlements



Case	Fruitful Landscape, Katutura	Windhoek Riverwalk	Farm Okukuna - Eloolo Permaculture Project	Community and NGO driven riverbed rehabilitation	Green recreational spaces (e.g., Goreangab Dam, UN Plaza)
Description	Academic living lab[illegible]ory: Ecosystem and soil restoration initiative, designed as a learning lab for students	Programme: Urban riverbed rehabilitation programme, connecting historically segregated neighbourhoods through green walking/cycling paths	Project: NGO-run permaculture project, in partnership with CoW municipality	Programme: Urban river rehabilitation programmes within informal settlements	Programme: Accessible and inclusive multifunctional green space, designed specifically for north/north-western Windhoek
Scale	Private landholding	CoW	Private landholding	Neighbourhoods	Single site initiatives

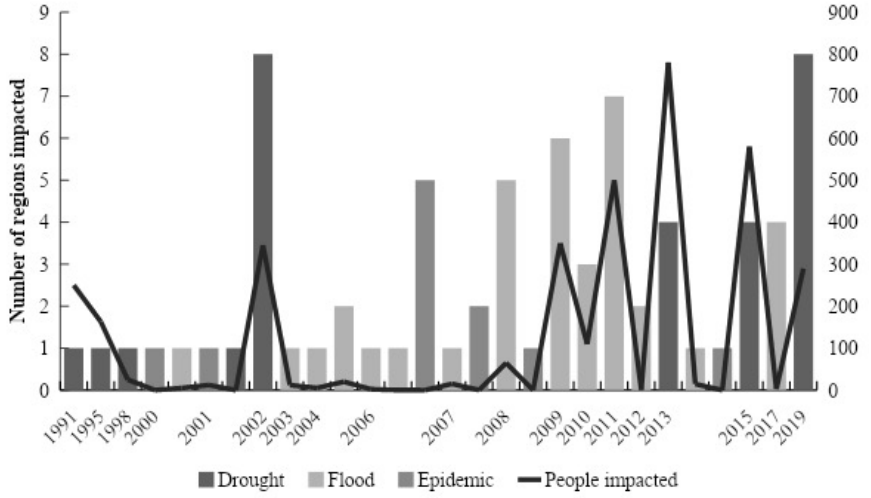
In review with Sustainability

Benefits and limits of migration in supporting climate resilience along the rural-peri urban continuum: the case of north-central and central Namibia



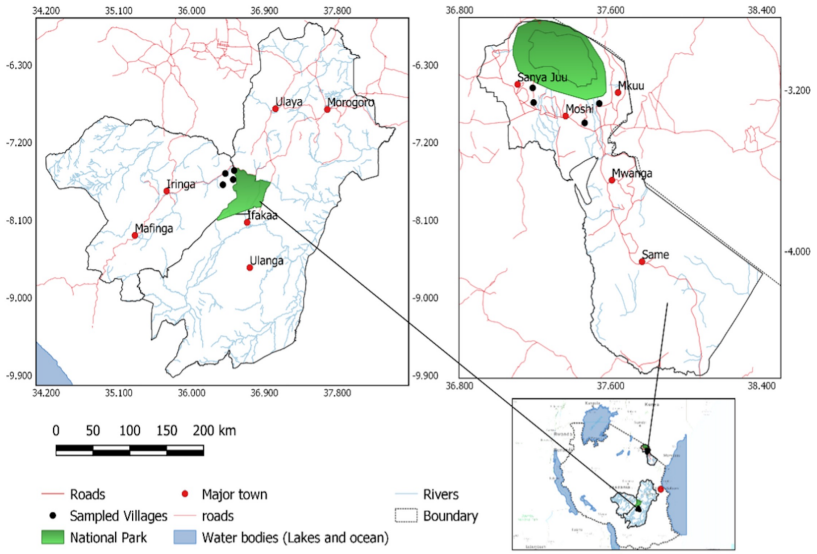
Adaptation is supported by deeply embedded rural –urban linkages

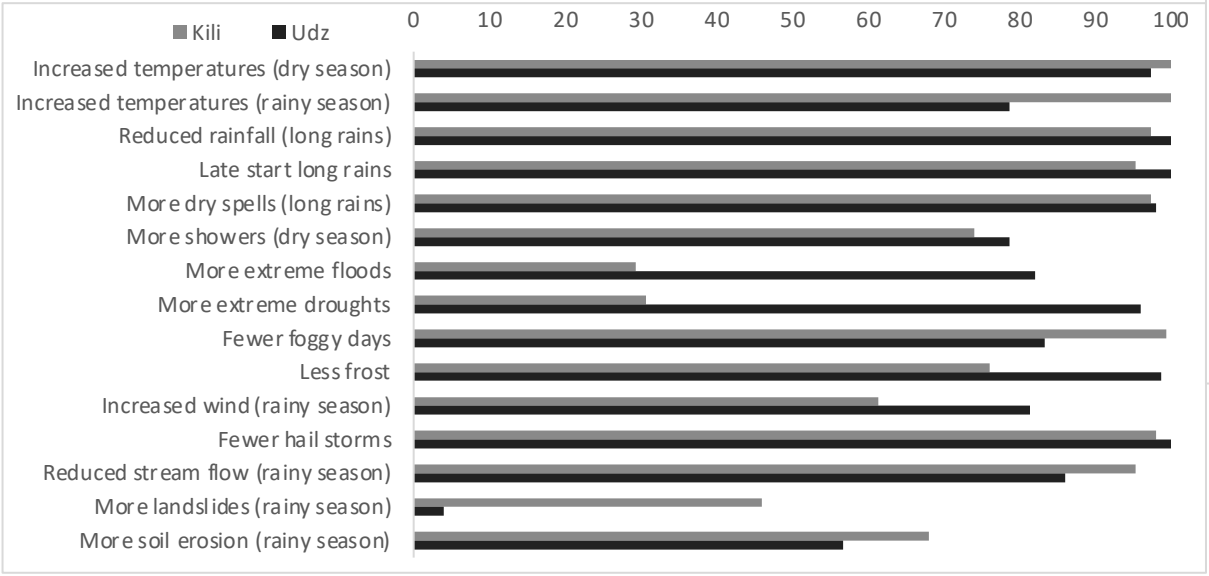
Benefits – drought, flood adaptation, socioeconomic development
Limitations – energy and sanitation access

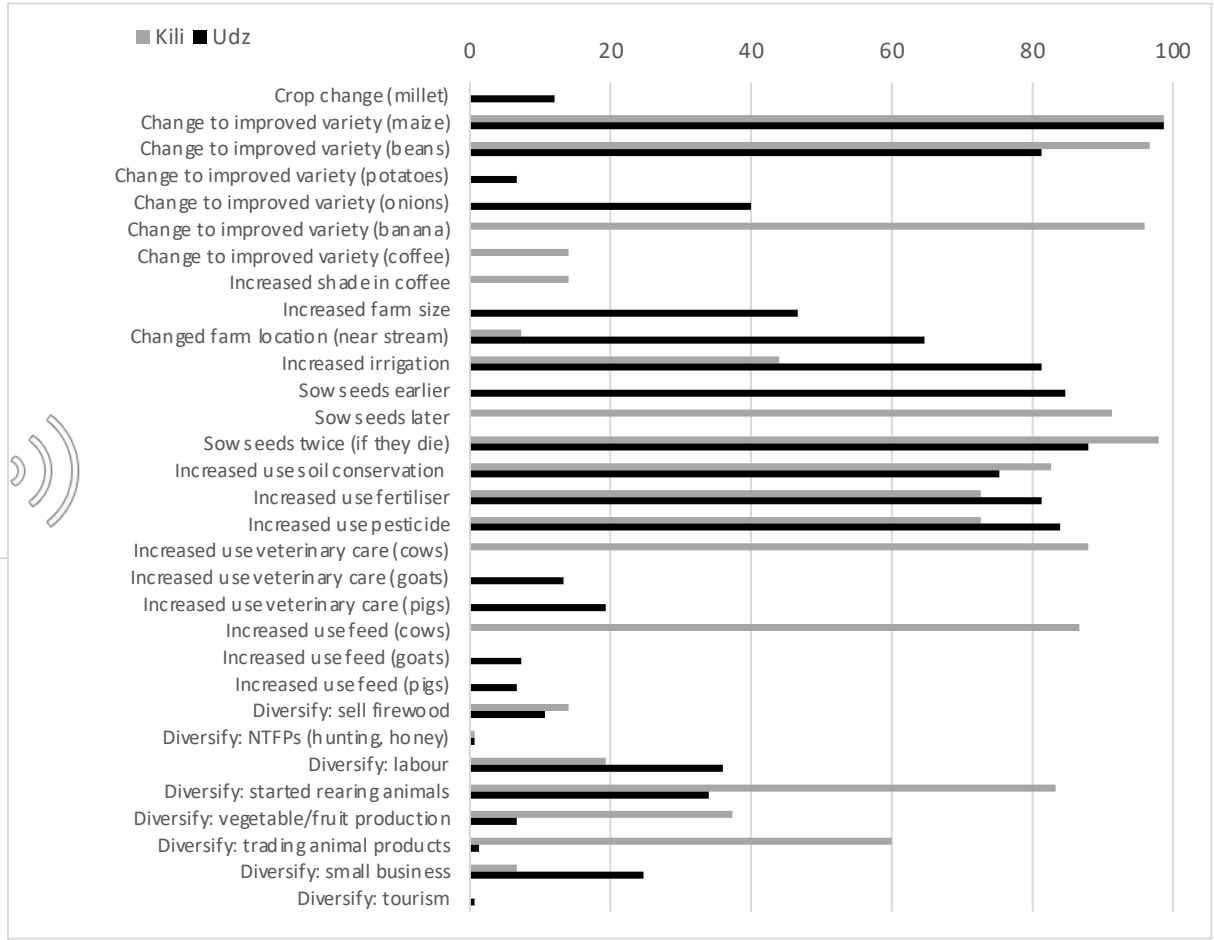


Thorn et al . In prep. Regional Environmental Change

Climate impacts and adaptation responses in two mountain regions in Tanzania







Submitted to Land Special Issue on Mountains

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Special issue Environmental Policy Design and Implementation

sustainability

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Environmental Policy Design and Implementation: Toward Sustainable Society

Guest Editors:

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Deadline for manuscript submissions:
31 May 2021

Message from the Guest Editors

The purpose of this Special Issue is to explore and advance our understanding of, with regards to Sub-Saharan Africa in particular: (a) the present state and effectiveness of local, national, or regional policies engaging with, and transforming, the climatological, environmental, social, and economic impacts and consequences of primary and secondary sector expansion and urbanization; and (b) how environmental policies might be designed and embedded into future regional economic and urban development planning to encourage coordination and coherence across sectors and policy domains to deliver sustainable transformations for meeting Agenda 2030.

We encourage contributions that adopt research and practice perspectives concerning evidence of policy trade-offs, synergies, challenges, and opportunities. In particular, we invite interdisciplinary studies that examine social–ecological interactions occurring between land-use change, livelihoods, primary and secondary sector activities, and urban planning. Empirical studies drawing on multiple case studies, reviews, and conceptual submissions that adopt novel epistemological or methodological approaches are welcomed.

mdpi.com/si/35310

Special Issue

With a focus on SSA , the SI aims to advance our understanding of

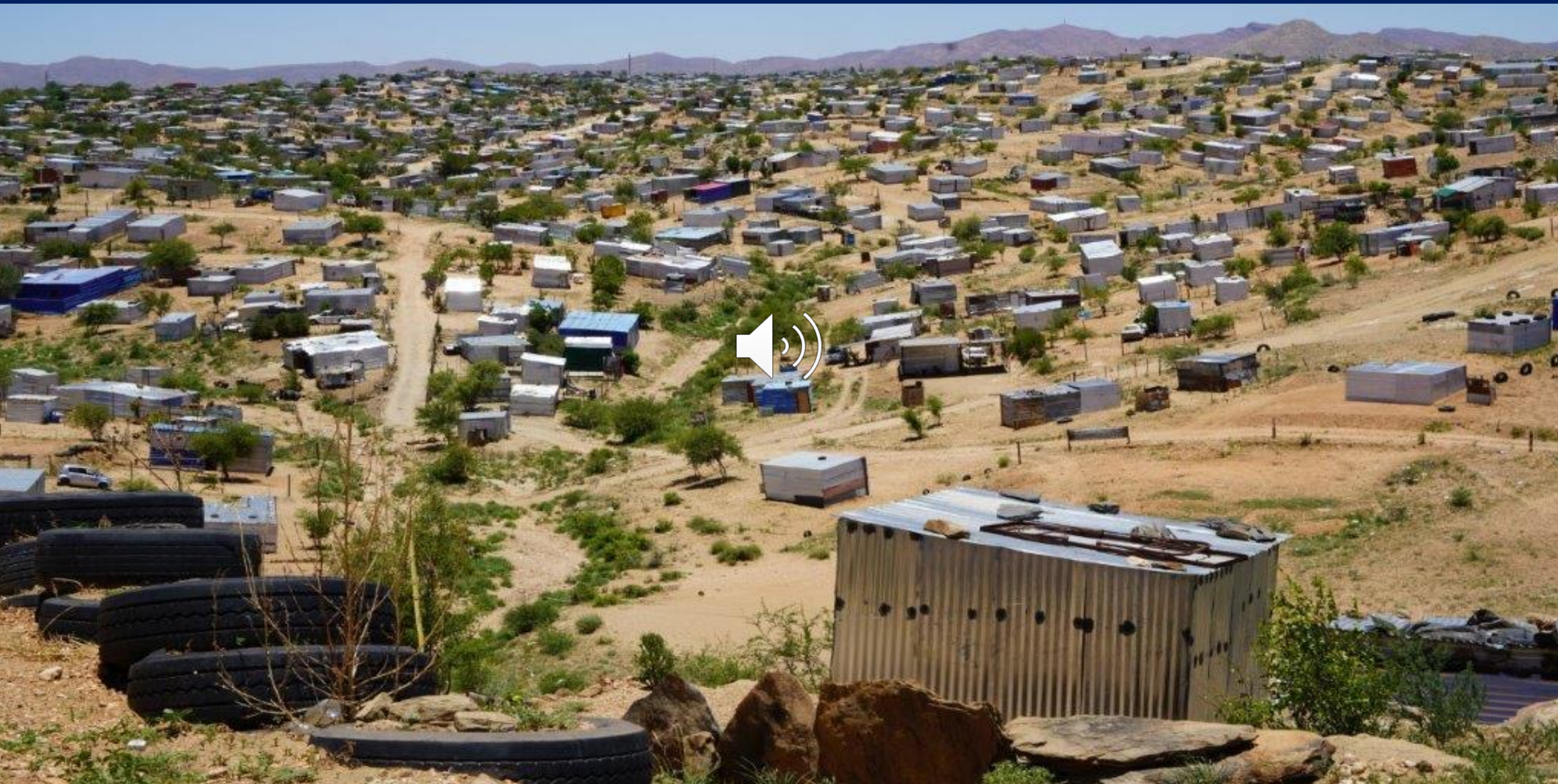
(a) the present state and effectiveness of local, national, and regional policies engaging with, and transforming, the climatological, environmental, social, and economic impacts and consequences of primary and secondary sector expansion and urbanization; and

(b) how environmental policies might be designed and embedded into future regional economic and urban development planning to encourage coordination and coherence across sectors and policy domains to deliver sustainable transformations for meeting Agenda 2030 and African Union Agenda 2063.

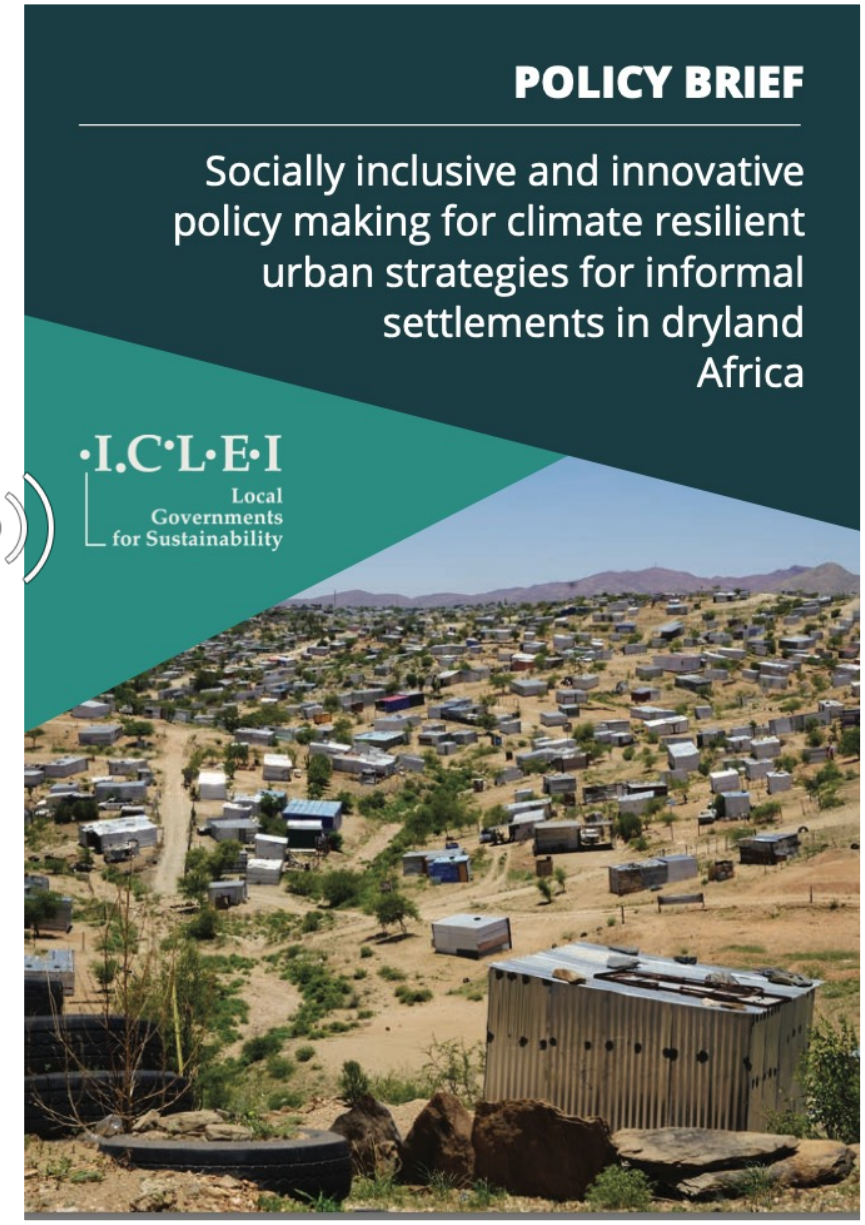
11 contributions – currently in review

The African Academy of Sciences · United Nations Economic Commission for Africa · WISER · UKaid from the British people · CR4D

Engagement and outreach



Policy briefs for local authorities



Posters

Dryland nature-based solutions for informal settlement upgrading schemes in Africa

Thorn, J. P. R.[1,2], Kavonic, J.[3], Hejnowicz, A.P.[4], Marchant, R.[1], Ajala, O. [5], Muller, A. [6], Delgado, G. [7], Shackleton, S. [2], Cinderby, S. [8]

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Introduction

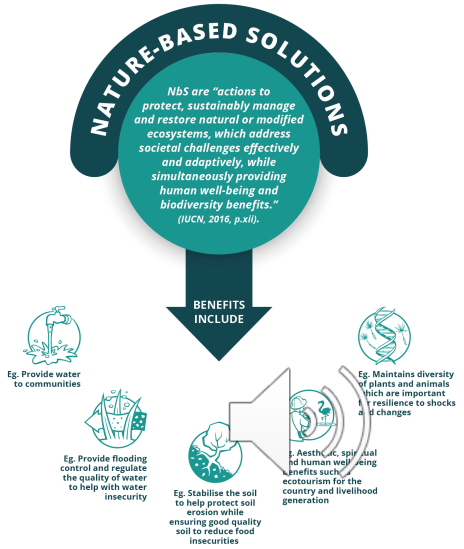
Dryland ecosystems occupy 40% of Earth's terrestrial surface, characterised by high spatial and temporal rainfall variability. Drylands are particularly vulnerable due to changing rainfall patterns and land degradation – aggravating poverty, food and water insecurity. This is particularly the case in rapidly growing informal settlements across Africa. Building, protecting and restoring nature-based solutions (NbS) can benefit resource-constrained informal settlements, due to cost-effectiveness, health and economic co-benefits. Yet, little effort has been made to implement NbS in fragile drylands peri-urban areas. Concurrently, less attention has been paid to adaptation in informal settlements, even though living conditions often cannot withstand extreme events. City and national governments use upgrading schemes to address rapid unplanned peri-urban growth and build resilience. In some instances, in-situ upgrading programmes combined with flexible tenure systems and NbS can significantly benefit peri-urban populations and the wider city landscape.

Focus

Based on an ongoing research in Namibia, Kenya and Tanzania, the "Peri-Urban Resilient Ecosystems" partnership presents ten practical recommendations to strengthen informal settlement upgrading schemes through NbS for urban policy makers, planners, designers, shack dweller federations and local authorities operating in dryland systems.

Link to full brief: https://africa.iclei.org/wp-content/uploads/2021/02/nbs-policy-brief-final.pdf.

Further information: jessica.thorn@york.ac.uk



Examples of informal settlement landscapes, resource extraction and NbS in Windhoek, Gobabis, Oshikati, Namibia. Credits: Thorn, J., Marchant, R

Recommendations

1: Integrate dryland nature-based solutions into in-situ upgrading schemes

Given the range of interventions classified as NbS and the cross-sectoral co-benefits, as new processes and designs for informal area upgrading are interrogated and implemented, opportunities for NbS implementation should be explored. NbS measures are often more cost-effective than manufactured and engineered alternatives in the long term.

2: Effectively partner with civil society organizations and the private sector

Communities, supported by NGOs, local governments and relevant Slum/Shack Dwellers Federations actively seek good relations with politicians and city officials to support co-production and have developed methods for effective engagement. Involving stakeholder consultation from the outset to explore NbS in upgrading, can help ensure alternatives are feasible.

3: Integrate hybridised approaches of green, blue and grey infrastructure

Use the urban living system (e.g., green areas, riverbeds) and the built environment (e.g., roads, buildings) together to better meet all the integrated needs of cities. Policy makers can also help by encouraging experimentation, learning, and innovation in the private sector through subsidies and tax incentives for NbS.

4: Explore integrated approaches to upgrading with complementary co-benefits

Integrated approaches for climate adaptation and mitigation that fosters interconnections among sectors, between governance levels, from the settlement and city scale to the wider catchment and different phases of infrastructure's lifecycles build stronger environmental, social, and economic sustainability.

5: Keep drylands alive through soil biodiversity

Soil biodiversity and soil organic carbon management are vital elements in supporting multiple ecosystem services. Upgrading schemes can consider the promotion of agroecological practices to maintain soil organic matter in and around homes in informal settlements to sustain key landscape functions and increase self sufficiency.

6: Plant indigenous trees along roads and in households

Prior to upgrading settlements, developments often clear away important habitat for biodiversity. Woody and herbaceous species can help restore degraded ecosystems based on biophysical and ecological properties and socio-economic value. We encourage environmental by-laws that require developers to pro-actively include plans for indigenous tree planting on their land, enforced through regular consultation.

7: Link informal transport networks with green spaces

Inherited poor urban designs means communities often face costly and long commutes to employment opportunities. Parks and green spaces can create more connected cities, through pedestrian or cycling routes, whilst addressing urban sprawl, improving health and wellbeing and reducing GHG emissions. Doing so requires ensuring pedestrian security and maintaining clean routes void of solid waste.

8: Shift perspective from "unplanned" to "unserviced"

Informality, including the informal economy and informal settlements, is an integral part of most growing African cities and the source of innovations that can be harnessed for the betterment of the wider city. Changes in perceptions of decision makers regarding informality is necessary not only to foster better engagement with informal settlement representatives and municipalities, but also use NbS as the ideal entry point to service settlements.

9: Experiment with "untried beginnings"

The principle of 'Urban Tinkering' re-imagines the use of existing urban elements, such as open green spaces or dilapidated buildings, and identifies valuable shifts in how they work. NbS are extremely well positioned to support this experimentation, design adaptability and innovation - allowing infrastructure to serve multiple functions that address context specific challenges.

10: Generate and use relevant data for evidence-based decision making

Climate change provides large investment prospects to transform cities. Currently, insufficient data and knowledge prevent promising business cases from becoming apparent and compelling. Meanwhile, too often decisions are made ignoring the evidence base. Due to the governance and finance frameworks inherent to NbS implementation, NbS can help collect the necessary data, laying the foundation for an investment-friendly environment.

Website and six blogs

ACDI African Climate & Development Initiative

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Green infrastructure for climate adaptation in peri-urban areas

Jump to: What we do · Intended impacts · Key insights · [illegible] and funders · Our team · Updates · Outputs

Fifty-nine percent of Sub-Saharan African urban populations live in informal settlements (UN-HABITAT 2019), expected to triple by 2050. Despite an increase in improved housing from 11% to 23% between 2000-2015, 53 million urban Africans were still living in unimproved housing in 2015, often in highly overcrowded conditions, with large deficits in city infrastructure and public service provision, and in hazardous sites such as riparian corridors and on steep slopes (Shatterthwaite et al. 2018, Tusting et al. 2019). These complex natural and socio-cultural dynamics, combined with climate variability, severe and persistent drought, extreme rainfall and heatwaves, expose much of the population to high levels of risk, and threaten an irreversible collapse in ecosystem diversity and functioning (Thorn et al. 2015, Dodman et al. 2017, Shatterthwaite 2017).

Ecosystem-based solutions in the form of ecological (or green) infrastructure (EI or GI) have emerged as spatial planning tools for ensuring functional networks of natural and semi-natural areas. They demonstrate the importance of ecological systems as part of the infrastructural fabric that supports and sustains society and builds resilience (Harrison et al. 2014, Lindley et al. 2018, Cilliers 2019).

In various cases across Sub-Saharan Africa, well-functioning ecosystems provide diverse provisioning, regulating, supporting and cultural services to society that can buffer against risks arising from droughts and floods, and can reduce the loss of lives, assets and critical infrastructure (Kaoma and Shackleton 2014, Seburanga et al. 2014, Adegun 2018), with benefits for physical/psychological health, social equity and wellbeing (Shackleton et al. 2015, Kopecka et al. 2018). Urban green infrastructure (UGI) can lengthen the life of existing built infrastructure, make areas more attractive for investment and require minimal input and maintenance. Yet, informal urbanisation continues to intrude upon and undermine ecological space (e.g., illegal dumping, open defecation, criminality), while encroachment on formal green spaces that can be of ecological importance (Adegun 2019), especially urban parks, is common (Bhattacharya 2014, Israt and Adam 2017). Moreover, most research on UGI outcomes to enhance climate resilience has been conducted in formal settlements in the Global North, while the unique sociocultural context, and spatial challenges in Sub-Saharan Africa means that Africa must not necessarily emulate Western models of green infrastructure planning.

Urban green infrastructure can help in recovering from hazards or provide safety nets. Urban agriculture, hill forestation, terracing, green public open spaces, and clearing invasive alien plants can all help to reduce erosion, filter grey water, provide medicine, timber, fodder, windbreaks, and shade, promote the provision of downstream water, regulate flood shocks, reduce sedimentation and run-off, and complement drainage.

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Chaired pan - Africanist conference

Nature-based solutions, gender equity and interconnectivity for climate resilience in Africa

- Climate resilience to water scarcity and abundance
- Ecological infrastructure, ecosystem services and nature-based adaptation
- Balancing conservation and development agendas
- Bioeconomy in Sub Saharan Africa
- Advancing leadership of African women in STEM
- Environmental data processing
- ICT and innovative connectivity as an enabler for sustainable development
- Science communication for policy and press
- The role of the private sector in the social and ecological compact
- Methods for engaging complex systems and interdisciplinarity
- Feeding and securing a healthy future
- Rethinking the future of African research

Conference proceedings book

ABOUT INTERSOL

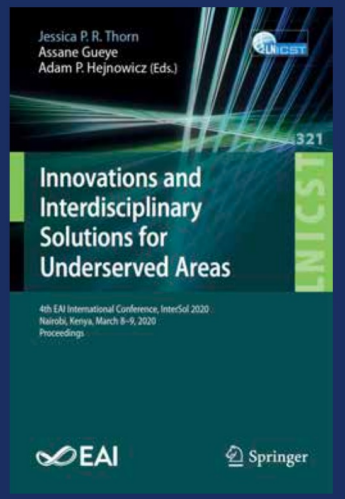
Today, there is a consensus that such challenges require solutions that are not amenable to separate single discipline investigation but require collaboration between many types of traditional disciplines. There is a need for more transdisciplinary practice: where research has a real-world impact.

An international conference intended to

(1) encourage innovative interdisciplinary research, development, and education that focus on solving problems in underserved a… in Africa and beyond

(2) create an international research and development community around “interdisciplinary solutions,” which meets annually, publish in international fora, and incentivize members of the community to initiate interdisciplinary research projects that address needs.

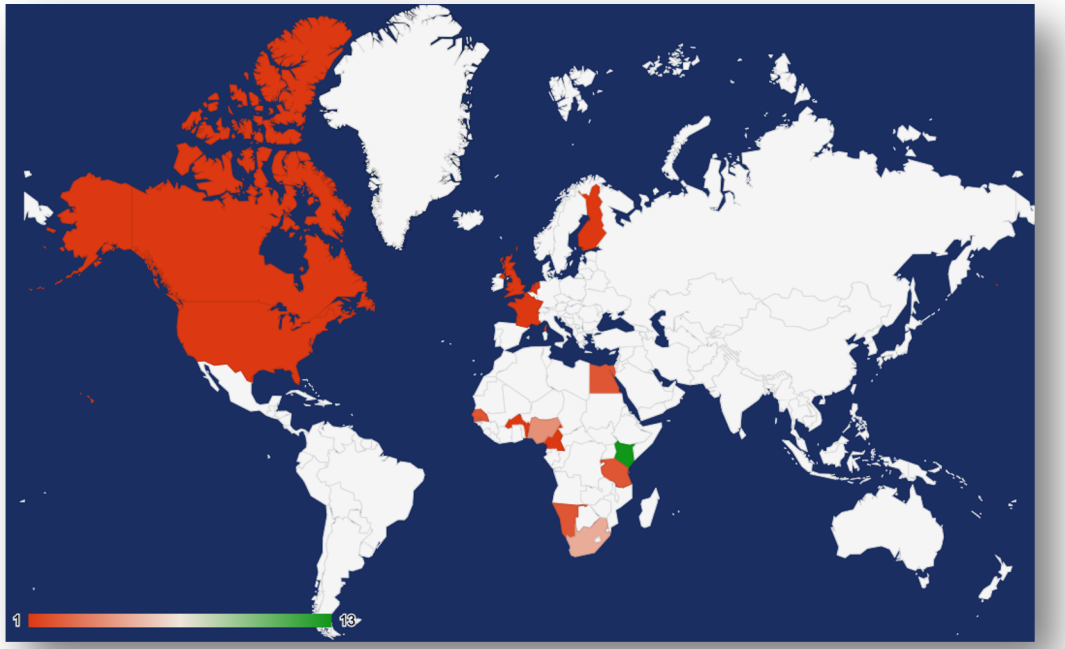
Editions:
Dakar, Senegal, 2017
Kigali, Rwanda, 2018
Cairo, Egypt, 2019
Viritual/Nairobi, Kenya 2020/1

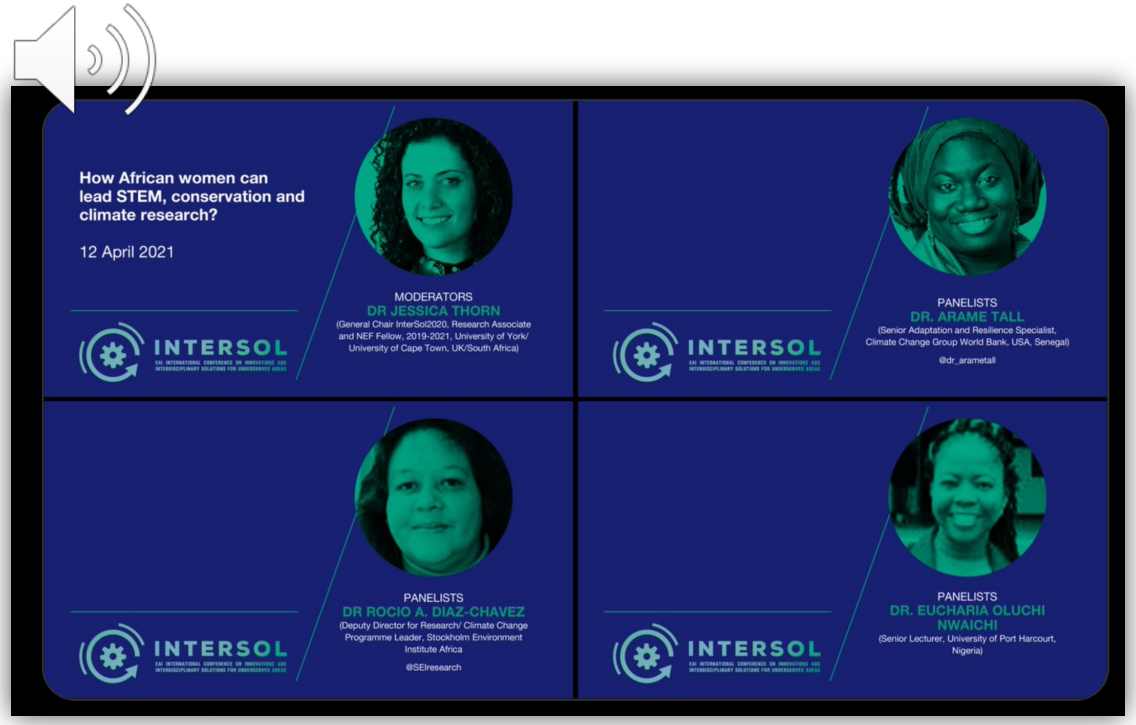


Link: https://link.springer.com/book/10.1007%2F978-3-030-51051-0

Pan - Africanist conference

Book published by Springer
Workshops - science communication, e learning
Panels – women in stem, private social ecological compact
Paper presentations
Ignite presentations
Posters
300 registrants





IPCC and GEO6 UN Reports

The newly launched Global Environment Outlook for Business briefs look at the GEO findings through a business lens. Written 'by business for business', the briefs bring the science of the GEO to the business community to support them in developing plans, business strategies, technology pathways, mechanisms and enablers towards building a green and circular economy.

GEO for Business is led by a high-level Advisory Committee of major business and non-governmental organizations working on the environment. These short and stimulating products will be supporting UNEP's priority for the super year for Nature while providing 'how-to guides' for business on specific environmental issues. Six thematic briefs covering three systemic areas: food, waste and energy will be published throughout 2021. They are as follows:

- **Adapt to survive: Business transformation in a time of uncertainty ›**
- **Moving from linear to a circular economy and what this means for business**
- **The changing role of business in transforming food systems**
- **How business can manage the transformation towards deep decarbonization and full electrification**
- **Future-proofing infrastructure for climate resilience**
- **Changing finance, financing change**

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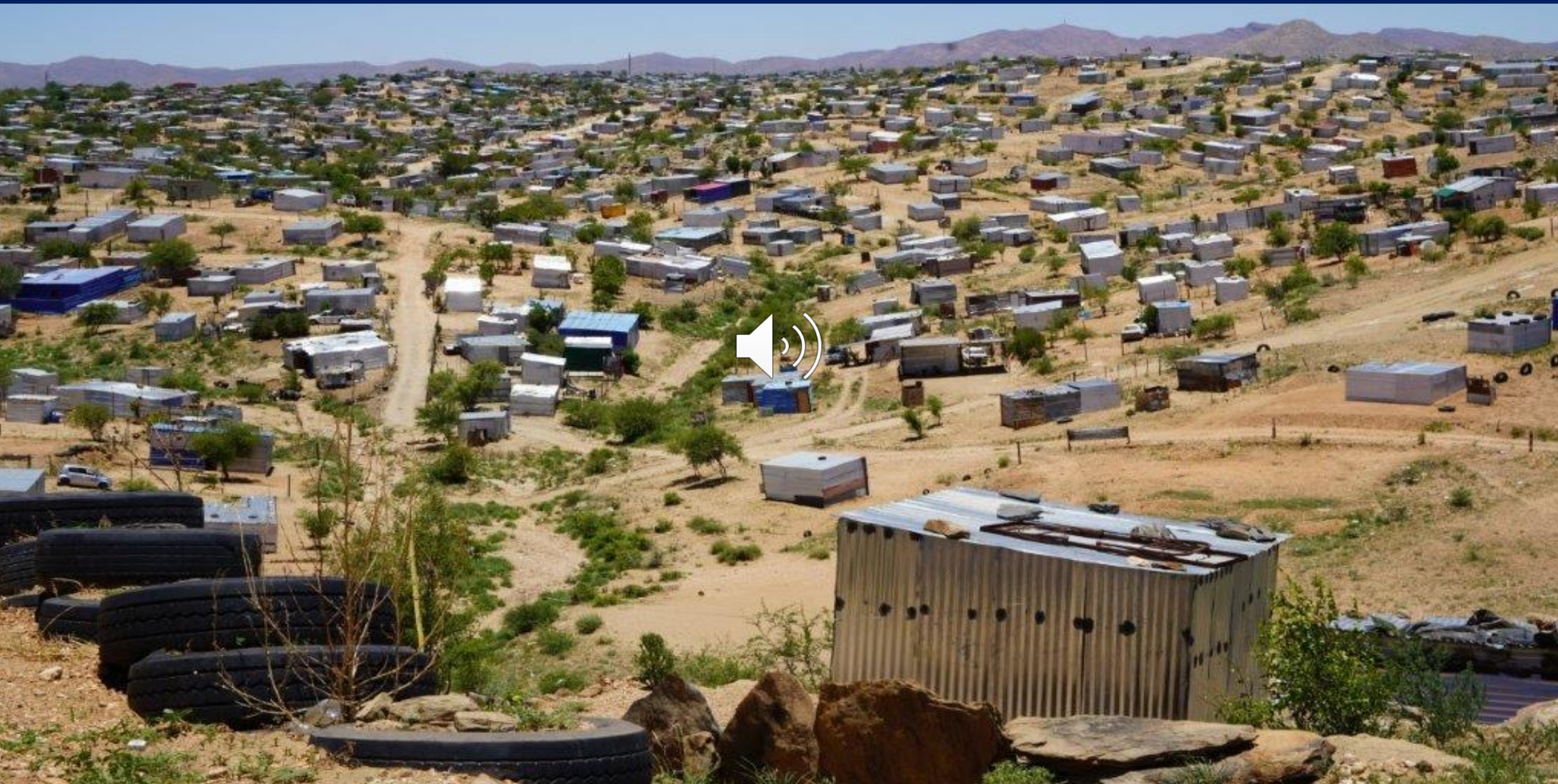
Capacity building



Capacity building: MSc students trained

Wilson Masele, University of Dar es Salaam - The role of biodiversity in supporting resilience to climate change in peri-urban settlements: A case of urban agricultural biodiversity in Dar es Salaam

Michael Mdongwe, University of Dar es Salaam - The contribution of urban green infrastructure in informal settlement upgrading: the case of Buza Sigara, Dar es Salaam Tanzania

Tapiwa Maruza, Namibian University of Science and Technology - The unjust city: Legitimizing informal trade in Windhoek, Namibia's central business district and the role of green spaces in enhancing public space

Amayaa Wijesinghe, University of Oxford - Using ecosystem-based adaptation (EbA) to increase climate resilience of peri-urban settlements in Windhoek, Namibia

Valentina Giombini, University of Oxford - Riverbeds in a post-apartheid city: potential for a resilient and integrated city

Saima Haukelo, University of York - Green infrastructure in peri urban settlements in Windhoek Namibia

Conclusions and key implications

An integrated landscape approach balances competing demands and multiple land uses, counter historic inequalities

Shared sense of responsibility, place, memory and meaning of public spaces

Coordination platforms to collaboratively overcome conflicting ordinances – urban-rural linkages, continually align with needs

Accelerated, simplified land tenure reforms and upgrade informal settlements

Proactively plan for agropastoral livelihoods in drylands, sustainable harvesting of fodder

Local communities central for long-term maintenance, security and surveillance

Scale monetary valuation of ecosystem services and internal costs

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Next steps

- Expand this research in Madagascar, Ghana, Kenya and Uganda
- Focus on heat stress and flooding
- Upland – lowland connections in supporting and hindering climate resilience
- Transdisciplinary practice
- Building partnerships and collaboration

Project Team

The project is jointly coordinated by the ACDI and the York Institute for Tropical Ecology, Department of Environment and Geography at the University of York. Key collaborating research partners include FRACTAL, University of Dar es Salaam, University of Namibia, University of Oxford, Slum Dwellers International, and Stockholm Environment Institute.

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