

URBAN FORESTS & GREEN SPACES IN AFRICA

Case Studies and Lessons from Across the Continent



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CENTRE ON AFRICAN PUBLIC SPACES

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Cover photos, clockwise from top left: An avenue of indigenous *Albizia* spp. in Plateau, Abidjan, Côte d'Ivoire. An *Ochna* sp. on a Nairobi highway verge. Closed canopy in Bahir Dar, Ethiopia. Photos C Watson. Traveller's palms *(Ravenala madagascariensis)* shield an apartment complex in Nairobi, Kenya. Photo A Gerow. Trees in downtown Kampala, Uganda. Photo D Padde. A veteran neem tree in Mombasa, Kenya. Photo C Watson.

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FOREWORD

There is a particular kind of knowledge that grows only in place. It does not travel well in spreadsheets or sit easily in imported frameworks. It is knowledge rooted in soil: in the acacia that survives the dry season, the indigenous tree that a grandmother planted along a township boundary, the park that a community refused to surrender when the city forgot about it. It is knowledge that belongs to African cities, and it is long overdue that we gather it, honour it, and put it to work.

This compendium, *Urban Forests and Green Spaces in Africa: Case Studies and Lessons from Across the Continent,* is an act of recovery as much as it is a record. It recovers the voices of practitioners who are quietly greening African cities, often without the resources that comparable initiatives in the Global North can count on. It recovers the wisdom of communities who understood, long before the climate crisis brought it to our notice, that trees are not decoration but infrastructure. And it recovers, for policy-makers and decision-makers at every level, a growing body of evidence that African cities are not merely recipients of global knowledge and sources of raw data but generators of knowledge of immense global import.

Johannesburg City Parks and Zoo manages over 2,600 hectares of urban green infrastructure across one of Africa's most complex, unequal, and dynamic cities. We manage this inheritance not as a custodian of the past but as a steward of the future. Every tree planted in a township that was historically denied green space is an act of spatial justice. Every urban forest protected in the face of development pressure is a statement about what kind of city we believe our residents deserve. And every piece of knowledge we generate from that work, every lesson, every failure, every unexpected success, belongs not only to Johannesburg but to the continent.

That spirit of continental solidarity is precisely what animates the pages that follow. The case studies collected here span diverse geographies, climates, governance contexts, and scales. They emerge from cities grappling with inherited inequality in tree distribution, from municipalities building green infrastructure

on constrained budgets, from activist-led initiatives that are outperforming top-down programmes, and from innovators who are finding distinctly African solutions to distinctly African challenges. What unites these contributions is not a uniform model or methodologies. It is high standards, creativity, fluency in tech tools to measure tree canopy health and other vital urban parameters, and a shared commitment to evidence-based, science-based approaches and global best practices. The goal is always the same: achieving cities that are greener, more resilient, fairer, and more alive.

The timing of this publication is not incidental. Africa is urbanising faster than any other region on earth. By 2050, the continent's urban population is projected to more than double, adding hundreds of millions of people to cities that are already navigating the compounding pressures of climate change, inequality, and infrastructure deficits. The decisions made in the next decade, about what we plant, where we plant it, who has access to green space, and how we protect what we have, will shape the liveability of African cities for generations. We cannot afford to make those decisions in ignorance of our own experience. While we must look outward to new global guidance, like the 3-30-300 rule for city trees, answers are also here among us.

I am proud that the City of Johannesburg, through Johannesburg City Parks and Zoo, has been part of the broader movement to build continental knowledge networks in urban forestry and public space. Through platforms such as the African Forum on Urban Forests, the Centre on African Public Spaces, and the Afrika Mazingira Collective, we have seen, again and again, what happens when African practitioners are given space to share their knowledge with one another rather than waiting for knowledge to be handed down from elsewhere. Ideas travel. Practices adapt. Coalitions form. Cities grow greener.

African approaches to greening their cities are a gift to the world.

Thanduxolo Mendrew

Managing Director, Johannesburg City Parks and Zoo

PREFACE

Green life is hanging on in African cities, often valiantly tended by communities or youth who understand what urban planning frameworks are only just beginning to articulate. Trees and green spaces are more than just 'amenities'. They are vital infrastructure, they are memory, they are health, they are home.

But our trees and green spaces are under immense pressure and need all our support. We need to protect them, safeguard existing parks and trees, create new green spaces, and grow more trees along residential and commercial streets and the unpaved alleys of informal settlements; around hospitals, government buildings, schools and malls; in parks, and in the forest remnants that thread through our densest urban neighbourhoods.

Simply put, our cities are in crisis: with less and less green space and shade for residents to sit, relax and exercise, and affected by global climate shifts that are causing heating up, more frequent and extreme flooding, and steady loss of biodiversity.

Fortunately, we are responding. The institutional memory of city departments that persist despite constrained resources is being jogged by a new global discourse about tree equity. African scholars are mapping the relationship between green space and urban wellbeing. Activists and concerned citizens are setting up tree nurseries, planting and tending trees, and holding hands around veteran trees at risk of being felled. African botanists are advising what to plant.

This upswell can be seen in this important compendium. The first ever collection on Africa's urban forest, it gathers case studies that span the continent. They represent cities navigating rapid urbanisation, cities recovering from environmental neglect, cities investing in green as a deliberate response to climate vulnerability, cities where trees are unhealthy and need a boost, and cities where 'Friends of' groups impactfully co-manage parks with authorities. Each case study is a lesson. Together, they form a body of evidence that African cities can draw upon as they plan, advocate, and build. And they inform the world.

The compendium emerges directly from and is a knowledge product of the Second African Forum on Urban Forests (AFUF) in Johannesburg in March 2025, which brought together more than 430 delegates from over 35 African countries,

and gave rise to the Johannesburg Declaration 2025 and the Afrika Mazingira Collective, a community of practice connecting urban forestry and green space practitioners. It will serve as an anchor for the Third African Forum on Urban Forests in Johannesburg in 2027, where it will be launched not in a conference hall, but outdoors, in one of our city's living green spaces, through an exhibition that brings its pages into the landscape they describe.

As the Convener of the Centre on African Public Spaces, a continental knowledge exchange platform developed in partnership with UN-Habitat and GIZ, I have had the privilege of witnessing what happens when African practitioners are given the space to speak to one another. The conversations that emerge are not abstract. They hold loss and possibility in the same breath, carry names and histories, and are grounded in specific soils, specific tree species, specific settings. This compendium honours that specificity, while drawing out the patterns and principles that can travel.

Of those who contributed, 47% were researchers, 20% activists, 16% government employees, 9% staff of NGOs/not-for-profits, and 8% students. I am deeply grateful to each and every one of you. You are the authors of this work in the truest sense. I am grateful also to our editor, Cathy Watson, whose careful eye and commitment shaped every page. To the City of Johannesburg and Johannesburg City Parks and Zoo, the institutional home from which this work has grown, thank you for your unwavering support. You made its continental scope possible.

May this compendium be argued with, built upon, and returned to. May it find its way into the hands of the practitioners, planners, and advocates who are, right now, making decisions about the trees, rivers, gardens, wetlands, parks in our neighbourhoods and cities, and the green futures our children will inherit. May it be a contribution from Africa to global knowledge on urban forests.

Ayanda Roji

Convener, Centre on African Public Spaces
Convener, Second African Forum on Urban Forests
Head of Environmental Education and Research, Johannesburg City Parks and Zoo

INTRODUCTION

Putting together this volume has been both a great pleasure and a mission, involving a year's intense interactions with academics, city officials, practitioners, activists and students. It was not easy. Urban forestry in Africa is ancient: read about the treed settlements that have always existed in Senegal and Ghana. But urban forestry is also very new. Not a single university course in Africa is yet entirely dedicated to it.

Together we struggled. But the result is a triumph: 34 case studies from 74 contributors – 80% African, 64% male, 36% female – in 14 countries.

To locate the studies, we reached out to all who presented at the 2nd African Forum on Urban Forests (AFUF): 34 stepped up, submitting 25. We sorely regret those we missed, including one from a Senegalese forester who transplants city baobabs stranded by road building. We also regret geographic gaps such as Sierra Leone.

For non-AFUF case studies, we located nine that we felt Africa and the entire world needed to hear, including one on Kigali's Nyandungu Eco-Park and another on Nairobi's Karura Forest. Today, these two protected and restored green spaces receive up to a staggering 7,000 and 80,000 visitors/month, respectively, and their birds, amphibians and other taxa have rebounded.

Most solicited case studies came through our networks. But we located one online, going to great lengths to find its author, who had researched what motivates people in Ethiopia to visit parks and what they want from them. Significantly, 80% of her respondents said: 'to enjoy the environment'. But 40%, mostly women, observed that they did not always feel secure.

Of the case studies, 14 arose out of research. Due to the constraints of length and flow, we were only able to allude to their methodologies. Fuller descriptions are available, however, in the related journal article, the link to which we provide wherever possible, and the email contact of the lead author is provided for every study.

Case studies addressed myriad themes, the most common being governance (mentioned by 13), the role of the community (11), and biodiversity, heat, and access to trees (9 each). Given this multiplicity, we opted to organise the case

studies by place, focusing on seven capitals, ranging in size from 1.7 million people (Kigali) to 8 million (Dar es Salaam); 16 regional urban centres, from Rama (population 7,000) to Greater Kumasi (over 4 million); and, fleetingly, seven Ugandan towns newly classified as cities with populations in the hundreds of thousands.

Naturally, we dive deeply into Johannesburg, from where we invite you to read two particularly cautionary cases on how invasive alien plants took over a nature reserve and a fungus is devastating urban trees because just four genera account for 96%. Diversifying Africa's urban forest is an urgent need.

You may then be flummoxed to read that efforts to do exactly that struggled in Soweto. Reasons included hesitancy about trees: communities did not want to attract owls or lightning or to sweep leaves, and traditional healers debarked them. This is a human-centred book with many such details.

It is far from a book of gloom and doom, however. We have one case study on the destruction of Ibadan's forest. But hope shines bright. Two of our favourites are on the greening of disadvantaged areas of Harare and Dakar by young activists. We also particularly like a case study from Ghana that shows that old trees offer irreplaceable habitat for biodiversity, and one from Morocco that explains that the cooling effect of large parks only extends a few hundred metres from their edge: therefore, cities need both parks and 'distributed' trees.

Our great hope is that this compendium brings greater recognition to urban forest and green space. They give so many benefits that we had to say: 'Let's stop listing them, it's getting repetitive'. We also hope that this book makes urban forestry seem more doable. While studying urban forestry is important (see Learning Resources), so is learning by doing. So, be an urban forest pioneer. Try out some of Africa's thousands of trees. Forge alliances with communities, city officials, nursery operators, foresters, and botanists. Remember it is more important to defend existing trees than to plant. You can do both.

Cathy Watson

Editor, Senior advisor CIFOR-ICRAF, urban forestry practitioner, Senior Ashoka Fellow

‘Urban forestry is the art, science and technology of managing all individual trees, tree stands, and forest in and around urban areas.’

– PROFESSOR CECIL KONIJNENDIJK, NATURE BASED SOLUTIONS INSTITUTE

URBAN FORESTS IN

SOUTHERN AFRICA

CHAPTER 1

SOUTH AFRICA

BACKGROUND

As South African ecologists and historians tell it, Johannesburg was for millennia inhabited by Bantu people who farmed crops and raised livestock in grassland with scant trees, an ecosystem called the Highveld. However, the 1830s saw the arrival of Boer farmers, descendants of Dutch, German and French Huguenot settlers who had begun establishing themselves in the Cape of Good Hope in 1652; they brought European trees such as walnuts and oaks. Then, altering the ecosystem further, from 1886 onwards, millions of trees of *Eucalyptus* species were planted to provide mine props and fuel as Johannesburg exploded into a mining mega-city with the discovery along a 35-mile geological escarpment (the Witwatersrand) of the world's largest gold deposit.

Immigrants all over the world try to plant the trees of home, but today botanists and ecologists in South Africa agree that there were few indigenous tree species that the intruders could have resorted to in Johannesburg to meet their requirements. South Africa has remarkably little closed-canopy forest – it makes up just 0.25% to 0.59% of the county's surface area (Grundy and Wynberg, 2001) – while short-stature savanna woodlands make up between 35% and 40% (Shackleton and Mander, 2000). It would not have seemed obvious for them to look in those biomes for avenue or plantation tree species, especially in the middle of a gold rush.

With tremendous need for trees, the end result in Johannesburg was a heavily treed city with up to 10 million trees consisting almost entirely of exotic species and concentrated in the areas where people of European descent lived. There were very few trees, either exotic or indigenous, in areas formally categorised as African by apartheid laws in 1948. Every urban forest endeavour today in Johannesburg is dealing with this legacy.

By the early 2010s, it was becoming clear that the trees in Johannesburg were in crisis: ageing, sickened and declining. Then in 2017 the first polyphagous shot-hole borer (PSHB) infestation by the *Euwallacea fornicatus* beetle was reported. Tree diversity was known to be low, but no one had studied exactly what the tree makeup was that was making Johannesburg so vulnerable, and it was not until 2024 that tree diversity began to be measured.

Since then much has happened to start building a more resilient and inclusive urban forest in South Africa. Read the five case studies and three interviews in this chapter to find out more.

CASE STUDY #1

The consequences of an almost monocultural urban forest and the need for indigenous trees in Johannesburg

Johannesburg City Parks and Zoo (JCPZ) arboricultural advisor Adelaide Chokoe

In 2024 at JCPZ, given the challenges of the city's forest, Adelaide Chokoe and others decided that they needed a census and examination of trees in Johannesburg. She assembled and led a team comprised of herself, a trained horticulturalist with nine years' experience at JCPZ, a botanist, a GIS specialist, and a botanical assistant to examine issues of tree diversity and the PSHB scourge and to work out what to do.

Data was collected along streets and in parks in Johannesburg's 'old suburbs', including Dunkeld, Forest Town and Emmarentia in Region B; Rosebank, Houghton and Melrose in Region E; and Inner City, Braamfontein and Kensington in Region F. Data was captured on GIS and analysed using Excel. The team counted and assessed a total of 5,739 trees. The results showed an astounding lack of tree diversity in Johannesburg's old suburbs, with just four genera prominent:

- 52.4% were plane trees (genus *Platanus)* from Europe or Western Asia;
- 30.2% were *Jacaranda mimosifolia*, originally from Brazil, the most ornamental and commonly planted species of the *Jacaranda* genus;
- 8.7% were oak species (genus *Quercus)*, likely from Europe;
- 4.6% were maples (genus *Acer)*, some of which, such as North American box elder *(Acer negundo)* and Chinese maple *(Acer buergerianum)*, are invasive in South Africa.

Johannesburg's tree planting has pivoted to diverse indigenous species. Supported by the city, the Jukskei Park project in Alexandra township in Region E focuses on reintroducing indigenous vegetation, removing invasive plants, creating green space, recycling, and keeping the river clean. Visible in this photo are newly planted *Celtis africana* and *Combretum erythrophyllum*. Photo: C Watson.

The results also showed that most of the trees in the 'old suburbs' are hosts to the polyphagous shot-hole borer (PSHB) or *Euwallacea fornicatus* that carries the fungus *Fusarium* that damages the trees' vessels and causes death and wilt.

Monoculture can create an environmental desert. It also puts pressure on city resources. Deforestation is imminent as the trees die. As a result of the lack of tree diversity, which has favoured the spread of PSHB-FD and other diseases, Johannesburg faces loss of tree cover and the costs associated with removal of dead trees, tree planting and tree maintenance.

JCPZ, however, are taking steps in the right direction to managing the city's urban forest by planting diverse trees from South Africa's rich flora.

'What this case study fundamentally reveals is the complex decisions all cities face about what city trees to plant, and a city making a very major move to greater tree equity.'

– CECIL KONIJNENDIJK, URBAN FORESTER

Lessons learned

- The city is requesting nurseries to diversify their stock to include more indigenous species suitable for planting in the Highveld, such as *Dombeya rotundifolia*, *Searsia pendulina*, *Heteropyxis natalensis*, *Pittosporum viridiflorum*, and *Harpephyllum caffrum*.
- The city now purposefully plants to mitigate climate change impacts, such as flooding and the urban heat island effect: 16,000 indigenous trees are being planted in greater

In 2007, JCPZ established a 60ha cemetery adjacent to Diepsloot, a dense poor township. In the years that followed, it planted the area with trees and shrubs of over 12 indigenous species, such as *Carissa macrocarpa* and *Dombeya rotundifolia* (above) as well as white stinkwood *(Celtis africana)*, red currant *(Searsia chirindensis)*, karee *(Searsia lancea)*, wild peach (*Kiggelaria africana*), and river bushwillow *(Combretum erythrophyllum)*. Photos: C Watson.



Left: Adelaide Chokoe. Centre: Paul Maluke, one of the founders of Alex Water Warriors, the NGO implementing the Jukskei River rehabilitation. Right: Mothers with their children on the clean, grassed river edge shaded by elderly *Populus deltoides* trees; this North American tree, the eastern cottonwood, is no longer favoured in city planting, but these large old trees provide welcome shade and other services to these women, as well as habitat for biodiversity. Photos: C Watson.

Alexandra township as a nature-based solution.

- The city is taking steps to avoid low diversity when planting indigenous trees after it emerged that 91% of the indigenous trees planted in 2006 under the flagship project 'Greening of Soweto' were made up of only four species (two species made up 60%), and seven other indigenous trees contributed just 7%.

'This new tree diversity will become part of Johannesburg's landscape.'

– JOSEPH NDOU, JCPZ REGIONAL MANAGER

Recommendation

- Strive to plant diverse tree species, largely indigenous but some valued exotics as well.

Further reading

https://www.researchgate.net/publication/318234390_Tree_Diversity_Drives_Forest_Stand_Resistance_to_Natural_Disturbances

For queries on this case study, email:
achokoe@Jhbcityparks.com

CASE STUDY #2

Assessing approaches to tracking the spread of the polyphagous shot-hole borer in the urban forest: a Johannesburg case study

Marko F. Mudede, Solomon W. Newete, Khaled Abutaleb, Marcus J. Byrne – School of Animal, Plant and Environmental Sciences, University of the Witwatersrand; Agricultural Research Council – Natural Resources and Engineering (ARC-NRE), Geo-Informatics Division; National Authority for Remote Sensing and Space Sciences (NARSS), Cairo, Egypt; Centre for Invasion Biology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand

Urban trees in the City of Johannesburg (CoJ) are to be found along streets, around institutions, and in parks, cemeteries and derelict lots. They are unevenly distributed with more trees in the northern than the southern parts of the city. They are also largely exotic and were planted during the colonial era for aesthetic and beautification purposes as well as for use in building, mining and land reclamation.

Dominant exotic trees in the city include *Jacaranda mimosifolia*, *Platanus* x *hispanica* (commonly known as *Platanus* x *acerifolia* or the London plane tree), *Eucalyptus* species, *Quercus robur*, *Q. suber*, *Q. palustris*, *Liquidambar styraciflua*, *Acer negundo*, *A. buergerianum*, and *Pinus* species. Indigenous trees include *Celtis africana* and *Vachellia* and *Combretum* species.

The *Platanus* x *acerifolia*, one of Johannesburg's iconic street trees, is predominantly found in the suburbs of Saxonwold, Forest Town, Rosebank, Greenside, Parktown suburbs and Houghton Estate. *Quercus robur* is found most commonly in Kensington and Jeppestown suburbs, and *Jacaranda mimosifolia* in the northern suburbs.

Platanus x *acerifolia*, *Quercus robur*, *Acer negundo* and *A. buergerianum* are among the street trees particularly attacked by the invasive insect pest called polyphagous shot-hole borer (PSHB) or *Euwallacea fornicatus* which carries the fungus *Fusarium*. The disease associated with this pest is called *Fusarium* Dieback (FD). The PSHB originates from Southeast Asia and accidentally arrived in South Africa. It attacks both native and exotic trees in the city.

First reported in South Africa in 2017, the exact date of PSHB's initial arrival in the CoJ remains uncertain, and the extent of the spread and distribution of PSHB has not yet been quantified.

Seeking to throw light on this, the team classified trees infested by PSHB in the CoJ, identifying other potential host species, and determining when the pest was first present in the city. Additionally, they explored how citizen science-derived data and Google Street View (GSV) can be applied to mapping and monitoring the spread of PSHB-FD infestation.

In the Houghton Estate residential suburb, a group of citizen scientists (volunteers) collected data to map PSHB infestation on trees. For each tree, they recorded the species, GPS coordinates, street name, infestation levels across three parts of the tree (trunk, branches, and canopy), the number of PSHB entrance holes, and visible signs of infestation (frass and oozing). To ensure data reliability, a validation exercise was conducted by a University of the Witwatersrand researcher (Marko F. Mudede), who compared the citizen scientist records with researcher-collected data. Of the 785

trees surveyed, 157 trees (20%) were randomly selected for validation.

A similar validation approach was applied using GSV data. In 2022, the researcher surveyed 1,137 trees across the CoJ, recording their geolocations during fieldwork. These trees were then located on GSV to check whether images were available for any year between 2010 and 2022. Where images existed, signs of PSHB infestation were assessed by examining the trunk for entrance holes or staining across all available years. (Staining refers to the brown sap or discoloration left around the holes on tree trunks after attack by the PSHB.) These holes, approximately 2mm in diameter, are created as the PSHB drills into the tree trunks or branches. Dieback is the progressive death of branches, beginning at the tips and moving downward, caused by PSHB infestation. It is most commonly observed in *Quercus robur*, *Acer negundo*, and *Platanus* trees. To examine each tree for signs of PSHB infestation, available images were inspected by clicking on each image and selecting 'see more dates', which displayed all historical images from 2010 to 2022. Each image was visually assessed, using zoom where necessary, for signs of staining, dieback, and entrance holes. Trees showing no evidence of these symptoms were recorded as non-infested. Similarly, if an image was unclear, the tree was also classified as non-infested. For validation, only 2022 GSV images were directly compared with the 2022 field survey data. GSV can also be used to quantify and map the abundance and density of street trees and other vegetation.

'Currently the most feasible management options are to remove all dead or heavily PSHB infested trees from within the city and restrict movement of infested wood.'

– DRS M MUDEDE, S NEWETE AND COLLEAGUES

The findings indicate that:

- all seven regions of the CoJ are infested with PSHB, which has significant implications for its management and efforts to limit its further spread within the city and neighbouring areas;
- the PSHB has been present in CoJ since at least 2017 as evidenced by the GSV survey;

Monitoring a PSHB infestation for five years in Johannesburg's urban forest using Google Street View. The red circle shows PSHB infestation signs (brown stains) on a *Platanus racemosa*. Photo: S Newete.

- it took approximately five years to spread to nearby regions of the city;
- *Platanus* spp., *Acer* spp. and *Quercus* spp. (plane, maple and oak, respectively) are particularly heavily infested and require urgent management intervention to prevent any further loss.

Lessons learned

- Johannesburg's urban forest is profoundly threatened by PSHB.
- Detection by way of Google Street View, field survey and citizen science is effective.
- Controlling and reducing further spread of PSHB infestation is challenging.
- Currently the most feasible management options are to remove all dead and heavily PSHB infested trees from within the city and restrict movement of infested wood.

Recommendations

- Diversify city trees by planting more native trees, particularly resistant indigenous species, in areas where trees have died, with particular attention to areas that lack trees, such as Soweto and Alexandra townships.
- JCPZ plans to plant 200,000 trees in the next three years to provide greater access to green spaces and improve the health of city residents: managing PSHB-FD must be taken into account.

Further reading

- A citizen science method to monitor a polyphagous shot-hole borer infestation in Johannesburg's urban forest. **https://doi.org/10.1016/j.ufug.2024.128368**
- Monitoring a polyphagous shot-hole borer infestation in an urban forest using Google Street View in the City of Johannesburg, South Africa. **https://doi.org/10.1007/s10530-025-03595-4**

For queries on this case study, email:
mfmudede@gmail.com
newetes@arc.agric.za

Top: View of a monoculture of plane trees in Johannesburg. Above: English oak experiencing dieback caused by infestation by the beetle PSHB with its associated fungus *Fusarium*. Photos: S Newete.

CASE STUDY #3

'Where social capital is high, the volunteer model can work': management of invasive alien plants (IAPs) in Kloofendal Nature Reserve, Johannesburg

Dr Takalani Nelufule, senior lecturer in Nature Conservation at the University of South Africa, and Karin Spottiswoode, founding member, Friends of Kloofendal

Kloofendal Nature Reserve (KNR), managed by JCPZ, is a cultural heritage and ecotourism facility about 8km from Soweto and 25km from Johannesburg's CBD. The site of the first gold mine in Johannesburg and one of the city's first nature reserves, its 128 hectares offer respite, environmental education, and an opportunity to exercise on trails.

Situated in the transition zone between the Bankenveld, Drakensberg and Savanna ecosystems, the reserve has high conservation value and is home to mammals such as duiker, mountain reedbuck, mongoose and mole rats. Open daily, it is fully fenced, has round-the-clock security, and offers talks and guided walks, mainly organised by Friends of Kloofendal (FroK), a non-profit founded in 2002.

In 2020, FroK members recognised the risk posed by IAPs and created a 'weeding team'. Drawing on its learnings, FroK leader Karin Spottiswoode published *Invasive Alien and Problem Plants on the Witwatersrand and Magaliesberg* as an aid to teaching JCPZ staff, workers and volunteers how to identify and remove IAPs.

In 2024, Dr Takalani Nelufule surveyed the distribution and abundance of IAPs in 10 of JCPZ's 25 protected areas: Alberts

Hands-on education and training for Extended Public Workers Programme workers identifying IAPs and learning how to use the different tools to manually remove IAPs in the Kloofendal Nature Reserve. Photo: S Spottiswoode.

Farm Conservancy, Beaulieu Bird Sanctuary, Fourways Garden Nature Reserve, Kloofendal Nature Reserve, Linksfield Ridge Nature Reserve, Little Falls Ridge Nature Reserve, Lonehill Koppies Nature Reserve, Rietfontein Ridge Nature Reserve, Ruimsig Butterfly Nature Reserve, and The Wilds Nature Reserve.

All 10 were heavily infested: 356,775 individual IAPs of 175 species were found, of which 169 originated from outside South Africa. Five other species, identified as expansive, were native species from other South African regions that have become a problem outside their original geographies.

The number of IAP species recorded as present varied across the 10 reserves. Alberts Farm Conservancy and Beaulieu Bird Sanctuary had the highest number, with 72 and 69 respectively. Lonehill Koppies Nature Reserve was recorded to have just 12. Alberts Farm Conservancy also had the highest density of IAPs, with 3,369 individuals per hectare. Possibly because of the efforts of FroK, KNR recorded the lowest density at 320 individuals per hectare: 23 of the IAP species were trees, followed by herbs (14), shrubs (13), succulents (4), grasses (3), climbers (3) and one alien fern.

IAPs occur across KNR but grow most commonly in copses of indigenous bushes and trees, which give protection when the IAPs are young and are often replaced by the IAPs when the invasives become big. They also grow along neighbouring fences.

The most dominant and widespread of the IAP species in KNR were the Australian black wattle *Acacia mearnsii* and, from Central and South America, two species of the potato/eggplant/tomato genus – *Solanum pseudocapsicum* and *S. mauritianum*; the yellow flowering *Cestrum parqui*; *Lantana camara*; and *Salvia tiliifolia*, which in the reserve forms dense stands under tree canopies and grows on rocky hillsides among other areas. Without control, such species can outcompete native species, disrupting ecosystem functioning.

Total eradication of IAPs is extremely rare

Environmental education for school groups in the Kloofendal Nature Reserve led by FGASA qualified guides managed by FroK. Photo: S Spottiswoode.

but it is possible to reduce their density to an extent that they become manageable. From 2020 to 2024, FroK volunteers, together with Expanded Public Works Programme workers allocated by JCPZ, removed 14,722 individual plants of *Solanum mauritianum* in KNR. The latest surveys in 2025 recorded just 2,466 individuals of the invasive.

All told, between 2020 and 2025 in KNR, an estimated 140,765 individual IAPs were removed by FroK volunteers as well as teams from schools, Scouts, Voortrekkers, and businesses. This work continues to this day, and volunteers acknowledge that, besides helping preserve indigenous flora, it contributes to their physical and psychological wellbeing.

Since many species grow in the same disturbed patch of land, it is more efficient to work on all of them that are there, rather than focusing on one species at a time.

Removal methods include pulling out younger trees and shrubs with tree poppers, ring barking, cutting, and poisoning. The 'starvation method' is also used, particularly to combat bush encroachment. It involves cutting trees down and repeatedly removing their leaves and young branches of any regrowth from the cut stump so that they cannot photosynthesise. Follow-up is essential to control new young plants from coming up from seeds, underground stems, and remaining

roots, but eventually the IAPs will die.

Woody plants shorter than 3.5m with a stem diameter of 10cm or less are controlled manually, mostly using tree poppers. Handsaws and secateurs are used to cut away obstructing branches to free up access to work on plants. Young trees are either ring barked or stripped of bark from knee height down to the roots using a panga or machete.

Alternatively, the tree is sawn low down and an arboricide chemical (water-soluble Kaput gel) applied with a paintbrush onto the freshly cut stump. The application and safety instructions in the herbicide producer's manual are followed closely, as are safety measures as stipulated by DFFE: **https://invasives.org.za/wp-content/uploads/2022/06/Herbicides-for-Invasive-Alien-Plant-Control.pdf**

Each plant removed is recorded using the GPS Essentials app on an Android phone. Data captured includes species name, coordinates, date, time, number of individuals removed, and notes such as size of plant. Volunteers or community members are encouraged to wear welding gloves (i.e., elbow-high, thick leather gloves, usually blue) when working on species with thorns, such as *Lantana camara*, *Solanum sisymbriifolium*, *Rubus cuneifolius*, as well as species with allergenic properties such as *Solanum mauritianum* and *Araujia sericifera*. When using herbicides, they are also encouraged to wear masks and protective glasses, not to touch or rub their eyes or nose, and to wash their hands after working with herbicides and indeed on any IAP, as some are toxic. A first-aid kit is always carried to the field.

Dr Takalani Nelufule stands in front of dense and profusely growing *Solanum mauritianum*, one of the most common invasive alien plants in the reserve. Photo: Image Moloto.

IAPs pulled out are left on site to decompose, except for *Opuntia* and *Cereus* species, which self-propagate and spread. Where possible, fruits and seeds are put in black plastic refuse bags and sealed before being taken to a garbage disposal site where they are left to rot. Dry seeds are not burnt since rising hot air disperses light seeds into the air.

Lessons learned

- Nature reserves are severely threatened by invasive aliens.
- Focus on invasive species as an integral part of urban forestry.

Recommendations

- Where possible, form a 'friends group' to help tackle the crisis. Aim for a mixed paid worker/volunteer model and build dedicated municipal teams, trained in identifying and removing IAPs and recording work done. Well-trained teams will save cities money and reduce work having to be repeated.
- Conduct public education campaigns on the extreme danger posed by IAPs.
- Encourage planting of native species.
- Permit zero introduction of new alien species into urban forests.
- Measure work done to show reduction of IAPs where this has occurred. Independent assessment may be needed.

Further reading

- Spottiswoode K. L. (2024). *Invasive Alien and Problem Plants on The Witwatersrand and Magaliesberg*. Field Guide.
- **https://invasives.org.za/wp-content/uploads/2025/02/AlP3Feb25_KarinSpottiswoode.pdf**

For queries on this case study, email:
takalani.nelu@gmail.com

CASE STUDY #4

'It is better to plant fewer trees and keep them alive than to aim for a large number': Lessons from the Greening Soweto project

Elize van Staden, Senior Lecturer, University of South Africa (UNISA)

Worldwide, large-scale tree-planting projects are implemented to increase the urban forest, and often cite very large numbers. The National Tree Growing Restoration Campaign in Kenya aims to plant 15 billion trees by 2030. In 2021, Ghana had a project to 'Plant 5 million trees in a single day'. Rarely, however, are the survival rates of trees reported.

For her PhD, Elize van Staden investigated the trees planted during the Greening Soweto project in the City of Johannesburg, launched by the then mayor Amos Masondo in 2006 with a target to plant 200,000 trees just before the start of the FIFA 2010 World Cup held that year in South Africa. Soweto was established to house Johannesburg's black workforce and became internationally known following its 1976 student uprising. It is South Africa's largest township, which is best defined as a suburb formerly officially designated for black occupation by apartheid legislation.

The aim of the project was to transform Soweto's dusty streets, barren wastelands and landfill sites to provide ecosystem services and eliminate the 'green divide', the difference in tree cover between the city's wealthy north and poorer southwest. Aiming also to ensure that the benefits of the 2010 FIFA World Cup extended beyond the event, the greening initiative became a legacy project for Mayor Masondo. The target of 200,000 trees planted was reached just before the World Cup started, and Johannesburg City Parks and Zoo (JCPZ) won a Gold Liveable Communities Award for the project at the UN-endorsed Liveable Communities (LivCom) Awards in Chicago.

Van Staden's research methods included using the tree register of the project provided by the city; Google Street View; field studies or ground truthing to verify and evaluate the existing trees individually; and determining the standing carbon stock value of the trees and extrapolating carbon values to 30 years of growth. Findings were rich with implications for large-scale tree planting.

Left: A *Eucalyptus* provides a modicum of green in Kliptown, the oldest residential district in Soweto. Right: A government-supplied house in 2007. Housing programmes can consider incorporating trees. Photo: J Ross.

As elsewhere, in Soweto, where trees are present, they offer huge services. Above left: Children enjoy a leafy playground. Above: A hairdresser takes care of a client under a tree. Left: A group of homeless people from Zimbabwe inhabit a small encampment in a green treed space. Photos: G Khan.

'Every tree planted in a township that was historically denied green space is an act of spatial justice.' – THANDUZOLO NENDREW, MANAGING DIRECTOR, JOHANNESBURG CITY PARKS AND ZOO

As it became clear that Soweto had insufficient available and appropriate space for 200,000 trees, trees were planted in all seven regions of the city. Furthermore, rather than the planned 200,000 trees, 206,000 were planted, of which 68% were planted in townships.

Only indigenous tree species were used, with 13 different species identified across the city. However, 91% of the trees was made up of only four species, and two species made up 60%, which is concerning as it does not create a species-diverse urban forest.

The tree register lacked detail: e.g., tree species were not provided, only numbers of trees; planting locations included only street names; incomplete locations such as 'various parks and various government institutions' were sometimes provided; and trees were given to schools and individual community members. As a result, 41% of the trees were unaccounted for.

The Google Street View process and the subsequent site visits indicated that 15% of the planted trees were 'missing', meaning that they were either not planted in the first place, were dead, broken or only presenting as coppice growth, or were just not where the tree register indicated them to be. This meant that 56% (41+15%) of the trees could not be verified as existing.

Most missing trees were those that had been planted on vacant land, informal residential land, in parks with high levels of human activity, or on unmaintained grass or bare soil. The best locations for the trees planted in terms of survival were in maintained parks, road medians in formal residential areas, and the edges of streets. Tree species that had the best survival rate and therefore were perhaps best adapted to the urban environment were *Celtis*

africana, Combretum erythrophyllum, Searsia lancea and *Olea europaea* subsp. *africana*.

In 2017, carbon stocks of the trees planted were estimated at 30,390 tCO_2 of standing carbon stocks and valued at R3,646,812 or US$303,901 (assuming a CO_2 price of US$10). By extrapolating this value and assuming that all the planted trees were alive in 2031, the project could have potentially contributed 387,170 tCO_2 of sequestered carbon stocks valued at R46,460,511 or US$3,871,709 as mitigation action against climate change. Unfortunately, the extrapolated sequestered carbon stocks for the 44% known surviving trees resulted in an estimated 142,403 tCO_2, equating to a potential loss of 36% in the carbon value of the project in the long term.

Growth and survival of trees was positively correlated with visible proof of tree maintenance: visibly maintained trees showed better growth and quality. Lack of overall tree maintenance was common, however, including the absence of structural pruning to create or improve the shape of the tree; pruning to remove coppice growth or dead and damaged branches; removal of constrictions (wires and ties) around tree stems; straightening of skew-growing trees; and repair of damage caused by bark harvesting. Evidence of mulching and fertiliser applications was also not visible. The municipality indicated that, where possible, newly planted trees are watered once a month for the first six months.

Vandalism also contributed to the large number of dead, severely damaged, and missing trees. Very little evidence of community ownership of the project was found.

Lessons learned

- Capture tree species, date planted, and GPS coordinates or a detailed location of each tree planted and maintain a detailed register. Keep records of trees donated to schools or communities.
- Plant large trees safe distances from infrastructure or in parks; species with thorns, such as *Vachellia* sp., should not be planted on road verges.
- Follow best practices, e.g., choose a good quality tree, excavate an adequate hole, compost and fertilise, and stake trees correctly.
- Plant larger trees to help deter vandalism.
- Learn from the past and from research. Lessons from Greening Soweto positively impacted later drives such as the Greening, Cleaning and Planting of Trees project launched in 2021 to plant 10 million trees over five years. Progress was slow at first. But eventually the Department of Forestry, Fisheries and the Environment shared a plan; created a project website; set up a stakeholder forum; made trees available to entities that could not afford to buy them; and opted for a more realistic approach, which included planting smaller numbers of trees.

Recommendations

- Rather than plant a large number of trees, plant fewer and use resources saved to maintain the planted trees to attain higher survival and an improved value contribution.
- Community engagement should educate communities on tree planting, be conducted regularly, and inspire stewardship.

Further reading

Van Staden, E. M., and Stoffberg, G. H. (2021). 'The Greening Soweto tree-planting project in South Africa – Eliminating the "green divide" legacy of apartheid'. *ScienceDirect*, *Urban Forestry & Urban Greening*. 65 – 127371.

For queries on this case study, email:
vstadem@unisa.ac.za





The profound joy and comfort that humans derive from the presence of trees are apparent in these photos taken in Soweto in March 2026. Clockwise: Two men enjoy sitting along a tree-lined street; a man exercises next to a park; unhoused people enjoy a modicum of peace in a glade; a young boy summersaults off a slab of rock next to a friend in a children's park; and a neat shop under a tree. Photos: G Khan.

INTERVIEW WITH BISHOP NGOBELI

Senior Manager, Protected Areas and Environmental Enforcement, JCPZ

‘HOMELESSNESS IS A PROBLEM IN OUR GREEN SPACES’

‘My focus is biodiversity and indigenous trees. We give communities *Celtis africana*, African olive species *(Olea* spp.), and the very hardy *Combretum* species. Not many people are able to propagate them. So, we work with the Walter Sisulu Botanical Garden and the South African Biodiversity Institute.

‘We also have a huge drive to have people plant fruit trees inside their plots or homesteads. When I was a herd boy, I ate from iconic African fruit species like *Searsia chirindensis* (Umhlabamvubu in Zulu, Umhlakothi in Xhosa) and *Sclerocarya birrea* (marula). Marula is also a good street tree and can bring income.

‘In Johannesburg, we have 1,993 public open spaces that are maintained at least monthly. Many of these are impacted by people living in them, which makes other people feel unsafe to go there.

‘I did a survey of 132 homeless people – 14 women, the rest men; 87 were South African, 17 from Zimbabwe, 16 from Lesotho, eight

from Mozambique and four from Malawi. You wouldn't believe that some of them are homeless. They live in very organised groups. Some are gardeners and workers who need to live close to their jobs. Those from Lesotho are recyclers.

'We have to enforce the law and get them to go to shelters. But some homeless people take drugs, and you can't go if you are high. You can imagine my pain. I am a nature conservationist. I had to go and buy them tents, mattresses, sleeping bags.'

Opposite: A makeshift dwelling in a public nature area. Top: A homeless encampment in Joubert Park, Hillbrow, Johannesburg. Above: A researcher interviews homeless men in a Johannesburg city park. Photos: G Khan.

INTERVIEW WITH VUYOLWETHU YANI

Rare plant expert, JCPZ

'WE MAINLY DO RESCUES'

Contending with theft of wild growing plants

Vuyolwethu Yani is a Johannesburg city botanical expert. Her words prompt reflection on whether other cities employ a botanist, let alone a rescue specialist.

'My role is to lead plant rescues in nature reserves across the city. One plant we rescued was *Cineraria longipes*, a critically endangered herb that was down to just three individuals. One of its very few natural habitats is the Soweto Highveld Grassland.

'Generally, we help with the problem of illegally harvested plants, which are mostly the medicinal plants and also orchids.

'The botanical garden used to be mostly exotic species. But today, any tree that dies is replaced by an indigenous one. Two indigenous trees we have brought in are *Erythrina lysistemon* and *E. zeyheri*. The second is an endemic. It is found only in South Africa.'

> 'The botanical garden used to be mostly exotic species. But today, any tree that dies is replaced by an indigenous one.'
>
> – VUYOLWETHU YANI, JCPZ RARE PLANT EXPERT

INTERVIEW WITH SINAH MAGOLO

Environment Education Manager, JCPZ

‘WE DON’T WANT OWLS HERE’

Managing community pushback to trees

Magolo, 47, was intimately involved with the Greening of Soweto project. This interview reveals the barriers to tree planting even if people want trees.

‘Day to day, I was responsible for education and awareness and community participation. I was training community-based educators and volunteers, ensuring that they support the project and encouraging them to take care of newly planted trees in their homes and those planted outside on their streets.

‘At the beginning, many local communities were unreceptive. They cited issues like if the trees are not well maintained, they will attract criminal elements and other social ills, and escalate crime. Some were not in favour of any tree. They said leaves block their drains. They did not like the idea of sweeping and preferred bare ground with no trees.

‘Also, JCPZ was offering indigenous trees, and some community members had their superstitions about them. So we had to manage those beliefs and demystify them.

‘We developed a programme that covered what indigenous trees are and why it is important to plant different species. The benefits of each indigenous species being planted were conveyed. Every species has its benefits.

‘We went over the danger of using trees as shelter during thunder and lightning. We suggested that communities invest in lightning conductors. Those answers satisfied them.

‘But then community members started saying that the trees were bringing owls, and they didn’t want owls. And indeed, any owl they see, they kill it, because of fear of witchcraft. Fear of owls is deep-seated in our culture. So we came up with a talk explaining that owls go out in the dark because of their eyesight, and no other reason. Now youth-based organisations are working with us on this. The Kliptown Youth Programme is teaching children the value of owls. Soweto experiences rodent issues, for which owls can provide the solutions. A family of barn owls can control up to 2,500 rats a year.

‘We also had traditional healers (sangomas) ringbarking the trees and sometimes taking all the bark, from the roots to the branches, killing the trees and threatening our tree canopy. Trees particularly harvested for medicine include *Searsia lancea*, *Vachellia xanthophloea* and *Combretum erythrophyllum*. To reduce the high vandalism, we stopped planting them and replaced them with species not targeted for medicine.

‘For medicinal trees, we now have programmes to educate communities on harvesting methods that sustain, restore, protect and conserve our trees. We have started working with sangomas and their associations, and they are becoming supportive. We are looking at how to educate their membership, and how to identify areas to plant the trees that they need. For both sides, this is still a very new initiative that will involve trial and error with lots of learning in the process of exploring solutions. The situation has improved. But overharvesting remains a challenge. And that goes for shrubs and flowers too. There is a bulbous flowering plant, *Boophone disticha*, which, even if you plant a lot of them, all will totally disappear.

‘I am most happy to see members of the community, especially the youth, taking a lead in the greening of the city, where every household will have trees inside and outside their home, especially in newly developed and previously underserved areas. As JCPZ, we cannot do it alone. We need all hands on deck.’

Top row: Outreach to reassure the public that owls are useful rat catchers, not bad omens. Photos: JCPZ. Centre: Sangoma initiates being welcomed, and Inyanga preparing drying of fresh traditional medicine (*muti*). Photos: Wikimedia Commons. Above left: A tree debarked for medicine. Photo: JCPZ. Above right: Magola with one of the traditional healers her team works with on sustainable harvesting of tree parts. Photo: JCPZ.

CASE STUDY #5

Durban's award-winning Buffelsdraai Community Reforestation Project: paying 'treepreneurs' for seedlings, greening a landfill

Thembelihle Mlokoti, Project Manager, and Errol Douwes, Senior Manager, Biodiversity Management Department, eThekwini Municipality

The local government for the city of Durban and surrounding areas in KwaZulu-Natal, eThekwini Metropolitan Municipality, faces increasingly extreme climate change-induced events. Aware of the devastation caused, particularly to marginalised communities in peri-urban areas, in 2008 the municipality decided to improve management of mangrove, swamp, dune, coastal, and scarp forests, wetlands, dams, and estuaries, and, in one peri-urban area, it launched the Buffelsdraai Community Reforestation Project.

Sibongile Simmane, a treepreneur from Osindisweni community, with a seedling she propagated in her home. Photo: E Douwes.

The aim was to ecologically restore the 821ha buffer zone around Durban's largest landfill, which covers 116.2ha and is located about 25km north of Durban's CBD. The thinking was, if strengthened and well maintained, such natural open spaces could buffer the city from hazards and deliver services such as cleaner water, flood attenuation, sediment control, and moderated stream flows.

Under the Buffelsdraai Biodiversity Management Department, the main intervention of the Buffelsdraai Community Reforestation Project has been to increase tree cover. This case study considers the project's achievements and challenges from 2008–2025.

Phase 1 began in 2008 with a goal of offsetting 42,000 tCO_2 equivalent in partnership with eThekwini Municipality's Cleansing and Solid Waste department, the custodian of the landfill. The municipality also appointed WildTrust (Wildlands Conservation Trust), a South African non-profit, non-government and public welfare organisation, to coordinate with local communities and capacitate community members to start growing trees.

By increasing its tree cover and vegetation, the 821ha buffer zone was expected to better shield nearby communities from landfill odours and airborne toxins. Additionally, the trees were expected to reduce atmospheric greenhouse gases by sequestering carbon.

External stakeholders such as political and traditional leaders, universities, and communities were brought in to brainstorm the best way to implement the project. Once a clear path forward was agreed, funding was secured. The bulk came from the municipality, but co-funding was sourced from the Danish International Development Agency (DANIDA), and from South Africa's National Green Fund.

From 2008 to 2015, the community was paid to plant indigenous trees *Brachylaena discolor, Bridelia micrantha, Clerodendrum glabrum, Dalbergia obovata, Dombeya tiliacea, Erythrina lysistemon, Ficus natalensis, F. sur, Millettia grandis, Protorhus longifolia, Sapium integerrimum, Syzygium cordatum, Trichilia dregeana, T. emetica,* and *Vachellia robusta*.

Species suited to drier or moister conditions

Top and above: Before and after photos of the reforested Buffelsdraai Landfill Site buffer zone. Photos: E Douwes.

Mzwandile Dladla, a treepreneur from Buffelsdraai community, with groceries he traded with credit notes. Photos: E Douwes.

were allocated to matching habitats, and the trees were planted in an irregular pattern to achieve near natural spacing. Planting densities were ~1,000 trees/ha in most areas, increasing to ~2,000 trees/ha in riparian zones. In total, ~659,018 trees were planted during this seven-year period. Growth and survival were monitored continuously and found to be exceptionally good at ~98%. Dead seedlings were replaced from the stock of trees kept in the onsite tree storage facility.

Buffelsdraai and Osindisweni – the two adjacent communities – were receptive to growing trees. WildTrust employed 'facilitators' to meet with community members and explain its tried-and-tested 'Indigenous Trees for Life' approach. The aim was to encourage community members to register as 'treepreneurs', who would collect seeds and grow the trees at their homesteads. Approximately 500 people, 60% men and 40% women, received training on how to collect seed and raise the seedlings in used 2-litre plastic bottles. Seedlings had to be cared for until they attained 30cm in height.

The main benefit for treepreneurs was that they could trade their trees to the project for credit notes, which in turn could be exchanged for food or used to pay for other costs such as school fees. WildTrust's facilitators managed the exchange and collected the seedlings.

South Africa's poverty level is set at R1,109 (US$63)/person/month or R13,308 (US$760)/year. Data from 2015 shows that 59% of households in Buffelsdraai had incomes below this threshold, and 40% of its 15–65-year-olds were either unemployed or not economically active. The figures for Osindisweni were 47% and 48% respectively. The inhabitants of both areas are mostly migrants from rural areas: over 90% were of African ethnicity.

Phase 2 (2016–25) saw a change in focus. The previous target had been to offset carbon with some biodiversity and social benefits. The new target was to increase the diversity of tree species with the goal of establishing coastal scarp forest, within a grassland-forest mosaic that is typical of KwaZulu-Natal's Coastal Belt. Species selection was based on the reference vegetation of the natural scarp forest near the landfill.

Earnings varied with the number of trees that people traded, but the treepreneur model was a success. One treepreneur, Bongiwe Hlatshwayo, earned R80,000 (US$4,555) over six years and was recognised as a 'super grower'. The value paid per tree increased from R5 per tree in the early stages to R12 per tree more recently.

The municipality has also helped treepreneurs register their businesses through its Business Unit and sell outside the project, and community members earn income through casual site-related tasks such as digging holes and planting. Unskilled workers are paid according to South Africa's national guidelines, in 2025 earning an average of R5,673.70/month, about US$315. An estimated R50,000,000

(US$2,833,030) has directly benefited community members.

The project has been directly responsible for:

- planting ~1,059,455 indigenous trees and other plants on 560ha of old sugarcane lands;
- bringing back healthy ecosystems which now generate many services;
- creating more than 500 jobs in the adjacent low-income peri-urban communities of Buffelsdraai and Osindisweni;
- restoring vegetation diversity by planting a mix of 141 locally indigenous species of trees, shrubs, herbs, and understorey species;
- sequestering ~150,000 tons of Co_2 equivalent as an emissions offset for the 2010 FIFA World Cup matches played in Durban;
- increasing biodiversity and achieving a growing and regularly monitored diversity of mammals, reptiles, amphibians, invertebrates, and birds. Bird species have increased from 80 species in 2008 to 204 in 2025.

The buffer zone is now home to two Near Threatened Red Data species, the Woolly-necked Stork and Lanner Falcon. And Ezemvelo KZN Wildlife, the KwaZulu-Natal Nature Conservation Board, now deems the forest with its wetland and grassy fringe to be 'most suitable habitat' for the threatened black-headed dwarf chameleon and Pickersgill's reed frog.

The project received a Gold Standard validation for its social, biodiversity and carbon sequestration benefits from the Climate, Community & Biodiversity Alliance in 2015, and was a UN Decade on Ecosystem Restoration founding project in 2020, and a finalist in the International Association of Horticultural Producers World Green City Award in 2024. It hosts the City Nature Challenge and Great Southern BioBlitz where citizens record species – as of March 2025, it had made 6,668 observations of 1,276 species on iNaturalist. Rare sightings include the Martial Eagle and Southern Bald Ibis. The city of Durban is now recognised as a leader in Africa for addressing climate change vulnerability and adaptation amid widespread poverty.

Strengthened ecosystems near the landfill site appear to be providing cleaner air, more stable soils, reduced erosion, improved water retention, flow and quality in the rivers, and protection from frequent flooding. The area is more visually appealing: one researcher found local communities value the forest for its beauty and spiritual and cultural significance.

Lessons learned

- Political and community buy-in, secure funding, a dedicated team, and external partnerships, including with the researchers, are critical to success.
- Even after 17 years, invasive alien plant species are still a major obstacle to forest re-establishment and need unrelenting attention.
- Survival rate of planted trees is a key indicator of success.
- Continuing problems are illegal dumping of waste; livestock grazing, which leads to tree trampling; unregulated hunting, which changes predator-prey dynamics; illegal sand mining; robbery, theft of municipal assets, and housing encroachment.
- Administrative delays hold up project outcomes.

Recommendation

- Municipalities and cities should adopt tree planting around landfills and other large infrastructure sites as a standard operating procedure.
- Creating green jobs and incomes for the urban and peri-urban poor and incentives for community stewardship are vital and should also be standard practice.

Further reading

The Durban Forest (2015). Durban Botanic Gardens Trust, edited by Mark Mattson.

For queries on this case study, email:
Thembelihle.Mlokoti@durban.gov.za
Errol.Douwes@durban.gov.za

CHAPTER 2

ZIMBABWE

BACKGROUND

With only 40 people per square kilometre, only 32.67% of Zimbabweans residing in urban areas (2024), and even some deurbanisation (2002–12), Zimbabwe's urban forest might be expected to be healthy. In fact, it is under colossal pressure.

In Harare, 'developers seize green space, and trees vanish at the hands of rural-to-urban migrants battling to live by selling firewood,' Jeffrey Moyo reported in InDepthNews in 2022.

Still, Zimbabwe has much to work with, including: a strong history of urban planning, which can potentially militate for city trees; and six forest types, among them miombo and mopane, with hundreds of species to draw on such as baobab, marula, and sweet-fruited muzhanje *(Uapaca kirkiana)*.

David Coltart is the Mayor of Bulawayo, Zimbabwe's second largest city. He says: 'Besides planting individual trees, we are also very interested in pocket forests. Even if it is just a corner, when you plant five trees of five different indigenous species – tall, short, spreading – it becomes a small ecosystem,' the city's chief elected official explains.

In Bulawayo Centenary Park, the city recently planted 200 trees of 100 indigenous species.

Dr Blessing Dhliwayo is an urban forestry researcher in Zimbabwe. 'Urban forests

A thriving *Khaya anthotheca* planted in 2023. Photo: Green the Ghetto.

can thrive in our country if governance, infrastructure and community engagement align,' he says.

He stipulates, however, that this requires embedding urban forestry within infracture planning and treating trees as assets that deliver cooling, stormwater regulation and public health benefits.

Furthermore, says the researcher, who is now at Stellenbosch University: 'Community engagement must align with material realities. Engagement must be continuous, practical, and grounded in everyday life.'

About the first case study, Dhliwayo observes that 'the historical linkage is especially important, since colonial planning of African townships shapes present-day patterns of green inequality.'

About the second, he says: 'Bulawayo faces chronic water shortages, so tree preferences should be analysed in relation to the city's water scarcity.'

Read the case studies to learn more.

CASE STUDY #6

Restoring green spaces in low-income high-density suburbs: the Greening Kuwadzana Project in Harare

Tafadzwa Gwini, Green the Ghetto

In Zimbabwe, a high-density suburb, also known as a township, is a residential area characterised by a high population density and lower-income residents.

The low-income high-density suburb of Kuwadzana sits 11km from Harare's CBD.

Even for a country that experienced dispossession since 1890, armed conflict 1966–80, subsequent turmoil, and suspension from the World Bank and IMF since 2000, social amenities are minimal in Kuwadzana. In a 2018 African Development Bank article, 'Water at last for Kuwadzana residents', a mother of seven expresses relief that water pipes have been repaired: 'We would go to the borehole at 3am. It was scary but there was no alternative.'

The apathy many residents exhibit towards trying to reverse inequality, including the tree gap, can be understood in the context of such trauma. Founded on the idea that substance abuse, prostitution, crime, domestic violence and mental illness are partly a result of lack of green space, the Greening Kuwadzana Project started in 2020 to restore and improve green space, which it considers fundamental public health infrastructure.

The project aimed to plant at least 5,000 trees from 2020–25, but as of May 2025, had planted over 6,500 in public and private spaces including main roads, sports facilities, community parks, schools, churches, public offices, business premises, and homes. Duri Green Finger Nursery, a nursery within Kuwadzana, donated 80% of the seedlings: 90% of seedlings planted were of species indigenous to Zimbabwe, the balance were mostly exotic fruit trees to address food insecurity.

The project is inspired by scholars such as Sullivan and Kuo (2001), who established a correlation in inner cities in the USA between

Young women participating in a Green the Ghetto event to highlight the connection between mental health and the urban forest. Photos: Green the Ghetto.

environmental conditions and vulnerability to chronic mental fatigue and impulsive aggression, showing that households in areas with higher tree density reported lower domestic and other violence than households with lower tree cover or lacking nearby green space.

Finding that 63% of 112 men that it interviewed in Kuwadzana admitted to having lost control and physically or verbally assaulted their partner at least once, the project implemented a Trees Against Gender-based Violence programme, and also started Tree Care Therapy for Mental Health, enrolling people identified as at risk to maintain and monitor the trees planted.

Greening Kuwadzana Project's programmes also include Tree-lined Streets and the Indigenous Trees Park, which seek to increase tree density and access to green space to diminish the mental and physical health risks in a context of collapsing access to health care. Just 3% of people in Kuwadzana have a medical plan in case of an illness or accident. This makes green space even more important.

Paradoxically, lack of access to Western medicine has led to tree cutting. In 2024, Greening Kuwadzana Project lost 12 three-year-old *Kigelia africana* (Mubvee) trees, and environmentalists had to force the government to intervene, when a rumour spread that the tree had cancer-curing properties.

Realising that many were risking overdose and death by using traditional medicine without guidance from professional traditional medical practitioners, Greening Kuwadzana Project started a yearly event called Health & Indigenous Therapeutics with the Zimbabwe National Traditional Healers Association (ZINATHA). It aims to educate the community about the proper use and collection of traditional medicine. Traditional healers in Kuwadzana now work together to ensure that the community can harvest medicine from urban forests without destroying them.

Finally, realising that the message about the climate change was not being received and that most vandalism of trees was due to lack of information, the team started to communicate through art. Dance for Climate Action is an annual competition; Beats, Rhymes and Climate Justice uses hip-hop, dancehall and other urban music to bridge the gap between the climate COP and the ghetto; and Street Graffiti for Climate Action spreads the word about environmental justice. These have greatly increased the engagement of Kuwadzana residents in protecting the urban forest.

Left: A barber and friends plant a pride of Bolivia *(Tipuana tipu)* as they build the barber shop three years ago. Right: Today the shop has a shade-casting and attractive urban street tree outside it. Photos: T Gwini.

Since 2020, the project has hosted 75 events, attracting people of all ages from the community; partnered with the City of Harare, Zimbabwe Youth Council, Ministry of Environment, Forestry Commission of Zimbabwe and the Environmental Management Agency, and NGOs such as ActionAid Zimbabwe and Ndinewe Foundation; and been featured countless times in *The Herald* and *H-Metro*, on ZiFM, Classic 263 FM, Zimbabwe Broadcasting Corporation, 3KTV, and international outlets such as DW's Eco Africa.

Lessons learned

- Prolonged dry seasons and limited and unreliable water supply make it difficult to sustain newly planted trees and gardens.
- Big businesses frequently remove trees: in 2022 the project lost over 60 planted under the Tree-lined Streets Programme. In another incident, a large Musawu *(Ziziphus mauritiana)* and three two-year-old *Tipuana tipu* were cut by a company erecting a billboard. Vendors lost their shade, and efforts to bring the company to book were futile.
- Many residents of low-income high-density suburbs accept their fate and, when positive change comes, cannot resonate with it.

'On survival rates, we do not have the financial capacity to do monitoring and evaluation. The last that we did was in October 2023 when survival stood at 70%. A major loss happened during the 2023 elections. We also lost fruit trees in schools and at district council properties due to change of land use. From then, we have planted more trees and, on face value, we have lost less than 10%.'

– TAFADZWA GWINI

Recommendations

- Clearer policies are needed so that construction and illegal settlements are less likely to encroach on green space, and expanding illegal farming due to economic insecurity does not at the same time reduce tree cover and degrade green space, including wetlands and parks.
- Better coordination between government departments is necessary. The City of Harare's parks department can allocate areas for trees, but the roads department can cut them: in 2022–25, Greening Kuwadzana recorded over 75 trees cut by official departments. When burning dry grass to improve visibility, the management department can also burn planted trees.
- Jurisdiction for urban forests needs clarity. The Forestry Commission of Zimbabwe holds that low-income high-density suburbs are the responsibilty of city councils.

Further reading

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- **https://www.newsday.co.zw/local-news/article/200031587/mumvee-craze-hits-zim-as-tree-species-faces-extinction**
- **https://pelumzimbabwe.wixsite.com/pelumzimbabwe/post/urban-youth-lead-efforts-to-green-cities**

For queries on this case study, email:
etgwini@gmail.com

CASE STUDY #7

How do people who frequent Bulawayo's city centre think about exotic and indigenous trees?

Gideon Mhlanga, 4th-year student in Electronic Engineering, National University of Science and Technology

Bulawayo is the second-largest city in Zimbabwe, has a population of 1.5 million, and a city area of 546km^2. It was founded by the Ndebele king Mzilikazi, whose son Lobengula succeeded him and named the town. The town was then captured in 1893 by British South Africa Company soldiers during the First Matabele War, and the first white settlers arrived. The town attained town status in 1894, municipality status in 1897, and city status in 1943. Bulawayo is Zimbabwe's principal industrial centre, once producing cars, electronic products, textiles, furniture, food products and more. It is also the headquarters of Zimbabwe's rail network and hosts the National Art Gallery, Natural History Museum of Zimbabwe, and over a dozen colleges and universities.

This important city has had extensive urban tree cover but it is under threat. According to Global Forest Watch: 'From 2001 to 2024, Bulawayo lost 64ha of tree cover, equivalent to 24% of the tree cover area that it had in 2000.'

This case study is based on 113 people who interact every day with trees in Bulawayo's CBD. The profile of the 113 respondents was: 44.2% were female, 55.8 % male; 43.4% aged 18–25, 35.4% 26–35, 15% 36–45, and 6.2% over 46. Just 3% identified as white while 97% identified as African.

Citing their highest academic qualification, 2.7% said primary education, 27.4% secondary, 20.4% high school, 17.7% a certificate, 9.7% a diploma, 15.9% a bachelor's degree, and 5.3% a master's degree. Slightly less than 1% professed to no academic qualification. The majority (64.6%) were employed while 8.8% were unemployed; 26.5% said student.

It sought to understand who engages with the city's trees, their amenities and



Left to right: Benefiting from the urban forest, people stroll, shop, vend and wait for taxis and public transport under trees along 8th and 4th avenues, Leopold Takawira Avenue, and Fife Street. Customers buy funeral flowers and curios such as sculptures, beads, leather shields and traditional platters woven from reeds. The trees here are still healthy and provide shade for parked cars, states author Gideon Mhlanga. Photos: T Singwango.

A drone's view of trees along Samuel Parirenyatwa Road. Serving as shade for parking spaces and giving the road high 'walkability', the majority are *Jacaranda mimosifolia*. They also provide shade for school-going children and for flats and offices. Photo: T Singwango.

disservices, and how they use them in daily life and view the trade-offs between indigenous and exotic species.

With respect to disservices, while 13.3% had encountered no negative issue with regard to a CBD tree, 28.3% had encountered falling branches, 28.3% bird droppings, 11.5% allergies, 10.6% other negative issues, and 1.8% problems with tree leaves; 29.2% of those surveyed were concerned about allergies triggered by trees, with exotic *Jacaranda mimosifolia* cited as the most allergy-causing tree.

Almost all (91.2%) could recognise and distinguish indigenous and exotic species and understood the difference. For beauty and appearance, 60.2% said exotic trees were better, while 38.9% preferred indigenous ones. Almost all (87.6%) said they were aware of medicinal qualities for many or some indigenous tree species.

Asked what they would like to see planted in the CBD, 35.4% prefered exotic trees, 23.9% indigenous trees, and 39.8% had no preference. Fifty per cent said they would not support the replacement of exotics trees in the CBD with indigenous ones, 40% said they would, while 10% did not say; 45.5% said there could be potential negative effects, 28.6% believed that there could be none, while 25.9% were unsure. Further, 39.8% expressed no opinion about whether indigenous trees were better, a neutrality that presents an opportunity to raise awareness about the ecological, cultural, and aesthetic benefits of different tree types.

Asked which indigenous trees would be good for replacing some exotics, the response was overwhelmingly native fruit trees: Uxakux-aku *(Azanza garckeana)*, which produces a popular, chewy, sweet dry-season fruit, was suggested by 51.4%; Umviyo *(Vangueria infausta)* by 9%; Umqokolo *(Dovyalis afra)* by 6.3%; Umtshwankela *(Vitex payos)* by 5.4%; Umkhemeswane *(Strychnos spinosa)* by 5.4%, and Umkhomo *(Adansonia digitata)* by 3.6%. Others suggested were hardwood Umkamba *(Afzelia quanzensis)*; medicinal indigenous trees; Umkhiwa *(Ficus sycomorus)*, and Umnyii *(Phyllogeiton zeyheri)*, each by 0.9%.

Specific recommendations for Bulawayo CBD based on mapping of species and tree health include:

- Make active progress on planting the indigenous species, largely native fruit trees, that have been suggested by respondents to the survey, since exotic trees are currently in the vast majority and this will be transformative.
- Focus on planting indigenous and exotic trees, particularly along major streets with deteriorating tree health (e.g. 8th to 15th avenues, and R. Mugabe and S. Parirenyatwa roads).
- Replace dead and failing *Jacaranda mimosifolia* to preserve Bulawayo's iconic look; replace dead and damaged trees such as *Grevillea robusta*, pine, *Lagunaria patersonia*, *Schinus terebinthifolius* and *Delonix regia*, which though exotic, contribute to urban cooling, air purification, and carbon sequestration, making the urban environment more liveable; and replace dead and dying indigenous trees, such as *Khaya anthotheca*, for their ecosystem services and other benefits as well as to help ensure genetic diversity, ecological balance and the wellbeing of the fauna reliant on these trees for habitat.

Lessons learned

- In introducing new trees and managing the urban forest, context-aware species selection and placement and audience-specific engagement are necessary.
- Transition toward more indigenous planting will need to preserve perceived amenities, address common disamenities, and tailor choice to distinct audience needs.
- Urban tree management must balance amenity, safety, and cultural-ecological values for its diverse user base.
- A balanced approach to exotics and indigenous trees is important. Efforts to educate and engage the public, alongside exploring solutions that combine the benefits of both tree types, can ensure that urban tree planning aligns with community preferences and environmental priorities.

Recommendations

- Urban planners and environmental advocates need to focus on species that minimise allergenic impacts.
- Proactive pruning and maintenance programmes can reduce risks of falling trees and bird droppings, especially in high-traffic or residential areas.
- Implement IoT-enabled monitoring systems

Left: Leopold Takawira Avenue, where Evelyn High School is located. Trees planted along this road merge with those in the City Park creating dense canopy. Right: Green spaces by the Bulawayo Tower Block that include *Jacaranda mimosifolia* trees and also green lawn with sitting bays. Photos: T Singwango.

for newly planted trees to track health and growth, ensuring early detection of stress or disease.
- Collaborate with schools, NGOs, and urban planners in tree replanting and growing initiatives to foster a sense of ownership and care for the urban environment.

Further reading

- Maphosa, S. N. (2025) 'An Assessment of the Distribution, Contribution, and Management of Urban Green Spaces to Local Livelihoods of Bulawayo (Zimbabwe) and Johannesburg (South Africa)'. MSc Thesis. University of South Africa. **https://doi.org/10.13140/rg.2.2.29148.71040.**
- Maseko, B. and Siziba, L. (2024). 'Environmental Conservation and the Bulawayo CBD as a Linguistic Landscape Construction: An Ecolinguistics Perspective,' *Journal of Asian and African Studies*, 61(1), pp. 429–445. **https://doi.org/10.1177/00219096241291054.**

For queries on this case study, email:
gideonmhlanga2@gmail.com

Urban greening in Mombasa, Kenya, along one of the city's busiest arteries. Led by the city's Chief Sustainability Officer and with Kenya National Highways Authority and climate action groups, they obtained permission to dig holes through asphalt and planted 40 large seedlings of 11 coastal forest species. Local workers will be facilitated to maintain the trees, which are also protected by green netting. Photos: J Chesoli.

URBAN FORESTS IN

EAST AFRICA

CHAPTER 3

KENYA

BACKGROUND

In the late 1890s, the site of downtown Nairobi was a wetland alongside grassland with scattered acacia trees. For the Masai people, who called it Enkare Nyrobi, it provided dry-season pasture and water for their livestock. In 1899, with the arrival of the Kenya-Uganda Railway, the British introduced Australian eucalypts to drain the swamp and supply wood fuel for steam locomotives.

In 1906, Karachi-born Alibhai Mulla Jeevanjee donated a 2ha park to the nascent city. In 1907, the 30.4ha Nairobi Arboretum was set up to trial exotic trees, and, in 1925, the 60ha City Park was established. Between the neighbourhoods of Parklands and Muthaiga, it served as a green buffer zone between the Asian and European communities.

Other key urban forest dates in Kenya's capital include:

- 1947, when English horticulturist Peter Greensmith became Parks Superintendent and rolled out roundabouts of succulents and bougainvillea, and avenues of jacaranda, Pride of Bolivia *(Tipuana tipu)* and *Washingtonia* palms for the next 20 years.
- 1969, when President Jomo Kenyatta opened the 12.9ha Uhuru Park.
- 1999, when Wangari Maathai (the scientist and activist who later became an MP and Nobel Peace Laureate) was injured while defending Karura Forest Reserve (gazetted by the British in 1932) from developers, setting the reserve on the route to becoming Africa's most successful urban forest (see Case study 8), which in turn later triggered efforts to secure Ngong and Ololua forests.
- 2020, during the COVID epidemic, when the city revived John Michuki Memorial Park and made it free to the public so that families cooped up at home could stretch their legs.

Today, Nairobi is ablaze with tree planting, including in the informal settlements like Kibera, Mathare and Korogocho. There, gardens of trees memorialise young men lost to violence, and former self-described gangsters have greened the banks of the Nairobi River. This wave of urban forestry is also spreading, with key regional towns increasingly prioritising urban trees (see Case study 12 on port city Mombasa).

President William Ruto's 2022 pledge to combat climate change by growing 15 billion trees by 2032 (with an initial target of 5 billion by 2027) evokes mixed reactions among urban foresters. In Nairobi, ambitious targets have led to a dash to get seedlings in the ground, often prioritising quantity over the 'Right Tree, Right Place' principle and with little aftercare. Paradoxically, while these saplings

struggle to take root, the construction of infrastructure and unregulated private development is leading to the felling of established and often 'veteran' trees.

However, few countries in Africa have the social capital of Kenya. In Nairobi alone, there are botanists at the National Museums of Kenya, academics at multiple universities, and experts at national advocacy groups like Nature Kenya and WildlifeDirect, key government agencies like the Kenya Forest Service and the Kenya Forestry Research Institute, and global powerhouses like IUCN, UNEP, and CIFOR-ICRAF.

The challenge for urban areas is where to plant trees, getting species right, protecting mature trees, and improving survival rates.

Further reading

'Nairobi recovers its green spaces during pandemic. Other cities can too.' **https://news.trust.org/item/20200824124618-bpc0a/**

CASE STUDY #8

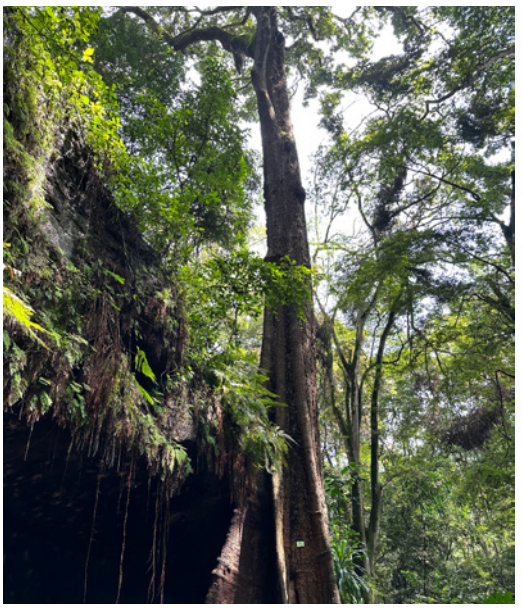
Karura Forest – so life-giving that doctors prescribe it: 'Some visitors have high blood pressure and have been advised to exercise'

Karanja Njoroge, Professor and former FKF board chair; Peter Njagi, FKF Ecosystem Biodiversity Coordinator; Chantal Mariotte, FKF board member

Karura Forest Reserve, located just 6km from Nairobi's CBD, is a mosaic of indigenous forest, regenerating secondary forest, exotic tree plantations, wetlands, rivers and riparian zones. It also has one lake, 60km of maintained walkways and bikeways, and a triple football pitch.

Covering 1,041ha, it is one of the few forests in the world located fully within major city limits, and the most visited city forest in Africa, which also makes it the most financially secure. In 2025 it received almost US$1,300,000 from entry fees of about 900,000 visitors, which went to a joint account of Kenya Forest Service (KFS) and Friends of Karura Forest (FKF), joint operators of the forest, to pay for the forest's maintenance, infrastructure and 122 staff.

FKF has its own separate revenue stream, mostly from bike rental, cafés and guided tours, under its ecotourism user rights as provided



A large buttressed *Manilkara discolor* near the Mau Mau cave in the forest. Photo: C Watson.

for by the Forest Act of 2016. The funds are used to benefit community members and for research. The government, meanwhile, pays for the salaries of the forest station manager, his deputy, and around ten rangers.

Kenyans make up 85% of visitors, adults paying the equivalent of just 90 US cents and children 35 US cents per entry. Adult foreign residents and tourists pay the equivalent of US$1.80 and US$5.30.

The forest is open every day from 06:00 to 19:00, with guards on duty 24 hours and 60 FKF scouts on patrol on rotation. According to statistics, it is 'extremely' safe. FKF's community assistance for the informal settlement that borders it, home to many of its staff and casual laborers, secures it further: over 700 children and youth from Huruma, as well as Githogoro and Gachie, have so far benefited from the FKF bursaries.

It was not always peaceful. 'Long before colonialism, Karura Forest was a sanctified place managed by the Gikuyu for worship, hunting and as source of medicine from trees like Muthiga *(Warburgia ugandensis)*,' says former FKF chairman Professor Karanja Njoroge. 'But the British gifted most of it to colonial farmers to grow coffee, and the community was denied access. The remaining part was also cleared and gazetted as a forest reserve in 1932 to grow foreign trees to fuel steam trains.'

> 'Green spaces do not need to be a perpetual fiscal drain. And access to green spaces requires fees such that all cadres of society are able to enjoy a walk or a jog.'
> – PROFESSOR KARANJA NJOROGE

In 1998, almost a third of the forest was secretly allocated to developers, and the Forest department received notice to quit. This triggered impassioned protests led by Professor Wangari Maathai, founder of the Green Belt Movement and later Nobel Peace Prize winner. She and her followers were badly defeated. All the while, the state of the forest was spiralling down – frequented by criminals and too dangerous to enter, home to illegal distilleries, its animals hunted for meat, and poached for its valuable Muhuhu trees *(Brachylaena huillensis)*.

Under the next government, however, Maathai became the Assistant Minister in

Karura Forest's nursery produces seedlings of over 30 indigenous species for replanting in areas cleared of exotics. Stephen Mbugua leads the team and comes from a nearby community, as do the nursery workers. On the right is a neatly labelled not commonly planted indigenous tree in the forest, *Margaritaria discoidea*. Photos: C Watson.

Karura Forest contains multiple wetlands that are particularly critical for waterfowl. Some are ephemeral and disappear in the dry months. Photo: C Watson.

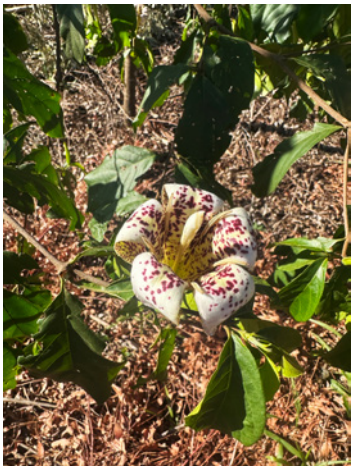
charge of Forests and in 2005 helped to push through a revised Forest Act that gave the right to Community Forest Associations (CFAs), like Friends of Kararu Forest, to play a major role in managing forests. FKF was founded in 2009, and, on 25 February 2010, the first MoU between KFS and FKF was signed and an electric fence erected around the forest.

The change was almost instant. Feeling secure, visitors poured in. Wildlife started returning and increasing: today, animals present include bushbabies, bushpig, bushbuck, duiker, suni, porcupine, genet, civet, fruit bats, and 230 bird species. And FKF began steadily replacing exotic trees with indigenous African montane forest species. Native tree cover has increased from 25% in 2009 to 63%. The forest's over 560 species of plants include trees *Teclea/Vepris nobilis*, *Rothmannia urcelliformis*, and *Uvariodendron anisatum*, which is endemic to Kenya.

One of the most remarkable achievements is the reintroduction of the threatened black-and-white colobus monkey *(Colobus guereza* subsp. *kikuyuensis)*; Karura had lost its native population in the 1960s and 1970s. A 'source' was identified in the Kipipiri agroecosystems of Nyandarua County, where farmers had cleared riverine habitats. The colobus monkey population, the most arboreal in Africa, was stranded on the remaining bushes, rock outcrops and on the ground. Without their staple diet of tree leaves, they resorted to raiding potato and cabbage fields. Conflict with farmers was escalating.

'The translocation began with pre-capture assessments and prolonged habituation of target groups to capture cages,' explains





Groups of women and children are a common sight in the forest. They patently feel safe and are often seen exercising on their own. On the right is *Rothmannia urcelliformis*, a flowering indigenous tree that occurs in Karura forest. Photos: C Watson.

primatologist Peter Njagi. 'This was essential to lure the families into the capture cages, allow accurate group composition assessments prior to capture, and ensure an all-family group capture. Capture operations were conducted using certified medium-sized primate capture cages under veterinary supervision. Entire family groups were targeted to maintain social cohesion. In total, 22 family groups comprising 142 adult males, females, juveniles and infants were captured, and translocated in three phases between May 2014 and March 2016. All individuals were checked for health, treated where necessary, and transported under controlled conditions.'

Professor Karanja Njoroge and environmentalist Wanjira Mathai, daughter of Nobel Prize winner Wangari Maathai who fought to defend the forest, with King Charles III, who visited Karura on a trip to Kenya in 2023. Photo: H Croze.

The 'soft' release into Karura Forest took several months, allowing animals to acclimatise before full dispersal. 'Post-release monitoring was a core component too,' adds Njagi, who now leads research for FKF. 'Researchers conduct intensive behavioural and ecological monitoring, record ranging patterns, feeding behaviour, habitat use, group cohesion, reproduction, associations with other primate species, and responses to predators. They also observe health and track survival rates.'

By 2025, the Karura colobus population had increased to over 30 family groups and an astounding 240 individuals, with multiple family groups established across the forest, especially the riverine habitats. 'Monitoring has continued for over ten years, documenting successful adaptation, stable home ranges and successful breeding,' says the researcher.

This was a science-based human-organised reintroduction. Biodiversity has also returned on its own. The five rivers that traverse the forest now have families of African clawless otters. Apex predators Crowned Eagles are back and reproducing. The owl population is growing. And side-striped jackals, among the smallest canines who live in families rather

than packs, are also regularly seen.

Equally phenomenal has been the impact for people, the forest particularly a boon to adults who live in a growing culture of processed food and long sedentary hours: in Kenya, non-communicable diseases account for over 50% of hospital admissions.

'They really value it. Many are diabetic or have high blood pressure and have been advised to exercise,' says forest scout Peter Kamau of Karura's up to 80,000 visitors a month.

Lessons learned

- Shifting from state-only management to a Community Forest Association model turned a high-crime area into a safe, top-tier attraction.
- Hiring from local informal settlements transformed former 'poachers' into professional forest scouts and provided a steady income stream.
- Intentional science-based ecological restoration proved that replacing exotic plantations (eucalyptus, cypress, pine, *Araucaria)* with indigenous species is essential for bringing back wildlife.
- Self-sustainability is achievable: modest gate and other fees can fully fund 122 permanent staff, proving that conservation does not always require government subsidies.

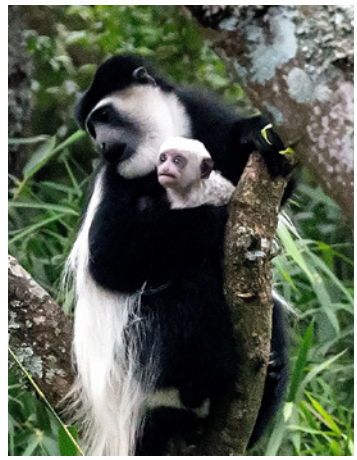
Recommendations

- Secure the perimeter first: always establish physical security (e.g., electric fencing) as a prerequisite for any reforestation or tourism activities.
- Formalise legal frameworks: use specific legislation (like the 2005 Forests Act) to create clear joint-management agreements between the state and the public.
- Diversify forest value: beyond trees, market forests as a hub for research and education to build deep public and scientific support.
- Ensure that 'maximising revenue' does not compromise the core mission of delivering health and social benefits to visitors, biodiversity and local livelihoods.

Further reading

- **https://friendsofkarura.org/**
- **https://friendsofkarura.org/forest-history/**

For queries on this case study, email:
director@cea.co.ke
peter.fundi@gmail.com
chantal.mariotte@gmail.com



Left: Because any tree cutting provokes concern among the public, managers of the forest use signposts to explain the reasons for clearance of exotics. Centre: Peter Njagi, who oversaw the translocation of the colobus. Right: Black-and-white colobus with baby thriving in Karura Forest. Photos: C Watson, P Njagi, H Croze.

CASE STUDY #9

Using the Miyawaki method can solve some of urban forestry's biggest headaches: a trial in Kenya

Samuel Kiboi, Associate Professor of Ecology and Environmental Sciences, University of Nairobi

Three challenges facing urban forestry are selecting the right tree species, making planted seedlings more likely to thrive, and finding a place for those trees. A Japanese approach called the Miyawaki method provides a way forward.

This case study looks at the potential of Miyawaki in Nairobi, and describes the trajectory of half a dozen such forests planted on the University of Nairobi campus, and their replicability.

The Miyawaki method involves creating highly dense small forests of up to 40 species of trees, based on the local historical climax vegetation. In Nairobi, much of which is at 1,700m above sea level, this would mean species of Kenya's dry upland montane forests, a great departure from the exotic species currently dominating the city, such as Australian *Eucalyptus* species, *Tipuana tipu* (from Bolivia), and *Jacaranda* (from Brazil).

Developed in the early 1970s by the late Japanese forest ecologist Akira Miyawaki, it also involves, after selecting species, improving the soil by mixing in organic material, and planting in a mixed manner meant to simulate a natural forest at a density of three seedlings/m^2. This induces very fast growth, since seedlings grown at high density compete for resources, and also induces higher than normal overall height growth, since light-demanding tree species in the mix push to stay in the top canopy layer.

Meanwhile, reduced light reaching the ground layer eliminates grasses and other competitors. Maintenance (weeding and replacement of dead trees) is done for the first three years, after which it is not required, and thereafter self-thinning occurs with shade-tolerant species surviving and those that cannot tolerate shade dying off or stagnating in the shrub layer.

A smiling Professor Kiboi holds leaves of endangered Kenyan tree *Brachylaena huillensis* in one of the Miyawaki forests on the campus of the University of Nairobi. Photo: C Watson.

Miyawaki also exploits niche differentiation and diversity. Deep-rooted species exploit deeper water tables. Species with shallower roots exploit upper parts of the moisture gradient. Variation in root structure means associations with different soil micro-organisms as well as the physical chemical micro environment niche requirements. The Miyawaki method is designed to minimise below-ground competition.

So how did it work in Nairobi? Professor Kiboi and colleagues chose the species by studying the vegetation structure in the city's relatively

undisturbed forests – Ngong, Oloolua and Karura. They found 82 trees species, which they narrowed down to 16.

The first Miyawaki forest at the University of Nairobi was planted on 24 April 2012. The aim was to create mini forests on the campus, leaving open areas between them to form a park. Across an area of 5m by 130m, 2,000 seedlings of 16 indigenous tree species were planted: *Schrebera alata*, *Rawsonia lucida*, *Cassipourea malosana*, *Vepris simplicifolia*, *Drypetes gerrardii*, *Elaeodendron buchananii*, *Croton megalocarpus*, *Brachylaena huillensis*, *Calodendrum capense*, *Ficus thonningii*, *Warburgia ugandensis*, *Olea europaea* subsp. *africana*, *O. capensis* subsp. *hochstetteri*, *Ehretia cymosa*, *Markhamia lutea* and *Cordia africana*.

Later, a further 10 species were added: *Maytenus undata*, *Albizia gummifera*, *Syzygium guineense*, *Acokanthera schimperi*, *Strychnos mitis*, *Craibia brownii*, *Ochna ovata*, *Vepris nobilis*, *V. trichocarpa* and *Trichilia emetica*.

Some *Cordia africana* reached 5.5m tall within just 28 months, growing at about 2.5m/year. *Ehretia cymosa* and *Markhamia lutea* grew at 2m/year, and *Vepris simplicifolia* and *Olea europaea* subsp. *africana* grew at 1.4m/year in 28 months.

With those encouraging growth rates, Kiboi and team planted further Miyawaki forests in 2013, 2014, 2016, 2018 and 2019. Today, one species they 'highly recommend' is *Calodendrum capense* or Cape chestnut, which has large, showy pink to white flowers between July and October; *Warburgia ugandensis*, *Cassipourea malosana* and *Croton megalocarpus* create excellent canopy. However, the last is not shade tolerant and is best at the edges, especially when planted together with fast-growing species such as *Cordia* and *Markhamia*.

Creating mini forests in urban areas by deploying the Miyawaki method helps support all four ecosystem services. They provision food for other organisms such as birds and insects; help regulate greenhouse gas emissions, CO_2 particularly, as well as temperatures; support urban ecosystems by creating microhabitats for other species; and, perhaps most importantly, deliver the cultural benefit of restoring dwindling human wellbeing by establishing micro forests in spaces such as walkways, riverbanks, schools and factories.

The professor's dream is to connect the Nairobi Arboretum forest with the City Park forest through Chiromo campus and the National Museum down through Nairobi River, and perhaps find a corridor though Pangani or Ngara areas into City Park. 'This would form nice connectivity for wildlife and other organisms within the city while providing much needed ecosystem services,' says Kiboi.

Students planting a Miyawaki forest on a bund on the University of Nairobi Chiromo campus in 2013 (left), and the dense growth after 6–7 years (right). Photos: S Kiboi and C Watson.

Lessons learned

- Miyawaki forests should be part of urban forest policies in Africa.
- The Miyawaki method can restore green to a city, improve its aesthetic quality, and help mitigate the effects of natural hazards and global warming.
- Miyawaki forests can drive positive changes in a very short time.
- A Miyawaki forest can be as small as a quarter of a tennis court or as big as space allows. In a large one, walking paths and benches where people can relax are possible. Another design is a matrix of small, connected Miyawaki forests for people and animals.
- A true forest has a closed canopy and little undergrowth, so security should not be a challenge. Miyawaki forests might be used as toilets if public amenities are not included near them.

Recommendations

- Other urban forestry projects in Kenya's capital should follow the lead of the University of Nairobi Miyawaki project and aim as much as possible to restore potential natural vegetation.
- The project needs to proactively communicate its findings about tree species suited to Nairobi to country environment officials, Kenya Forest Service, the media and more. At present, tree planting in Nairobi sometimes includes invasives; exotics are a routinely part of the planting palette, and seedling losses are high.
- The University of Nairobi Miyawaki project could consider proposing a network of Miyawaki forests to large schemes such as the the Nairobi Rivers Regeneration Project and the Nairobi Railway City project, which aims to transform 177ha of land in the centre of the capital.

Further reading

- **https://news.mongabay.com/2025/03/kenyas-cities-adopt-miyawaki-method-to-restore-lost-ecological-glory/**
- Kiboi, S., Fujiwara, K. and Mutiso, P., 2014. 'Sustainable Management of Urban Green Environments: Challenges and Opportunities.' In *Sustainable Living with Environmental Risks* (pp. 223–36). Springer, Japan.

For queries on this case study, email:
samuel.kiboi@uonbi.ac.ke

This project in Kenya was inspired by and enjoyed the support of Japanese institutions and the private sector. Photos: C Watson.

How to build a Miyawaki forest

- Clear a site, bring in topsoil, add manure, build soil carbon, the best source of which is biomass fixed by plants from the air. If possible, cut trunks and branches of fallen trees and place them at the bottom of the mound/site to be a future carbon source. Dig/pit holes.
- Select species based on the natural forest vegetation around the city.
- Raise seedlings of species selected or buy from nurseries around forests, which can also be encouraged to search for seeds of selected species.
- Plant the selected species randomly. The number of individuals per species should mimic their occurrence in nature.
- Replace dead seedlings. Self-thinning will occur. Canopy usually closes within three years and, by the fifth, the fastest growth rate may have been achieved, and true forest already established.
- Collect data scientifically every six months, including height and base diameter for each species. Photo: C Watson.

CASE STUDY #10

How urban forestry on road reserves in Nairobi brought respite to people and biodiversity: 'it is a guide for other roads'

Cathy Watson, Senior Advisor, CIFOR-ICRAF

In May 2019, contractors finished a 5km four-lane link road in northwest Nairobi. The Waiyaki Way-Red Hill Link Road was left entirely unlandscaped and, by December 2019, its bare road reserves were eroding; deep gullies, rills and rivulets were forming; and soil was blowing away and washing into drains and onto the sidewalks, becoming slippery mud.

It was an eyesore and discomforting for those using the road on foot or by car, but also an opportunity-in-waiting to plant trees. Neighbourhoods along the road contacted Kenya Urban Roads Authority, and KURA granted permission, framing what was to be done as 'beautification'.

This case study looks at one such undertaking, which is now, in 2026, in its seventh year. In total, it has planted lines and pocket forests of 1,857 trees and shrubs along both sides of the road, inside a roundabout, and on other islands. The area planted totals about 3.24ha.

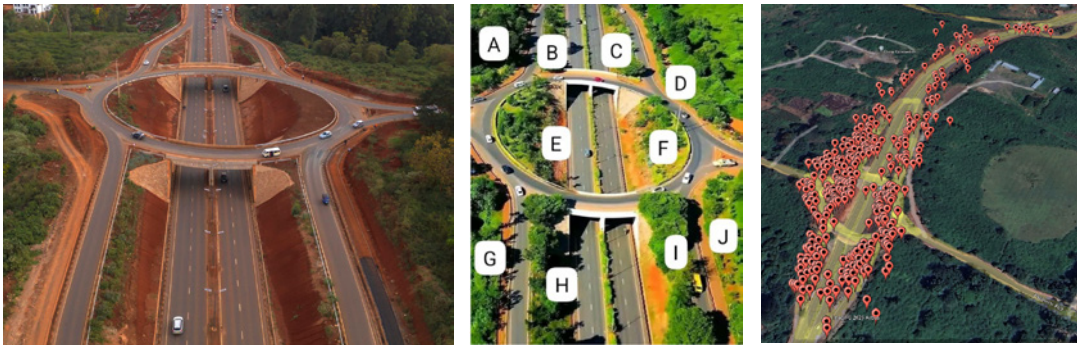
The aim was always to plant trees indigenous to the dry upland montane forest that would once have grown there. And the first planting on 28 January 2020 deployed 14 species, the seedlings sourced from the Friends of Karura Forest nursery. As time went on, five more nurseries raising indigenous tree species were identified, and more species were added.

Feeling their way forward intuitively and interactively, the team had many terms for what they were doing, including 'greening', 'restoring', 'reforesting', as well as building an 'arboretum', a 'native tree refugia' and a 'biodiversity corridor'. They were also 'creating green jobs', hiring four local nursery women and Masai watchmen who became part of the team, initially working one day a week, later two days.

Social justice and 'tree equity' (the idea that all communities should have equitable access to the benefits of trees) were additional goals. In pursuit of these, they planted grassed areas



A mother and child enjoy the grassed road reserve in 2020, even before the trees grew tall enough to cast shade. By year two, men became regulars under some trees, such as these large-leaved *Cordia africana* and *Vitex keniensis* (Meru oak). Photos: C Watson.



Left to right: An aerial shot of part of the bare link road in 2019; the same roundabout and adjacent road sections heavily vegetated by early 2025, with sections labelled for the first round of botanical inventory; an image of tagged and identified trees after a survey conducted by CIFOR-ICRAF. Photos: Courtesy of *The Star* newspaper, M Ochwangi, A Njogu Nguyo.

where pedestrians and people waiting to go to their night shifts could sit in tree shade.

The team also adhered to the 10-20-30 rule. Proposed by Dr Frank Santamour of the US Forest Service in 1990 to make urban forests more resilient to pests and diseases, it advises planting no more than 10% of any single tree species, 20% of any single genus, and 30% of any single family. And it removed dense thickets of invasive *Lantana camara* to create more room to plant and in the knowledge that invasives are a primary obstacle to ecological restoration in urban areas as they are elsewhere.

So how did it work out? In 2020, when the planting started, the entire stretch of highway the group was treating, approximately 1km long, had just three exotic Australian wattle trees *(Acacia mearnsii)*. By November 2025, the team had lost track of the number and species that had been planted and commissioned an inventory from a group of young Kenyan botanists to answer this question.

They found that the planted area now held 1,825 trees of 163 species, of which 142 were indigenous and 21 exotics – the vast majority of which were 'volunteers' that regenerated on their own.

The top three indigenous species were *Croton megalocarpus* (135 trees), *Markhamia lutea* (112) and *Spathodea campanulata* (104).

The indigenous trees also included nine threatened species, including critically endangered *Afrocanthium keniense*, a vulnerable flowering shrub native specifically to Nairobi City and its surrounding hills and facing a high risk of extinction due to habitat loss and urban development. 'This species is potentially threatened by pole cutting, as it produces a very straight stem,' explained lead botanist Julious Ochwangi.

They also included 12 rare species 'not currently facing a high risk of extinction but occurring in very small numbers, limited locations, or very specific habitats,' explained the botanists. Among them were rare shrub *Psychotria kirkii* var. *nairobiensis*, which only occurs around Nairobi.

So the project was excelling on species diversity and botany, and survival was near 100% with watering through the dry season, mulching, manuring, staking and regular checking. Birds nested, and tree frogs, chameleons, porcupines and other animals made themselves known.

But the big surprise was the social benefits, the most salient being shade, shelter and the creation of an attractive usable environment: the bypass is safer, and a small community of basket sellers, motorbike taximen, Uber drivers, security guards, and women selling tea and local food are now clustered under a stretch of the oldest and biggest trees.

Also hugely importantly, the restored hectares generate products: tree leaves, roots

and bark are heavily harvested for medicine, a boon to those who need it for their own use or to sell, but a risk to the tree. Also, cut grass is bundled up and taken away for livestock; long grass is cut for brooms; pruned branches are removed for firewood; and some fruit is picked and consumed, particularly of the fast-growing *Syzygium cordatum*.

Besides cooling, services include no more soil running onto the sidewalks and pathways, interception and infiltration of rain, and less runoff and puddling.

In total, the project has cost about US$5,000 a year for six years with 85% going to labour. This has come from donations, including a GoFundMe campaign, which has so far raised US$11,200.

'It is a guide for other roads,' says Lawrence Wachira, Environmental and Social Safeguards expert, Kenya Urban Roads Authority.

Lessons learned

- Urban forestry is accessible. Municipal authorities often welcome communities or individuals taking charge of a patch or pocket of land.
- Urban forestry is long-term. The trees planted under this project only came out of danger from trampling and breakage after about three years and still need care; for example, some trees branched over sidewalks, becoming a nuisance, and needing pruning.
- Relying on voluntary labour for a long-term project with digging, carrying and hours in the sun and rain is not feasible. Budget to pay for labour and take pride in it as it supports families.
- Free seedlings are likely to be common exotics and even invasives. Pay for seedlings to boost the tree nursery economy. This project has been a boon for the few nurseries around Nairobi that raise indigenous species, the seeds of which require costly expeditions into forests and savanna to collect.
- Many indigenous species grow extremely fast, easily 3m a year.

Recommendations

- Go out of your way to show city authorities that you are protecting the grey infrastructure and observing road safety precautions like not planting trees at road junctions.
- Prepare the land rather than just dig holes: for roadsides, remove rubble, turn over the whole area, treat with compost, manure and mulch.
- Plant grass to seal off erosion and create further cooling and a dignified place to sit.
- Seek the advice of botanists on indigenous species that once grew where you want to plant.

Left to right: An attempt to plant grass in 2020, but the soil needs much replenishment; repeated adding of plants like aloes, shrubs, and trees gradually vegetates the slope by 2023; by 2025, the slope is fairly well covered and can be seen holding moisture in the final picture. Photos: C Watson.

Planting begins on a steep slope in 2022. Bamboo is placed below the seedling to hold it and soil amendments in place; schoolchildren add more trees in 2024; the trees are well established by 2025. Photos: C Watson.

- Acquire a tree book: Africa has thousands of species to select from for urban planting.
- Document with photographs: it is the easiest and best record, especially as many indigenous species in Africa have never been planted, and how they grow, particularly out of their natural setting, is little known.
- Study urban forestry concepts like the 10-20-30 and the 3-30-300 rules.
- Move away from trees that appear promising but pose problems. Fast-growing flowering *Cordia africana* was one such case in this project. It is fast growing and flowering, two excellent traits, but struggled to establish apical dominance, and has extremely heavy leaf fall. Keep trialling species.
- Plant the most sought-after medicinal species (in this case *Zanthoxylum* spp.) out of easy line of sight.
- Plant large trees when there is adequate space: do not a waste a sizable piece of land on shrubs and small trees.

Further reading

- **https://swara.co.ke/restoring-nature-along-a-main-road-in-nairobi/**
- Useful trees and shrubs for Kenya: **https://www.cifor-icraf.org/publications/downloads/Publications/PDFS/B13601.pdf**

For queries on this case study, email:
cathyhwatson@gmail.com

Tree planting along roads elsewhere in Nairobi has learnt from the pioneering link road project. Left to right: Senior KURA officials plant in Loresho; a botanist- and activist-led project in Nairobi's industrial area pays men from Kibera informal settlement to tend newly planted trees; and community planting in Kitisuru. Photos: C Watson.

CASE STUDY #11

Street tree equity and diversity in Nairobi

Alice Gerow, tree-planting programme operations manager, Greater Paris Administration (Est Ensemble), and Vivian Kathambi, botanist, National Museums of Kenya and Ghent University

This case study of street trees across 12 neighbourhoods in Nairobi City County compares the abundance and diversity of street trees across a socioeconomic gradient, from affluent neighbourhoods like Spring Valley to informal settlements like Mathare.

A total of 2,047 trees were identified along 120 transect walks as part of a statistical inventory. The selection of streets to sample followed a spatially stratified random sampling approach: 10 transects were sampled in each of the 12 neighbourhoods, which were nested in four strata. To determine transect locations, 10 random points were generated in each neighbourhood, and the nearest road intersection identified as the starting point for a transect. From each intersection, a transect of 200m in length was established in a randomly chosen direction, resulting in 24km of street sampled.

Food sellers operate in the shade along a well-treed street in a middle-income area of Nairobi. As is typical of urban street trees in Kenya's capital, the trees in this photo are largely exotic species such as *Grevillea robusta*. Photo: A Gerow.

Left to right: Traveller's palms *(Ravenala madagascariensis)* and golden cane palms *(Chrysalidocarpus lutescens)* provide a wall of green cover in front of a new apartment building in an affluent area, and a line of elderly but healthy jacaranda trees provides shade along a street in a medium-income area. Photos: A Gerow.

Findings show stark disparities in abundance and diversity:

- Every transect in the wealthiest neighbourhoods had street trees: 91.5% of the 2,047 trees were located in the two more affluent areas.
- The remaining 8.5% of trees were distributed among low-income areas and informal settlements. In both areas, nearly half of transects had no trees.
- 142 species of tree were identified. However, these were also strongly right-skewed: 65% of the 2,047 trees were non-native; ten species, seven non-native, made up 41% of all trees.
- Exotic *Jacaranda mimosifolia* constituted 7% of the total street tree population, and exotics golden cane palm 4.6%, avocado 4.6%, *Grevillea robusta* 3.8%, loquat 3.1%, Alexander palm 3%, and *Cupressus arizonica* 2.9%.
- The most common indigenous species were *Filicium decipiens* 4.8%, *Croton megalocarpus* 4.6%, and *Dracaena steudneri* 3.0%.

Nairobi's street canopy is shaped by City County officials, but also by private resident, real estate, and community efforts. Higher-income streets featured professional landscaping. Where trees are present in low-income areas, they are planted by local institutions like churches and schools.

Nairobi today stands at a crossroads. Urban expansion has already caused roughly 10% forest loss over the past two decades. Efforts to green the city are under way. Nairobi is working with UN Habitat to catalogue public green spaces, while the Kenya Urban Roads Authority and Kenya Forest Service provide sites and seedlings for resident groups to grow roadside trees. Community-based organisations and social institutions are establishing pocket parks and planting trees in informal settlements. However, planting figures vary and survival rates are overlooked. Other cities can draw lessons from Nairobi's experience.



Washingtonia palms in Parklands, a middle-income area; a single large tree in an informal settlement; A Gerow and V Kathambi identify tree specimens collected around the city. Photos: A Gerow, C Watson.

Lessons learned

- Street trees are indispensable to a city's sustainability goals, climate resilience, and overall liveability. Yet global urban tree cover remains uneven, with underprivileged groups typically having least.
- In Nairobi, underprivileged and vulnerable populations experience far lower levels of tree cover, a disparity that represents an environmental justice concern, given the crucial benefits trees provide. The absence of trees is both a symptom and amplifier of inequality.
- Street tree inventories provide vital data on species, associated fauna, and maintenance needs, and citizens can contribute if trained.
- Street tree inventories must define what qualifies as a street tree and apply standardised protocols for health and other parameter measurements.
- Native trees are a minority and deserve more attention going forward, given their diversity and co-evolution with local fauna.

Recommendations

- Inventory street trees to move forward with planting and conservation strategies at the City-County scale: they are the most common and accessible layer of the urban forest.
- Prioritise underserved neighbourhoods to achieve canopy equity, evaluating assets, constraints, and needs for localised planting strategies.
- Set measurable canopy targets and apply the principle of 'the right tree in the right place'.
- Conserve the oldest and largest street trees.
- Integrate tree planting where road expansion is unavoidable.
- Encourage private planting through young tree distribution events, ideally featuring native species.
- Make a long-term investment in tree care to ensure that new plantings mature to deliver the intended benefits.
- Evaluate canopy distribution regularly to help correct the course towards equity and resilience against pests, disease, and climate stress.

Further reading

Street tree communities reflect socio-economic inequalities and legacy effects of colonial planning in Nairobi, Kenya. **https://www.sciencedirect.com/science/article/abs/pii/S1618866724003285**

For queries on this case study, email:
alice.gerow@gmail.com
Vivian.Kathambi@UGent.be

CASE STUDY #12

Protecting trees in Uhuru Garden in heat-stricken Mombasa

Cathy Watson, Senior Advisor, CIFOR-ICRAF; Basil Angaga, Chief Sustainability Officer, County Government of Mombasa; Paul Webala, Associate Professor, Masai Mara University; Kenya Mutiso, Director, African Forests; and Ngao Wanyonyi, Director, Coastal and Marine Resource Development (COMRED)

On 30 May 2025, two large trees were felled in Uhuru Garden, the premier green space of Mombasa, a rapidly growing city of 1.6 million facing a growing number of days of extreme heat a year. Located on Kenya's coast, public green space in the city is scarce and unevenly distributed. On average, residents have 3m², a third of the 9m² that the World Health Organization recommends as a minimum per person.

This case study examines how the quick actions of activists, media coverage, a botanical survey, science-based arguments, and a meeting with the county government responsible for the green space appear to have halted plans to remove further trees from Uhuru Garden, a heavily visited 1.1ha area of dense shade with large trees in the city's CBD. Temperatures in the Garden hover around a comfortable 26°C in contrast to 41.5°C, which is common on the unshaded avenue nearby.

The episode began early in the morning when young men with chainsaws disembarked from an unofficial vehicle and began to fell a large mango and then a large *Peltophorum pterocarpum*, a tree from mainland Southeast Asia and northern Australia.

Messages went out, and an activist from Together 4 Climate was first on the scene with a placard. Moments later a rapid response officer from Muslims for Human Rights arrived. The tree cutters 'claimed that 19 trees had been marked for removal and that they had permission from the county government,' according to a report the same day in *The Star* newspaper.

After some argument, the tree cutters retreated, taking with them a large amount of timber that they had pit sawn.

Although no more trees were cut, the situation appeared precarious, with some government officials defending their actions and the absence of public consultation and an Environmental Impact Assessment (EIA). The argument was that the trees were diseased and a risk to the public, though inspection of the

Park visitors pass time on benches in the shade. Local people reel in shock after the two large trees are cut. An activist holds a poster saying 'Save the Park'. Photos: C Watson, B Angaga.

Flowers of coastal tree species *Fernandoa magnifica* and *Majidea zanzibarica* that would thrive in Uhuru Garden were it to be renovated, and some of the 16,000 bats that roost there. Photos: African Forest, KenBat.

stumps did not seem to support that.

Many organisations and experts rallied to learn more about why the Garden was important, what its history was, and what it contained.

It was known that the park had walkways and seats and was a tourist mecca important to the livelihoods of tour guides. Interviews with visitors to the park showed the extent to which they relied on it as a place to meet others, defuse, escape crushing heat, or wait for a casual job to present itself. For homeless people, it was a place to sleep at night. For children, it had potential, although its play area was noted to be a dump for waste collected on adjacent streets. Further enquires yielded that other city parks, e.g., Railway Park, had been fenced, rendering them inaccessible.

Conferring, the county government's chief sustainability officer, the Kenyan NGO African Forest, and others decided that what was needed was a survey of the park, which, though small, was significantly contributing to social, ecological, and climate benefits. What trees did it contain?

Botanist Mwadime Nyange was asked to conduct an inventory. He counted a total of 143 trees and shrubs and identified 55 species. Uhuru Garden's ecosystem was found to be home to at least four rare and threatened trees: *Mkilua fragrans*, *Cynometra suaheliensis*, *Milicia excelsa* and the cycad *Encephalartos hildebrandtii*. Also present were trees from East Africa's much reduced and fragmented coastal forest biome: *Rauvolfia mombasiana*, *Ficus sansibarica*, *F. bussei*, *Majidea zanguebarica* and *Afzelia quanzensis*.

Nyange also pointed out that some of the largest trees in the garden were exotic species and that while the focus in this epoch of biodiversity loss is on indigenous trees, large exotic trees provide vast ecosystem benefits, including in this case hosting one of the most important bat colonies in East Africa, with approximately 16,000 individuals, of the IUCN's Near-Threatened straw-coloured fruit bat *(Eidolon helvum)*.

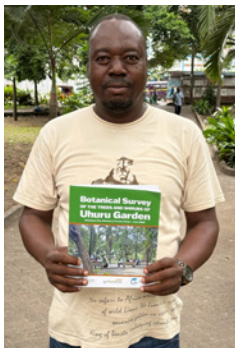
The report advised that future planting incorporate species from the coast and suggested that the Garden transition to being a native coastal species refuge. It further advised that decisions to remove a tree include an EIA and that it reflect the latest scientific thinking on tree growth and health, including that trees with cavities can be structurally strong, and older trees are naturally colonised by a wide array of organisms that create veteran tree habitats. It also advised that the likelihood of tree-related hazards can be reduced by good silvicultural practices and that, when storms and high winds are forecast, closing the Garden and broadcasting advisories to the public not to enter are in line with global best practice.

Some weeks later, the county government called a public consultation meeting, and many of the activists and experts came, including the country's leading bat expert, who travelled from Narok county in Kenya's Rift Valley. Presenting

the report did little to soften the mood. When the county said the trees were a risk, an environmental lawyer pointed out that going in a car was a risk and that risks are mitigated by taking precautions. One NGO present said it would pay for signage to warn people to avoid the Garden during periods of high winds.

Lessons learned

- In such an emergency, a coalition of people with different profiles is needed, from activitists to city officials to scientists: fast actors stopped the cutting, and researchers built the case for well-shaded public green space with tall veteran trees.
- Assembling facts, such as what trees are in a park or the number of people visiting a green space each day and for how long, is essential.
- Technical expertise is respected: in this example, the strongest points were made by the bat expert who spoke beyond bats to the entire ecosystem.
- More knowledge is needed in Kenya about management of urban trees, especially mature trees, which hold the most biodiversity and cast the most shade, but may drop branches or fall.
- Uhuru needs a 'Friends of' group to advocate for it and raise funds for upkeep, given constraints on and priorities of municipal government.



Small shops and homes adjacent to the Garden experience its cooling effect; the manager of Mombasa's green spaces holds up the botanical survey. Photos: C Watson.

- Mombasa needs to open its other parks to public use and improve the quantity and quality of city green space – there is huge pent-up demand. With the right information and a coalition, government listens. The County Government has now budgeted for the rehabilitation of Uhuru Garden in the 2025/26 budget cycle.

Recommendations

- Have a contact list, including of media, ready in case of an environmental emergency.
- Follow the law and expect other parties to do the same.
- Position tree removal/cutting a tree as an extreme last resort.
- Understand that while local authorities may feel under pressure to follow a risk-averse approach to trees, they have a duty to provide tree cover that reduces heat, enables physical exercise and socialising, and allows access to nature.
- Advocate for your city to develop a citywide strategy on trees for cooling and biodiversity.
- Apply to donors for funds for training in park management and arboriculture.

Further reading

- **https://african-forest.net/uhuru-garden-botanical-survey-report-how-you-can-help-preserve-mombasas-green-spaces/**
- 'Common sense risk management of trees: Guidance on trees and public safety in the UK for owners, managers and advisers.' **https://ntsgroup.org.uk/wp-content/uploads/2024/10/NTSG-full-guidance.pdf**
- Wanyonyi, I.N., Webala, P., Watson, C. 'Urban Green Spaces: A Sustainable Approach – Mombasa City cannot breathe without trees.' POLICY BRIEF. Coastal and Marine Resources Development, Mombasa. **www.comred.or.ke**

For queries on this case study, email:
Cathyhwatson@gmail.com
Paul.Webala@gmail.com
b.angaga@together4climate.org
Ngao.wanyonyi@comred.or.ke

CHAPTER 4

TANZANIA

BACKGROUND

Starting as a small port on the Indian Ocean in the mid-19th century and inhabited by peoples who spoke a common language called Swahili, the lingua franca up and down East Africa's coast, Dar es Salaam grew to be the booming commercial capital of Tanzania.

Located within East Africa's coastal forest ecosystem, it originally had abundant terrestrial vegetation and mangroves, and when colonial planners took over, they designed it with many green spaces. But its human population increased rapidly – to take one period, from 1980 to 2024, from about one million to 8.5 million – and urban development encroached on designated green spaces and other green areas. Weak urban planning and enforcement exacerbated the decline of urban green spaces, forests, nature reserves and parks.

Dar became 'a hot city with moderate to poor air quality despite being located on the Indian Ocean with a continuous breeze, with few places for children to play or people to relax, and low biological diversity,' says Anne Outwater, recipient of awards for environment conservation from the city government of Dar.

Read her case study here about how change is coming to Dar. Read also the case study of a tree-planting exercise in Moshi, a city in the highlands of northeastern Tanzania.

Left: A mango tree offers shade and comfort to vendors and shoppers at market stalls in Goba, an administrative ward experiencing rapid population growth due to urban expansion in Ubungo district, Dar es Salaam. Right: In a sign of ever-growing commitment to city trees, constructors make strenuous efforts to move this baobab tree as building progresses near the port of Dar es Salaam. Photos: A Outwater.

CASE STUDY #13

Swahilian city Dar es Salaam wants more than green on its 'fringes'

Anne Outwater, former head, Department of Community Health Nursing, Muhimbili University of Health and Allied Sciences

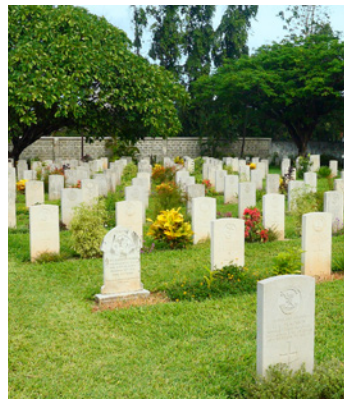
Dar es Salaam has a history of green spaces. Notable in its city centre are:

- Dar es Salaam Botanic Garden, which started in 1893 as a 243ha site where potential commercial crops like rubber, teak, coffee, tea and cotton were trialled. Today, measuring 57 hectares along Samora Avenue, it is more ornamental than scientific, but still contains many interesting plants, including a collection of palms planted in the 1990s. The remaining central portion provides shady relief from hot and busy streets, its website says.
- Dar es Salaam War Cemetery and the private Gymkhana Club, which, while almost entirely planted with alien species, provide ecosystem services such as cooling and oxygen production.

Further out are:

- Mwembe Yanga Public Park on Chihota Street is a place 'where the working class can spend time' (Du Plessis, 2019), as are the green spaces of Mnazi Mmoja and Kijitonyama Postal Grounds.
- Multiple graveyards, which are culturally sacred, often host rich remnant populations of native plants and some huge trees, particularly baobabs.
- Pande Game Reserve, the largest protected area in Dar es Salaam region and an Eastern Arc/Coastal Forest remnant, is among the world's highest priority areas for biodiversity conservation. Classified by Birdlife International as an 'Important Bird Area', it is also a key source of native plant seedlings.

Besides these designated green spaces, an unexpected amount of green is sustained by urban dwellers themselves. Kiunsi and Mwageni's study (2021) in four representative wards of Dar es Salaam's 90 wards found that almost one-third of the area of residential



From left to right: Mwembe Yanga Public Park; the palmetum (palm collection) in Dar es Salaam Botanical Garden; and the well-greened and little-disturbed Dar es Salaam War Cemetery. Photos: Mangapwani CC BY-SA 4.0 Wikimedia Commons; A Outwater.

spaces were open spaces, and that 'three-quarters of the households use(d) green spaces for shade provision and cooling, two-thirds as a source of food products, and a quarter for recreation and aesthetic purposes.'

In addition, some individuals in Dar have dedicated their gardens to nature conservation. Examples are the Rejuvenation Nature Space in Mikocheni B, and more than six hectares of 'sacred space' in a community at Ras Kilomoni near Bahari Beach. And, in the most affluent areas, many official residences have large gardens with remnant coastal trees, such as baobab or *Ficus* spp. The embassies and ambassadorial residences of China, Iran, Finland, Ireland, Italy, and the Aga Khan Foundation, for instance, are in close proximity to each other around Toure Drive and Kaunda Street, and together form a substantial green spot in Oyster Bay near the Tanzanite Bridge.

But besides the above, it can be observed that the green in the city is mostly in its 'fringes', with the most diverse indigenous green surviving along the 'fringes' of the ocean beaches, rivers, shambas, universities, sewage treatment plants, and sites under strict governmental control.

The eastern edge of Dar is about 100km long and consists almost entirely of white sand beaches. Mangrove forests occur at the mouths of 18 rivers and streams that flow from surrounding hills into the Indian Ocean, and are critical for drainage and water for bathing, washing clothes, animals and vegetable gardening. The most significant is the Msimbazi River, which arises from the Pugu/Kazimzumbwi Nature Forest Reserve and flows for about 35km through Dar es Salaam. At its mouth is a substantial and healthy mangrove forest.

Another fringe-type of site consists of nine municipal sewage treatment plants with waste stabilisation pond systems. These allow cool breezes to pass through, freshening urban air. Some have substantive well-documented wild bird populations.

The University of Dar es Salaam is beautified by many large remnant indigenous trees, although more recent planting has been of alien exotics. In another example of the 'fringe' phenomenon, however, Werema et al. (2025) found that wherever thickets survived on the campus, biodiversity was able to hang on. Despite the secondary nature of the remaining thickets, forest-dependent and forest-edge bird species were evident.

Happily, a shift towards a more resilient city, where urban forest is centre stage and not just on the fringe, is slowly taking off. Large trees and mangroves are enjoying more protection.Multiple books and resources have been produced emphasising the ecological importance of using native flora to rejuvenate

Left: Small farms in and around Dar es Salaam, such as this one in Miji Mwema, contribute disproportionately to city greenery, according to researchers N Mwageni and R Kiunsi. Right: The waste stabilisation ponds at Mabibo and Dar es Salaam are also green spaces, the contribution of which is not to be undervalued. Photos: A Outwater.

Top: A shopkeeper sits with his wares hanging in a *Pandanus kirkii* tree on a Dar beach. Called Mkadi in Swahili, this small coastal tree (4–8m) with 2m-high aerial roots is found only on sand above the high water line and prevents erosion. Above: One of the rivers running towards the Indian Ocean in Dar es Salaam. Though its water is polluted, its banks constitute some of the 'fringe' providing habitat for biodiversity in the city. Photos: A Outwater.

coastal ecosystems and of identifying exotic invasive species (e.g. Outwater et al., 2019, and Van Wyck et al., 2023). The World Bank is actively supporting projects such as the **Dar es Salaam Metropolitan Development Project** (DMD) and **Msimbazi Basin Development Project**, focusing on climate-resilient infrastructure, improving public spaces, enhancing drainage with green solutions, mapping tree cover, and building local capacity for sustainable urban planning.

The city council and municipal government invest in greening by overseeing remaining green spaces tree-planting campaigns.

Tree planting is not always easy or a plus. The DMD project wanted to plant native trees, and did plant some, but found it difficult to find seedlings and ended up planting many non-indigenous ones. And fashions have shifted through the decades, with previous efforts largely favouring exotics, the presence in the city of which ICLEI (2023) describes as 'disproportionate'. Some introduced trees and plants such as *Casuarina* spp. from Australia, *Leucaena leucocephala* from tropical America, Neem *(Azadirachta indica)* from India, and *Opuntia* (prickly pear) from Mexico became invasive and, by the time they were recognised as a problem, were seeding new generations, further displacing native species.

But big native trees surviving in Dar city are baobabs, strangler figs and *Ficus sur*, and many more can be grown. Encouragingly, in one example, today the government is supporting urban planting of *Trichilia emetica*, a tall hardwood.

Other important indigenous tree candidates for boosting Dar's urban forest include: for food, *Tamarindus indica*, *Saba comorensis*, *Annona senegalensis*, *Cissus rotundifolia*, and *Talinum portulacifolium*; for timber, *Milicia excelsa*; for cooling, *Baphia kirkii*; for flood management and aquifer replenishment, *Ficus sur*; for beach stabilisation, *Pandanus kirkii*; for cultural significance, *Dalbergia melanoxylon* (blackwood); for habitat creation, *Ficus* spp., *Syzygium cordatum (*white berry tree), as well as *Milicia excelsa* again; for beauty, *Adenium obesum*, *Hibiscus schizopetalus*, and *Kigelia africana*.

If rejuvenated and brought back from the 'fringe', species of the coastal forest ecosystem will be able to provide many of the services of intact ecosystems and provide a higher quality of life for the human beings that live within them. This important city, one of the fastest growing in Africa and the world, is expected be a model for other cities in Tanzania.

Lessons learned

- There is urgent need for ecological restoration in Dar es Salaam and the forest ecosystem of the Swahili coast: encroachment continues and green is being pushed towards the fringes, surfacing in welcome but unexpected places.
- There is some awareness of the importance of trees, but little expertise about which are native and the role of indigenous plants in stabilising and rejuvenating ecosystems.
- Native seedlings are not easily available.
- Positively, however, remaining green spaces are vigorously safeguarded by entities including Tanzania Wildlife Division, the Tanzanian army (JWTZ), and security guards.
- Surviving thickets and vegetated ocean and river edges continue to provide a habitat for birds, including forest-dependent ones, and families and individuals support greenery around their homes.
- Finally, illustrated books to support native plants have been produced by NGOs with support from municipal authorities.

Recommendations

- Increase awareness of the ecological importance of native flora to restore and rejuvenate the unique coastal and riverine environment of Dar es Salaam, and make it a priority for all public planting.
- Target entities with larger land holdings to provide pockets of safety for local biodiversity: adjacent institutions can join together, for an ecosystem effect.
- Design urban landscapes that are nature-friendly by planting trees native to coastal East Africa along arterial roads and streets, in public parks, and on hospital grounds and school campuses.
- Empower individuals and groups to integrate indigenous plants into everyday landscapes such as homes, gardens and public spaces.
- Build institutional competencies and capacity.

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For queries on this case study, email:
aoutwater7@gmal.com

CASE STUDY #14

Building Moshi's urban forest through an extended school-focused event

Dr Ernita van Wyk, senior professional officer – social-ecological systems, ICLEI Cities Biodiversity Center

Moshi is a lush, tree-rich town covering 59km^2. It lies within the Eastern Arc mountain chain in the foothills of the iconic Mount Kilimanjaro in northeastern Tanzania, which makes it an internationally important biodiversity hotspot with high levels of species endemism. Local people hold a strong spiritual connection with the natural environment and foster cultural beliefs that underpin reverence for their mountains, rivers, springs and forests. Moshi is also an agricultural hub, one of Tanzania's major coffee-producing centres: shaded coffee, livestock and crop agriculture meet wild biodiversity to produce Moshi's unique landscape.

Moshi is also well known in Tanzania for its municipal innovations in waste management, greening, cleanliness, collaboration with the private sector and smart methods for enforcing environmental compliance. It routinely wins national environmental awards. Its trees receive particular attention: tree cutting and pruning, for example, are strictly regulated. That being said, with a population of about 200,000 and an annual population growth rate of 3%, largely due to rural-to-urban migration, Moshi's natural assets are under pressure and need protecting.

Urban areas need trees. By storing carbon while releasing oxygen, trees combat climate change by merely existing. They also increase property values, and improve air quality and the wellbeing of people and animals. Trees provide habitat for biodiversity and cool down the streets shared by locals and visitors.

Looking back at 2019, this case study examines an extended event during which Moshi municipality and the education sector came together to plant trees. Its significance goes beyond a single day, however. Globally, Nature-based Solutions (NbSs), such as

Positively, some cities have gained tree cover and urban forest as seen along these streets in Moshi in photos taken in 2007 and 2023. Photos: S Nygard. Wikimedia Commons, distributed under a CC By 2.0 license. L Ayiga. Wikimedia Commons, distributed under a CC By 4.0 license.

greening and tree-planting, are surprisingly scarce in the education sector. National and international policies increasingly advocate for integrating NbSs into learning environments, e.g., the European Commission's Green Deal and the UN Decade on Ecosystem Restoration both highlight the importance of embedding nature into education systems as part of a broader sustainability transformation. An article on the Nature of Cities website provides food for thought on this: if the benefits of nature-based solutions in education are clear, why aren't they more mainstream?

In 2019, during Moshi's rainy season, the municipality and the education sector came together for a special tree-planting event as part of the **INTERACT-Bio** project, implemented by ICLEI Africa. The event took place as part of an outreach component of the project, which was supported by two collaborating NGOs: Nipe Fagio and BORDA Tanzania, in collaboration with the Kilimanjaro Project.

Children from Kimochi Primary and Secondary schools, as well as teachers, headmasters and political and community leaders, assembled to learn about the importance of trees in urban environments. It started with an educational visit to the Kiviwama Arboretum, where a tree expert from the Kilimanjaro Project emphasised: 'Students have a responsibility to share their knowledge about trees with their friends so that many may grow up with the spirit of preserving and nurturing trees in their towns and cities.'

Following the Arboretum visit, each of the 250 participants planted a tree, chosen from five different species: *Rauvolfia afra*, *Ficus sycomorus*, *Trichilia emetica* and *Khaya anthotheca*, all of which are native to Africa and Moshi in particular, and *Syzygium cumini*, a fruit tree from South Asia but

Students with their seedlings in a day of learning about tree planting and care under the INTERACT-BIO project. Schools are ideal settings for education on nature-based solutions. Photo: Courtesy of ICLEI Africa.

Left: A student collects a seedling, the care of which will be his responsibility. Right: thriving young *Rauvolfia afra* trees, a fast-growing medicinal tree, a year and a half after planting. Photos: ICLEI Africa.

naturalised in East Africa.

The day also included a training session where students and teachers learned about the value of urban greening and were each given one tree and a handout on tree varieties and how to grow them. The 'scholars' adopted their trees, and, together with headmasters, made a commitment to care for them going forward. The importance of care and monitoring tree survival was further facilitated by the use of an app called 'Tree Tracker'. Free on Play Store for smartphones, it is designed to support reforestation in the world's most rural regions. See **https://map.treetracker.org/**

'Do we fully understand what teachers and schools actually need from us? Without closer alignment between educational needs and the NbS community's offerings, uptake is likely to remain on the edges of the education endeavour.'

– KELLY BALDWIN HEID, URBAN NATURE PLANS, ICLEI EUROPE

Finally, each scholar also received a tree to plant at home, ensuring that the urban greening extends into the community and residential areas. The timing of this planting, i.e. during the rainy season, ensured the best chance of survival for the 500 new trees in Moshi.

Lessons learned

- Schools can be ideal venues for creating urban forests and often have ample space for trees. They are also ideal for instilling in children a culture of care and knowledge of tree maintenance: each new cohort can be exposed to the benefits of trees and the care that they require to survive and thrive over time. In this way, schools can contribute to fostering understanding environmental health within each generation of scholars.
- Though tree survival was not tracked, the event and its aftermath likely contributed strong and growing evidence that learning in green spaces provides cognitive, emotional, and social benefits, such as improved academic performance, stronger mental health, better attention spans, fostering of environmental stewardship, and deeper

community cohesion.

- Many schools struggle to implement NbS education, however. Barriers include a lack of teacher training, rigid curricula, insufficient funding, and unequal access to green space. Another important barrier may be that NbS professionals have not yet made the case convincingly enough or provided suitable accessible materials for educators.
- The education sector and the youth are sometimes undervalued participants in urban greening efforts. Society's youth cohort is an important 'client' in intergenerational learning and preparing the next generation for climate impacts, and transferring skills and a love of nature for creating a better quality of life in urban environments.
- Local government and related municipal regulations are important partners in urban greening efforts. They provide political leadership, statutory regulations and associated compliance rules (e.g., to protect trees) and can facilitate participation by other sectors such as the private sector and education.

Recommendations

- Apply much more effort to understanding teacher training needs and materials for supporting greening programmes in schools across Africa, e.g., guidance on tree and shrub species selection and their functionality in urban environments is essential and should also extend to NGOs active in the urban greening space.
- Cities to adopt and endorse municipal-level Local Biodiversity Strategies and Action Plans (LBSAPs). These can be extremely useful in motivating funding for urban greening, as has been seen in Dar es Salaam. LBSAPs are non-statutory planning tools but are aligned with country-level biodiversity strategies, which in turn support UN global biodiversity policy such as the Kunming-Montreal Global Biodiversity Framework. Thus, they are strongly supported by signatory nations, also creating meaningful national-sub-national governance linkages for urban biodiversity.
- Assemble a multi-sector initiative in support of the education sector's participation in urban greening. Bringing together the education sector, local government, the private sector and nurseries/growers to explore collaboration and mutual support in urban greening would be highly advantageous. The African Forum on Urban Forests (AFUF) could possibly convene this, starting with a few pilot municipalities across Africa.

Further reading

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- **https://interactbio.iclei.org/wp-content/uploads/INTERACT-Bio-dialogue-urban-nature-FINAL.pdf**
- **https://interactbio.iclei.org/wp-content/uploads/Dar-es-Salaam-and-Moshi-Cooling-Hot-Cities-2.pdf**

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For queries on this case study, email:
ernita.van.wyk@iclei.org

A teacher holds a seedling prior to planting. Photo: ICLEI Africa.

CHAPTER 5

UGANDA

BACKGROUND

In 2020, Kampala was recognised as one of the 'Tree Cities of the World', an honour bestowed by The Arbor Day Foundation and UN Food and Agriculture Organization to recognise cities committed to grow and maintain their urban forest.

'Through this recognition, Kampala will join a network of like-minded cities who recognise the importance of trees in building healthy, resilient and happy cities,' explained Kampala Capital City Authority (KCCA) in 2021, adding: 'When a city joins Tree Cities of the World, they show their willingness to be a sustainability and urban forestry leader.' KCCA's website states that 'planting trees in a metropolitan area comes with a myriad of benefits. Increasing the number can help reduce costs for energy, stormwater management, and erosion control.'

Since 2020, other African cities, including Nairobi, Cape Town, Pretoria, Rabat and Kigali, have also become Tree Cities of the World. But, with its tree audits, tree labels, and non-motorised transport green corridors, Kampala is still a leader.

The second case study focuses on green spaces in seven 'upcountry' cities. Drawing on an investigation which aimed 'to spark a public dialogue on protecting and preserving open spaces for public use', this case study will encourage others around Africa to look at public spaces in their secondary cities.

A core standard of a Tree City of the World is 'knowing what you have'. On finishing this chapter, readers could ask themselves: 'Do we have an inventory of trees in our capital city and of parks in our other towns?' This is an important gap to fill.

Left: The former Children's Park in Kicementi now hosts a gas station and restaurant, but allows public access to remaining green space. Right: Kampala is still home to remarkable Mvule *(Milicia excelsa)* trees, such as this one in Bukoto. Photos: C Watson and I Pringle.

CASE STUDY #15

Integrating urban forestry, green mobility, and public engagement for city climate resilience in Kampala

Padde Daniel, Marvin Kibalama, Carol Nansimbe, urban foresters/ecologists, Kampala Capital City Authority (KCCA)

With a daytime population of over 2.5 million, Kampala is rapidly urbanising with increased pressure on green spaces, transport systems, and environmental quality. Tree loss, traffic congestion, urban heat stress, and the decline of public spaces threaten the city's identity as a 'garden city' and undermine public health and climate resilience.

This case study showcases how the city is addressing these escalating issues through four interventions: the Kampala Tree Audit; an Urban Forestry Management Plan; Non-Motorised Transport (NMT) corridors; and Tree Name Tagging. Under these, government, NGOs, and communities collaborate to boost the urban forest and build a more resilient city.

The Kampala Tree Audit, enabled in 2016 by a grant from the central government and European Union (EU), allowed Kampala Capital City Authority (KCCA) to recruit its first ever foresters, biostatisticians, and GIS analysts. This initial five-member team was tasked to inventory Kampala's central division to gain accurate data about its urban tree asset, which at the time was largely unknown. With the head of landscaping, directorate of physical planning and others, it conducted a census of urban trees in the four central precincts of Kololo, Nakasero, Mulago, and Makerere, identifying species and assessing tree health, carbon stocks and canopy cover. With additional funding from FAO, AFD and the World Bank, the team did the same across the city divisions of Nakawa, Makindye, and Rubaga 2023–24.

As the result, today, the city public tree database holds information on a staggering 161,754 trees within public spaces, institutions and road reserves.

Left: A tree on Nile Avenue that is labelled to increase public knowledge of Kampala's urban forest. Below: The tree inventory/audit team collects data on tree size and health. Photos: KCCA urban foresters.

Findings include:

- estimated canopy cover is 15%;
- 88% of the trees are healthy, 12% unhealthy, dying or dead;
- species richness is high with over 373 species;
- species diversity (richness and relative abundance) is strongly skewed, however. Of the 161,754 audited trees, 101,905 (63%) are exotic and 59,849 (37%) native; 10 species make up 48.6%; and 50 are represented by a single individual;
- the ten commonest trees are avocado, Cuban palm *(Roystonea regia)*, mango, *Markhamia lutea*, *Dypsis lutescens* (Areca palm), *Polyalthia longifolia* (ashoka), jackfruit, guava, *Eugenia oleina* (former *Syzygium myrtifolium)*, and *Archontophoenix alexandrae* (Alexandra palm) – all but *M. lutea* are exotic;
- the five commonest indigenous trees are *Markhamia lutea*, *Sapium ellipticum*, *Khaya anthotheca*, *Antiaris toxicaria*, and *Vangueria apiculata*;
- eight indigenous trees are of conservation concern under IUCN and/or CITES frameworks: *Khaya anthotheca*, *Warburgia ugandensis*, *Prunus africana*, *Entandrophragma angolense* and *E. cylindricum* (Vulnerable); *Milicia excelsa* (Near Threatened); *Cordia millenii* and *Canarium schweinfurthii* (locally overexploited, habitat loss);
- the city's estimated mean carbon stock is 19.33 tCO_2e/ha^{-1}.

The second intervention, the Kampala Comprehensive Urban Forest Management Plan 2019–39, slated to be revised every five years, currently recommends increasing tree density from ~32 to 74 trees/ha; enhancing native species diversity; raising public awareness; protecting city trees from illegal activities; restoring biodiversity; and promoting ecotourism. Its 2025–30 objectives commit the city to planting at least 7,500 trees a year. Strategies include harnessing corporate social responsibility and urging communities to participate in weekly parish-level tree planting and maintenance of planted trees in their public spaces. Outcomes show improved climate resilience, as shown by 7% net increase in urban forest cover between 2016 and 2021 (Padde et al., 2025), but encroachment on green space continues.

The rationale for the third intervention – the

The non-motorised transport (NMT) – Luwum Street to Namirembe Road – corridor is heavily lined with *Tabebuia rosea* trees, which, though exotic, have a long and successful history in Kampala. Photo: P Daniel.

creation of a Non-Motorised Transport (NMT) green corridor – is that walking and cycling account for most daily trips in Kampala, yet pedestrians and cyclists compete with vehicles, and streets rarely feature safety and environmental quality. Launched in 2018, the first NMT corridor has been actualised along a 3km stretch of Luwum Street to Namirembe Road. Vehicles are discouraged on this thoroughfare to promote urban equity and climate adaptation; reduce road fatalities; and improve 'soft mobility' and the experience of walking and cycling. The design also features safe crossings, street lighting and segregated pedestrian and cyclist lanes. Positive outcomes include reduced congestion, improved air quality, safer commutes, and alignment with broader African urban mobility trends. Part of downtown Kampala is now cleaner and greener. Issues persist, however, with uncontrolled motorcycle usage: cyclists have called for stricter measures.

Tree Name Tagging aims to educate city residents about their trees. The tag text is derived from KCCA's Kampala Tree and Palm Directory and includes common and scientific names and uses. Trees are described as medicinal (e.g. *Warburgia ugandensis, Prunus africana);* edible (e.g. *Canarium schweinfurthii);* agroforestry (e.g. *Markhamia lutea*, *Albizia zygia);* and/or ornamental (e.g. *Delonix regia)*. Names are in English, Luganda, and other local languages. Social media discussion and NGO activities further promote species recognition.

Objectives include better public knowledge of over 300 tree species to aid planning, conservation, and appreciation of biodiversity. Results already suggest better species site matching; increased propagation of native species at the KCCA tree plant nursery and private roadside nurseries; and the public scaling back on some exotic species planting.

KCCA looks forward to increasing NMT corridors and linking them with more green spaces; scaling up the urban tree database and tagging to cover private property; developing an online public tree reporting platform for community engagement in managing trees; and disseminating insights from the Tree Audit and transport design model.

Lessons learned

- Data-driven urban forestry can strengthen city tree management.
- Green corridors can act as flagship climate adaptation projects.
- Combining interventions, such as NMT and community tree maintenance, can yield benefits like increased biodiversity and more social and safer streets.
- Low-cost engagement tools like tree tagging can strengthen public understanding.

Recommendations

- Other African cities can consider replicating Kampala's data-driven approach to conserving and increasing the size, diversity and health of their tree canopy.
- Set targets for increasing tree density, diversity and distribution.
- Integrate nature-based solutions such as trees into everyday urban infrastructure.
- Boost the proportion of indigenous trees, recognising the climatic, disease and pest, and biodiversity risks of a largely exotic tree canopy.

Further reading

- **https://www.kcca.go.ug/news/971/**
- **https://swara.co.ke/astounding-progress-kampalas-plan-for-trees/**
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For queries on this case study, email:
danpaddeyes@gmail.com
kibsmarvin@gmail.com
nansimbecarol@gmail.com

CASE STUDY #16

Uganda's seven new cities have open spaces. In what state are they? And what do people want?

David Ouma Balikowa, Advocates for Public Spaces

This case study draws on a report by Ugandan NGO Advocates for Public Spaces (APS). In partnership with HealthBridge Foundation of Canada, APS conducted research on open spaces in seven regional towns that attained city status in 2020. Across Arua, Fort Portal, Gulu, Jinja, Mbale, Mbarara and Masaka, APS identified and assessed 109 open spaces. The result was about 12 per city, although the actual number is likely to be even higher as the study was limited to urban cores managed by municipal councils before city status was granted.

Other results of the study were:

- Just over half (55%) of the spaces were publicly owned, 25% were part of government school grounds, 16% were privately owned but accessible to the public, and 4% belonged to private schools.
- Most open spaces (77%) were free to access and, where fees were charged, they were generally modest. Among those that charged, 6% required a fee of USh 2,000, 5% USh 1,000, 4.5% USh 10,000, and 4% USh 3,000. In 2025, the US dollar stood at about USh 3,500.
- 60% of respondents said they visited the open space closest to their home, while 37% did not, and 3% were unsure. Reasons for not visiting the nearest space included lack of space to walk or play (17%), fear of injury (10%), poor landscaping (7%), inadequate facilities (5%), fear of crime (3%), and lack of shade (3%). Community members used these spaces for socialising and recreation.
- Seating was in good condition in just 16% of spaces, and poor in 10%. Toilets were found in 56% of sites, and most were free to use. However, only 40% were clean, while half were average and 10% were in poor condition.
- About 30% of public spaces had green areas, 30% featured sports fields, and 30% included

The report singled out Fort Portal and Jinja cities for special praise. Above left is Fort Portal's Balya Road Greenbelt. Meanwhile, Jinja's many green spaces, such as its golf course (above right) and institutional planting (opposite page), are diverse with several located near iconic natural and cultural landmarks. Photos: B Sensasi.

walking paths, either paved or informal. Playgrounds were present in only 8% of spaces, limiting dedicated recreational space for younger children. Vendors were found in a number of open spaces – 34% sold soft drinks and water, 15% fruit juice, and just 1% items like ice cream and popcorn.

In addition, respondents cited multiple reasons for using open spaces. Playing (36%) was the most common, followed by meeting friends (11%), keeping fit (5%), relaxing or thinking (5%), and getting fresh air (4%); 3% mentioned health improvement and 2% finding peace and quiet. An additional 34% offered reasons like grazing cattle, caddying for golfers, collecting water, or walking through the space on the way to the market.

Just over half (52%) visited other open spaces that were not near their homes. Of those, 27% did so to walk or play, 12% because of the good condition of the facilities, 5% for the tree shade or shelter, and 4% due to better security. Another 44% gave reasons such as attending a community gathering, meeting friends, revising schoolwork, grazing cattle, or using the space as a resting point.

When asked what would motivate them to visit open spaces more often or stay longer, 84% had suggestions. Most frequent were improved condition of park facilities (22%), better park furniture (8%), more space to walk or play (11%), more shelter (6%), increased tree shade (6%), better landscaping (4%), safer crossing points (1%), and better security (4%).

In the 31.5% of open spaces with playgrounds, the equipment appeared deteriorated or eroded; 69% of playgrounds had grass and 31% soil. Most playgrounds (79%) were enclosed with a lockable fence. Shade came primarily from trees (49%), shelters (42%), and adjoining buildings (6%): 3% had no shade.

Landscaped green spaces were present in 42% of open spaces, natural vegetation in 39%, and mixed in 19%. In areas with green spaces, children were generally allowed to play (92%), though at 17.6% of the sites it was considered unsafe for them to do so. The green spaces were maintained in 97% of locations, while 3% showed signs of neglect.

Sports fields were common: 78% included goal posts, followed by structures for golf, basketball or netball (13%), and cricket (2%); 45% of sports fields were used for football, 27% for other games like volleyball and baseball, 24% as multipurpose fields, 3% for

‘Plant more trees to increase bird diversity and improve soundscapes to reduce anxiety and improve moods.’

other uses like netball or basketball, and 1% for cricket. Equipment was broken or missing at 43% of spaces, 47% had equipment with some damage, and 9% had equipment with very little damage.

Paths were present in many open spaces. Surfaces were most commonly soil (68.5%), gravel (15%), grass (9%), and concrete (7.4%). However, path conditions were mixed: only 20% were considered good, 38% average, 41% below average, and 1.6% poor. Paths were used by pedestrians, cyclists, and motorbike riders at 68% of the open spaces, while 32% were used for walking only. Vehicular traffic intersected the paths at the same 68% of sites, creating potential safety or comfort issues for walkers and cyclists.

Nearly all open spaces (89%) are bordered by streets, 7% have streets that cross through them, and 4% contain streets within their boundaries.

Those who did not visit cited a lack of suitable play areas (17%) or concerns about injury (10%). Signs indicated that children, elderly people, women, and people living with disabilities may be underserved.

Lessons learned

- Respondents had clear opinions about what they wanted, mentioning inter alia more tree shade, more room to walk or play, and more organised sports.
- Provision of open public spaces varies: Mbarara had the most (20) and Masaka City the fewest (11).
- Hygiene and safety need attention: lack of toilets, gaps in cleanliness, minimal security, and lack of first-aid facilities were salient.

Disparities in access may still exist. Peri-urban and lower-income areas were less likely to be part of the original urban municipal boundaries and therefore less likely to have accessible, well-maintained open spaces. Clockwise: Uganda Sport Ground, Mbale City; Mugulusi Green Belt, Fort Portal; Gulu airfield open space; Sazza playround, Masaka. Photos: B Sensasi.

Recommendations

- Strengthen oversight, coordination and governance of city green and public open spaces.
- Enact by-laws, enforce them through dedicated city units, and protect spaces from encroachment.
- Address the wide variation in conditions and amenities.
- Enhance access and inclusivity and diversify activities and facilities, particularly improving sport fields and playgrounds.

Further reading

'Availability and Quality of Open Public Spaces in The Seven New Cities of Uganda: Arua, Fort Portal, Gulu, Jinja, Mbale, Mbarara, and Masaka.' **https://healthbridge.ca/dist/library/Uganda_Summary_7-City-OPS_compressed.pdf**

For queries on this case study, email:
dobalikowa@gmail.com

'Open-space loss in secondary cities is often a timing problem, where land conversion pressure outpaces formal protection frameworks.'

– VICTOR NSEREKO WANTATE PHD, FOUNDER, LUKANGO TREE CONSERVANCY, FELLOW OF ROYAL SOCIETY OF BIOLOGY AND LINNEAN SOCIETY OF LONDON

Green spaces surveyed for this study also included Independence grounds, Mbarara; City Gardens, Masaka; and a children's playground in Jinja. Photos: B Sensasi.

CHAPTER 6

RWANDA

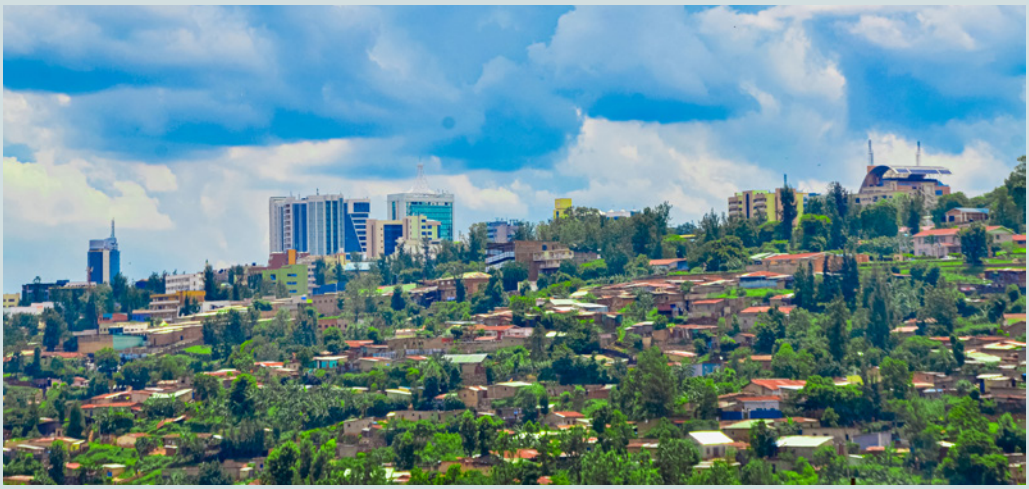
BACKGROUND

With 503 inhabitants/km^2, according to National Institute of Statistics of Rwanda, the country is one of the most densely populated in mainland Africa. Population is particularly dense in Kigali, standing, as of 2022, at 2,391 to 2,401 inhabitants/km^2.

Space is therefore at an absolute premium, and the government recognises green space as particularly vital, even if preventing houses, shops and other buildings from spreading into city forests is challenging (See Case study 18).

Rwanda is one of the very few countries in Africa with official guidance on urban forests. To sustainably manage urban forests and trees to maximise benefits to people in Kigali and secondary cities, The Rwanda Forestry Authority (RFA) recommends that:

The impressive Kigali Convention Centre, built 2009–2016, has a conference centre, hotel, tech park and museum. Its 14ha are well greened. Authorities might consider planting them further to create an arboretum with trees unique to Rwanda, such as the critically endangered *Rhamnus mildbraedii*. Photo: E Kwizera. Wikimedia Commons, distributed under a CC SA 4.0 license.



Seburanga et al. found that domestic garden tree stands, as seen greening this neighbourhood, were one of Kigali's most common urban forest typologies. Photo: P Gatete. Wikimedia Commons, distributed under a CC SA 4.0 license.

- trees planted along both sides of roads, streets or avenues be 5–10m in height and have deep root systems, green broad leaves, and flexible resilient branches (not brittle or self-pruning);
- roadside trees should preferably be single-stemmed with a pyramidal form; trees with rounded, conical, oval or slightly spreading crowns need periodical pruning to ensure good structure;
- long-lived tree species should be the first choice. (See Further reading.)

In other guidance, RFA advised not planting near power lines; landscaping roundabouts so that vehicles can see clearly; and prioritising tree species with cultural values, such as indigenous *Erythrina abyssinica* and *Ficus* and *Dracaena* species. It also recommended flowering shrubs and trees and said exotic and native tree species could be used.

Visitors to Kigali are struck by its green. But like most African cities, it struggles with a preponderance of exotic trees. Research by Seburanga et al. (2015) found a city green space network dominated by alien species (75%), and species around homes to be 'socioeconomic-driven'. Ornamental palms were characteristic of 'fortunate' quarters; fruit-bearing exotics such as guava and avocado of informal ones.

That was in 2014. Four years later, the 2018–24 Forest Sector Strategic Plan called for an urban forest strategy, mapping of potential areas for urban forest, and a 15% annual increase in the urban forest.

Rwanda has the ambition and ability to reach these goals. Read the three case studies here and well as the government's guidance below.

Further reading

- Rwanda Water Portal. *Agroforestry and urban forestry guidelines* **https://tinyurl.com/37j7t895** (accessed 2026)
- Government of Rwanda, Rwanda Forest Authority, WRI (2025) *Guidelines for trees and forest plantations and management in urban areas in Rwanda*. **https://www.rfa.rw/Guideline for Tree Forest Plantation Management in Urban Areas in Rwanda.pdf**

CASE STUDY #17

Rooting resilience: community-based urban nature-based solutions (NbSs) in Kigali

Marc Manyifika, lead, Urban Resilience for Africa, and Japheth Habinshuti, climate resilient cities associate, World Resources Institute

Kigali is celebrated for order and cleanliness. However, rapid urbanisation and changing climate patterns have exacerbated flooding, landslides, and soil erosion, particularly within the Lower Nyabarongo River catchment. These disproportionately affect communities in highly vulnerable, low-lying, informal settlements and are far more than conventional grey infrastructure problems.

This case study looks at a project that is starting a green transformation of Rwanda's capital. Scaling Urban Nature-based Solutions for Climate Adaptation in sub-Saharan Africa (SUNCASA) 2024–26 is targeting root causes of hydrological risk by putting under restoration critical upstream micro-catchments across Gasabo, Kicukiro, and Nyarugenge districts using nature as the primary engineer.

To date the four key interventions have been:

- **Afforestation and reforestation:** Over 390ha of degraded plantations and bare hillsides planted with more than 379,000 seedlings of 16 species, of which ten were indigenous – *Albizia gummifera*, *Maesopsis eminii*, *Markhamia lutea*, *Polyscias fulva*, *Podocarpus falcatus*, *Erythrina abyssinica*,

A school art competition. Pupils hold a poster. With words in Kinyarwanda, it says 'Our City is a Forest'. Photo: Courtesy of WRI.


Left: The project engages with the community. Right: Green City Club tree planting. The boys at left are carrying an indigenous tree, *Podocarpus falcatus*. Photo: Courtesy of WRI.

Ficus thonningii, *Croton megalocarpus*, *Senegalia polyacantha* and *Faidherbia albida* – and six exotic: *Alnus acuminata*, *Grevillea robusta*, *Cedrela serrata*, *Bambusa vulgaris*, *Jacaranda mimosifolia*, and *Carapa grandiflora*.

- **Agroforestry:** On over 1,650ha, planting seedlings of fruit trees and six tree species that grow well with crops, including the indigenous nitrogen-fixing *Albizia gummifera* and *A. adianthifolia*, given to farming households in the peri-urban and rural fringes of the city.
- **Buffer zone stabilisation:** More than 360ha of vulnerable riparian zones reinforced with deep-rooted vegetation like the indigenous *Erythrina abyssinica*.
- **Urban greening:** More than 108,000 trees planted around schools, on roadsides, and in Kigali model villages. While still in the early stages of growth, tree benefits such as canopy cover, cooling, and habitat creation are emerging. Planted species included flowering *Jacaranda mimosifolia*, indigenous trees *Ficus thonningii* and *Khaya anthotheca* (African mahogany), and avocado, mango and citrus.

‘Some initially proposed species had to be changed after consultation with farmers. Some believed that bamboo would highly compete with their crops and didn’t opt for it. They preferred non-competitive species and hated space-intensive species.’
– PROJECT STAFF

Crucially, this was not top-down: community engagement was central.

- Trees at schools were actively cared for by students and staff and so far have survival rates of 75–83%. In 17 schools, Green City Clubs were created to lead tree care and stewardship and raise environmental awareness.
- Roadside trees are currently maintained by the project team but will be handed over to the City to receive ongoing care from women’s and youth cleaning cooperatives employed by the administration.
- Forty-four community groups, known as ‘Friends of Nature Associations’, were established among agroforestry beneficiaries to share knowledge and collaborate on livelihood activities such as mushroom cultivation, horticulture, and livestock farming, fostering collective socioeconomic transformation.
- Residents have been not just labourers but co-designers and stewards, gaining practical skills in tree planting and care.
- In model villages, community pledges are raising chances of long-term survival of trees planted.

Perhaps most innovative is the project’s

**Above: Women loading seedlings to be transported to the planting site.
Below: A childcare facility at the tree nursery site. Photos: Courtesy of WRI.**

deliberate Gender Equality and Social Inclusion (GESI) lens. Recognising that women often bear the brunt of climate impacts yet face barriers to participating in solutions, SUNCASA aims for gender-responsiveness.

- At central tree nurseries in Kabuye and Mageragere, it has installed mobile toilets, handwashing stations, and, crucially, on-site daycare facilities that allowed 25 mothers to engage fully in nursery work and training.
- 44 youth volunteers (60% women) have been trained as monitors, building new environmental champions.
- Over 235 casual workers have received training on gender norms, and 45 couples engaged in dialogues on equitable household roles. Parents at nursery sites adopted rotational childcare schedules.

SUNCASA's impact is emerging. A cost-benefit analysis by the International Institute for Sustainable Development (IISD) indicates that every US dollar invested in these NbSs generates US$ 2.09 in economic, social, and environmental value. By December 2026 the project is anticipated to have generated nearly 5,000 direct jobs, including contractual and casual labour in tree nurseries, site preparation, planting and maintenance, monitoring, evaluation and learning, communication and project management. Over the coming decades, the city is expected to save over US$ 12 million in flood-related infrastructure costs and US$ 5.57 million in climate-related health expenses.

Lessons learned

- 'Green income' can be actualised. Besides jobs created, fruit trees are already producing harvests for household consumption and local markets.
- Large-scale tree planting is doable and enhances urban resilience and biodiversity. Early observations indicate increased bird activity, improved shade, and more favourable microclimate.
- Credible, location-specific data (like flood models) are essential to prioritise interventions and secure stakeholder buy-in, and must be continuously translated into relatable community benefits.
- Blend science, community action, and inclusive governance. SUNCASA began with integrated risk assessment to identify precise intervention points where NbSs would most effectively slow runoff, reduce flood peaks, and stabilise slopes.
- GESI is a multiplier, not a cost: proactively remove barriers to women's participation through childcare, safe facilities, and targeted leadership training.

- Investing in environmental education and leadership roles for youth in schools and villages ensures that stewardship extends beyond the project cycle.
- Partner: No single entity can achieve transformation. Synergy between international technical partners, government bodies, local NGOs, and community structures was the critical ingredient for scaling and legitimacy.

Recommendations

- Municipalities should formally integrate NbS targets and standards into District Development Plans, building codes, and green space masterplans, ensuring long-term budget allocation and enforcement.
- Develop local NbS value chains such as community-run nurseries, compost production, and eco-enterprises to turn conservation into a sustainable livelihood.
- Institutionalise community co-design: Make participatory risk mapping and solution design a mandatory step in urban infrastructure and climate adaptation projects.
- Legally recognise community groups as key stakeholders.
- Explore blended financing approaches. These could combine municipal budgets, results-based climate or carbon financing, and corporate ESG contributions from Kigali-based businesses.

Further reading

https://www.iisd.org/system/files/2025-04/suncasa-kigali-rwanda-tree-planting.pdf

For queries on this case study, email:
marc.manyifika@wri.org
Japheth.Habinshuti@wri.org

SUNCASA is implemented by a coalition including the International Institute for Sustainable Development (IISD) and the World Resources Institute (WRI), supported by locally based organisations such as the Albertine Rift Conservation Society (ARCOS Network), AVEGA Agahozo, and the Rwanda Young Water Professionals (RYWP), in close partnership with the City of Kigali and other government entities.

CASE STUDY #18

Preservation of forest resources in Kigali City: trends, challenges and opportunities

Ernest Uwayezu, Josephine Malonza, and Samuel Twizerimana, School of Architecture and Built Environment (SABE), College of Science and Technology (CST), University of Rwanda

Kigali, Rwanda's capital and economic centre, is one of Africa's fastest-growing cities and is experiencing marked urban sprawl as well as peri-urbanisation on its fringes. Over the past three decades, this rapid urbanisation combined with agricultural expansion and population growth have diminished forest resources in Kigali City, with land use conversion for urban development the main driver of loss.

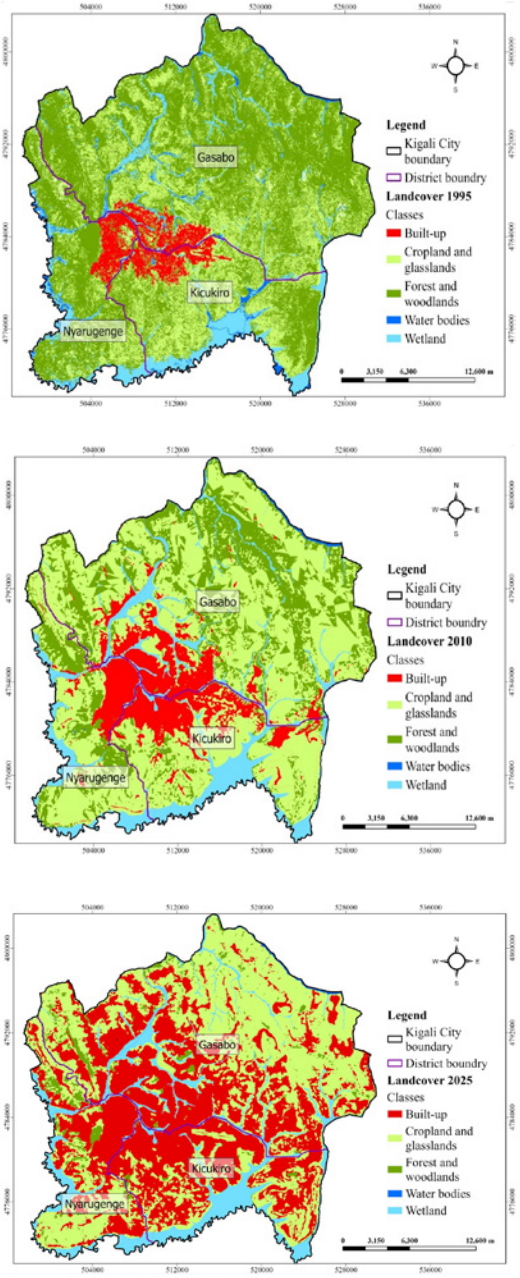
- From 1995 to 2000, the post-genocide recovery period, the city lost over 23,314ha of forest to built-up areas and cropland.
- From 2000 to 2020, it lost roughly 30% of its vegetation cover: green space declined from 26% to 18% of the city's area.
- From 2015 to 2020, forest cover decreased from ~6,140.61ha to 1,524.10ha through continued conversion to built-up areas and cropland. Wetlands also decreased, and just 1,524ha of forest remained.
- From 2020 to 2025, the city experienced slight forest restoration, with a rise of forest cover to ~2,497ha.

This case study looks at why, despite strong formal policies, forest loss has been so persistent. It also investigates the opportunities presented by existing policies and the challenges in their implementation. Finally, it probes what might have triggered what appears to be a slight recovery in forest cover between 2020 and 2025.

For the study, a literature review and spatial data analyses were conducted. During data collection, 42 community members were interviewed, and other informants included local leaders and government officials, including urban planners, and environmental experts. The study area was visited multiple times.

Findings reveal factors behind the loss of forest resources during the past decades.

Left: Housing encroachment on peri-urban forest in the sector of Kanyinya. Right: Part of Mount Kigali Forest plantation in Nyabugogo Cell on the bank of Nyabugogo River. Photos: S Twizerimana, February 2026.



As yet unpublished maps of Kigali land use and land cover in 1995, 2010 and 2025 compiled by the authors from data from the US Geological Service and the European Space Agency's Earth observation programme Copernicus. They show heavy loss of forest and woodland driven by urban and cropland expansion. Note the exponential increase in pale green and red at the expense of dark green.

These include:

- inadequate enforcement of zoning regulations, limited monitoring of compliance with zoning regulations by the local communities, and inconsistent application of penalties;
- institutional capacity gaps resulting in limited prevention measures against the violations of zoning regulations;
- a mismatch between policy intent and the on-the-ground reality that manifests as community resistance in densely populated areas, where housing and commerce are prioritised;
- a planning focus that prioritises other uses, often sidelining the integration of green space until after land degradation has occurred;
- a persistent failure to incorporate green infrastructure as a core component of early-stage development projects, leading to the unauthorised conversion of designated green zones;
- interventions, like green space development, only coming about after significant forest loss, highlighting a systemic planning shortfall;
- ecological infrastructure adopted reactively rather than being a foundational urban element.

Up until 2020, encroachment on forest resources occurred largely due to lack of enforcement of compliance to the 2012–19 Kigali City Master Plan. Members of local communities and government officials interviewed also pointed to the practice of land price speculation and the limited capacity of Kigali's poor and low-income groups to develop their dwellings in the planned zones as pivotal drivers of illegal conversion. This last observation is supported by field visits to Kimisagara, Jali, Kanyinya, Gikondo, Remera, Kinyinya, and Rusororo sectors, where plots covered by trees were in fact being cleared and prepared for construction.

Yet, in a 'paradox of implementation', myriad frameworks in Rwanda emphasise

sustainable urbanisation, and could potentially address the above situation. These include the Economic Development and Poverty Reduction Strategy (EDPRS 2), the 2018 National Forestry Policy, and Vision 2050, which have environmental sustainability/climate resilience as pillars; the National Strategy for Transformation 2 with its green growth/sustainable land management focus; the National Forest Policy, Green Growth and Climate Resilience Strategy, and Rwanda's Nationally Determined Contributions, which highlight forests as vital for carbon sequestration, soil conservation, biodiversity, and disaster risk reduction; the National Land Use and Development Master Plan, which describes forests/green corridors as critical; and the most recent Kigali City Master Plan (2020–50), which states that at least 25% of the city should be recreational and green.

Following the passage and implementation of those frameworks, there has been a small but noticeable shift from forest cover decline to a slight increase, which suggests movement in the right direction. More specifically, the slight increase could be ascribed to the implementation of Rwanda's National Forestry Policy (2018), enforcement of the 2020–50 Kigali City Master Plan, and restoration and afforestation programmes. In addition, it is the perception of respondents in this study that the City of Kigali *(Umujyi wa Kigali* in Kinyarwanda), government agencies and local NGOs embarked upon restoration following the adoption of the EDPRS 2 (2013–18). Their target areas have included particularly high slope zones where forest was degraded, and areas where illegal settlements were cleared.

'We hear concerns that we are losing greenery. We understand. We are continuing to make a conscious (and) deliberate plan and effort to protect and enhance our green spaces (and biodiversity). It has always been an integral part of planning in Kigali and it continues to be the case in this Updated Master Plan.' – CITY OF KIGALI STATEMENT, 4 SEPTEMBER 2020

Lessons learned

- Kigali's efforts to conserve forest resources are challenged by population growth and urban sprawl.
- Forest cover decline persists despite a protective regulatory framework, primarily due to limited enforcement.
- Forest cover loss is fuelled by speculative land market and competing land use interests.
- Even amid rapid urban expansion, Kigali City has opportunities to preserve and enhance its forest resources, inter alia through projects like Green City Kigali and Scaling Urban Nature-based Solutions (NbSs) for Climate Adaptation in sub-Saharan Africa (SUNCASA).
- The recent slight uptick in forest cover suggests that policies and guidance can work.

Recommendations

- Shift urban development thinking toward a compact city and vertical development and promote densification on smaller plots, making this a core role of the Rwanda Housing Authority.
- Promote green building standards such as green roofs and walls.
- Take advantage of remote sensing technology and geospatial monitoring to ensure real-time detection of encroachment as institutionalised by National Land Authority (NLA) and Kigali City.
- Coordinate more effectively between agencies in term of land use planning and development.
- Leverage the robust policies already available to overcome weak enforcement.
- Strengthen the enforcement capacity of

digital platforms, particularly the KUBAKA building permit system, to guarantee absolute compliance with the green space provisions of the Kigali City Master Plan 2020–50.
- Mandate that green infrastructure is a core design element and becomes standard for all developments.
- Evolve urban planning from reactive to proactive by prioritising green integration from planning stage.
- Apply universally the successful green space allocation formula from informal settlement upgrades.
- Use a dual approach of strict enforcement of zoning regulations and positive economic incentives.
- Apply stringent penalties for illegal forest conversion.
- Promote the alternative land value option when soliciting private sector investment.
- Shift community perception through community engagement and public awareness campaigns towards the long-term health and economic value of conserved forests versus short-term land sale profits.
- Overcome the root causes of policy failure and unsustainable land conversion by building upon the opportunities in Rwanda's existing regulatory framework.

Further reading

- **https://www.kigalicity.gov.rw/news-detail/city-of-kigali-launches-new-master-plan-2050**
- Manirakiza, V., Mugabe, L., Nsabimana, A., and Nzayirambaho, M. (2019). 'City Profile: Kigali, Rwanda.' *Environment and Urbanization ASIA*, 10(2), 290–307.
- Nshimiyimana, A. R., Niyigena, E., Nyandwi, E., Ngwijabagabo, H., and Rugengamanzi, G. (2023). 'Spatial Assessment of Urban Growth on Green Spaces in Rwanda: An insight from Rebero Mountain Landscape in Kicukiro District, City of Kigali.' *Rwanda Journal of Engineering, Science, Technology and Environment*, 5. **https://www.ajol.info/index.php/rjeste/article/view/249264**
- Twizerimana, S., Tuyishime, E., and Uwizeyimana, J. (2025). 'Managing urban growth and protecting the environment in Gasabo District, Rwanda.' *Discover Sustainability*, 6(1), 1277. **https://doi.org/10.1007/s43621-025-02117-5**

For queries on this case study, email:
e.uwayezu@ur.ac.rw
jmalonza@ur.ac.rw

CASE STUDY #19

Nyandungu Eco-Park in Kigali: in a complex urban ecosystem of forest, savanna, and wetland, benefits accrue for people and biodiversity

Venuste Nsengimana, Philippe S. Munyandamutsa, Centre of Excellence in Biodiversity and Natural Resource Management, University of Rwanda

Nyandungu Eco-Park is Kigali's largest and most important green space. It is to the capital of Rwanda what Karura Forest is to the capital of Kenya – a nature-based solution to healthy living in a city where it is not always easy to take a walk, run, bike, play on grass or gather as a family outdoors.

In 2024, Nyandungu Eco-Park attracted about 6,500 visitors a month, 70% of them local. Like Karura Forest, which charges minimally for entry to help support the park, Rwandan and East African Community citizens pay a fee of slightly less than US$1, foreign residents US$2, and international visitors US$3.5. In return, visitors experience nature and 10km of walkways, bikeways and other facilities.

Finally, the two urban nature areas also have in common that they are now safe and well managed but, prior to restoration, were grievously degrading.

The wetland portion of what became the eco-park had been damaged by decades of uncontrolled acitivites such as agriculture, heavy grazing by livestock, pollution from sewage and industry, and rapid urbanisation and sprawl. It had largely lost its capacity to act as a natural sponge for excess rainwater, with the result that floods regularly severed roads and damaged nearby dwellings and businesses. Mining and stone quarrying had destroyed habitat in its drier parts, including treed areas.

Change began in 2016 when Rwanda Environment Management Authority (REMA) launched a 4.5 billion RWF project to restore the area's natural functions. Likely little imagining the success story that would ensue,

Before and after: The lake area is clearly regenerating. Visible at right are bullrushes (*Typha* species) and other wetland plants critical for biodiversity as well as water purification. Photo: Rwanda Green Fund.

In one of the first steps towards restoration of the Nyandungu wetland, National Environment Week 2017 is launched with Umuganda (community work) to create the eco-tourism park. Photo: Rwanda Environment Management Authority (REMA).

it removed illegal businesses and created five catchment ponds and three recreational ponds to manage water flow and reduce pollution. It relocated farmers and residents, many of whom were assisted to find new livelihoods. It also reintroduced 17,000 indigenous trees of 55 native species, including *Croton megalocarpus*, *Ficus thonningii*, *F. ovata*, *Syzygium guineense*, *S. parvifolium*, *Markhamia lutea*, and *Hallea (Mitragyna) stipulosa*, the last a swamp-loving tree with many medicinal properties and useful timber, and classified as Vulnerable on the IUCN Red List of threatened species.

The 121ha Nyandungu Eco-Park was officially opened in July 2022 in what the Rwanda Development Board described as 'the single largest addition to public green space in Kigali in the city's history.' It is now a thriving wetland, forest and savanna habitat that includes acacia savanna, mixed woodlands, a restored fig forest, and an indigenous gallery forest.

In what is not just a wetlands story, spending time in the park is made better by trees, which also strengthen the park's ecological functions such as flood mitigation and pollution abatement. The water and air are now cleaner.

The urban park provides recreational services with the intention of conserving the environment and educating visitors. It is also used for academic research and education for biodiversity conservation and environment management in Rwanda. It has a medicinal plant garden.

Under an agreement with the Rwanda Environment Management Authority and the Rwanda Development Board, a private venue management company runs and stewards Nyandungu Eco-Park.

In June 2025, Rwanda's largest English-language paper reported that the park had received 77,000 visitors in 2024, up from 48,813 in 2022 and 67,222 in 2023, and 'was set to expand by an additional 43 hectares.' The initiative also generated approximately 4,000 green jobs, said *The New Times*, adding that 'nearly 200 bird species that had ceased to

From left to right: A walkway across the wetland; a visitor reading a poster about the restoration; evidence of ecosystem recovery – herons; and *Erythrina abyssinica*, an indigenous tree found in the eco-park. Photos: REMA, V Nsengimana, Rwanda Green Fund.

frequent it due to degradation had returned following its rehabilitation.'

That may be an overstatement. But what has happened to biodiversity? Before 2016, the hardworking wetland with its forested areas was sliding into ever greater degradation and had not been surveyed. But surveys since 2016 show numbers of species steadily increasing and biodiversity bouncing back.

A survey in 2016 revealed two species of dragonfly and damselfly; a survey in 2017 identified 97 plants; sampling in 2019 revealed seven species of amphibians and 373 plant species; assessments in 2021 found six species of amphibians, 12 waterbird species, and 132 plant species. Finally, in 2022, waterbird species alone were found to number 15.

However, more recently, in 2023, the Centre of Excellence in Biodiversity and Natural Resource Management (CoEB) at the University of Rwanda assessed multiple taxa. Plants were surveyed using the quadrat and plots; birds through point counts and across transects in early morning and late afternoon hours; amphibians by a visual encounter survey and night acoustic sampling; reptiles during the day using active searching and opportunistic encounter surveys; butterflies and dragonflies using sweep nets and visual identification in the field; and fish using scoop nets and fish traps.

Data were analysed for species richness and relative abundance, and specimens identified to family and species levels using identification keys, by consulting experts and by comparison with plant and animal specimens in University of Rwanda collections.

The results showed a strong increase in biodiversity, with 11 species of amphibians; two species of reptiles; 83 species of birds, including the Grey Crowned Crane *(Balearica regulorum)*, classified as Endangered on the IUCN Red List; 258 plant species (154 native and 104 non-native); seven species of fish; and 56 species of butterflies – the nymphalid group was dominant with 15 species. Also found were 29 macroinvertebrate families including 20 families of insects; three families of molluscs; two families of annelid worms; two families of crustaceans; and one family of arachnids (spiders).

Lessons learned

- The 121ha Nyandungu Eco-Park is a success for people and nature and will likely receive close to 100,000 visitors in 2026 and increasingly be a biodiversity hotspot. The presence of the iconic Grey Crowned Crane highlights the wetland's role as a refuge.
- The assemblage of taxa noted demonstrates restoration success and ecological integrity.
- The coexistence of high species richness across vertebrates, invertebrates, and plants reflects a structurally diverse ecosystem that provides multiple niches.
- And, the breadth of macroinvertebrate families and butterfly diversity points to functional resilience and trophic complexity, which are essential for ecosystem stability.

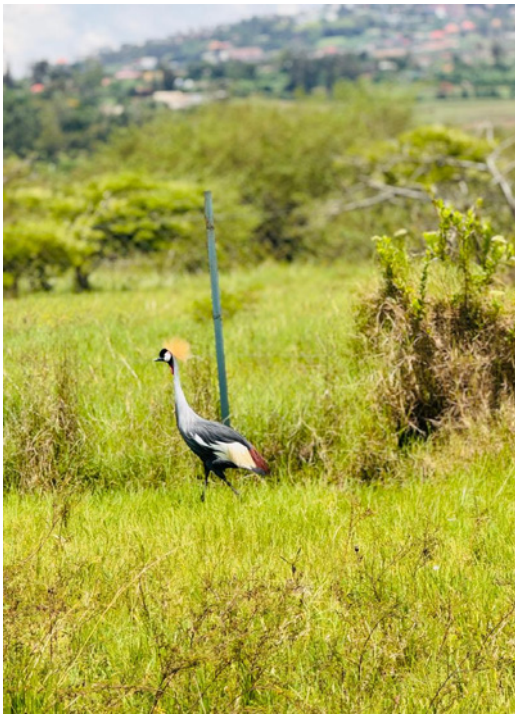
Recommendations

- Governments across Africa should secure and restore at least one substantial natural area within their capital city, as Kigali did with Nyandungu and Nairobi with Karura Forest. Plan early: in rapidly urbanising cities, land disappears fast. Where a large site is not feasible, a network of smaller restored green spaces can deliver similar benefits (e.g., exercise, socialising and destressing).
- For long-term sustainbility, there should be good management, and charging for entrance on a sliding scale.
- Judge success by footfall.
- For ecological sustainability, implement landscape-level planning and integrated management strategies that balance species conservation, invasive species control, and habitat protection.
- Continue to make it people-centred as well, delivering health and social benefit to visitors. In Nairobi, visitors to Karura Forest have been its greatest defenders in times of political pressure.

Further reading

https://www.newtimes.co.rw/article/27649/news/environment/nyandungu-eco-park-recorded-over-76000-visitors-in-2024

For queries on this case study, email:
v.nsengimana3@ur.ac.rw



A Grey Crowned Crane. Photo: V Nsengimana.

CHAPTER 7

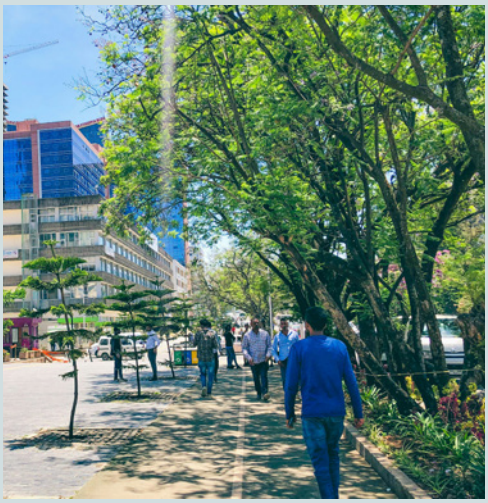
ETHIOPIA

BACKGROUND

Ethiopia has a strong tradition of trees in towns and around buildings, particularly its former Imperial buildings and Ethiopian Orthodox Tewahedo churches.

Further evidence of an urban tree tradition are roadside trees, which are found in even the smallest towns, shading shopfronts and the entrepreneurial young women who serve traditionally brewed coffee.

Tree loss is longstanding in Ethiopia: paintings by British artist Henry Salt 200 years ago show land degrading. Ethiopia's streets, however, are some of the best treed in Africa. In Bahir Dar, canopy closure is almost 100% along its main boulevard.



A well-treed street with Norfolk Island pine (*Araucaria heterophylla*) alongside more established jacaranda trees. Botanists suggest integrating more indigenous trees. 'It is not too late to add,' said a tree diversity expert. Photo: D Emale.

In 2019, Addis Ababa City Administration embarked upon two initiatives: the River and Riverside Development Project and Urban Transformation Corridors, which together constitute one of the most ambitious efforts to green an African city.

'In Addis, most households do not possess private gardens. By developing green public spaces, the city is providing people with green public goods,' says Ledet Muleta, director of international relations at the Mayor's office.

As of mid-2025, Addis Ababa had planted so many trees that it had increased tree cover from 2.8% to 22%, with a long-term goal of 30%.

The increase is hugely impressive. However, botanists would like to see the city diversify its species choice. Following through, the city's Gullele Botanic Garden provided over 41,000 seedlings, some of them threatened species.

'Most of the plants planted in Addis Ababa are exotic,' explained a botanist at Gullele. 'We have indigenous as well as endemic species that can be ornamental. We also want to introduce native plants, especially to children who have never seen them before. Planting such species in cities can conserve them.'

CASE STUDY #20

Use of parks in Hawassa, a regional capital in southern Ethiopia

Yeshewazef Gebrewold Hailegiorgis, senior lecturer at the School of Hotel and Tourism at Hawassa University College of Business and Economics

Hailegiorgis begins her 2017 study on 'Recreational Parks: Practices and Challenges in Hawassa City' by introducing Hawassa, saying it has a great open-air market, several squares, and immense tourist-attracting natural beauty in its surrounds, including a mountain and the lake on the shores of which Hawassa sits. But it only has two parks – Amora Gedel Park, which, at the time of her research, was receiving about 58,500 visitors a year, and Millennium Park, which was receiving about 1,000.

Interviewing some 315 of these visitors, as well as park staff and the head of Hawassa City Beautification, Parks and Cemetery Development and Administration work unit, Hailegiorgis' findings included:

- 65.7% of visitors to the parks were male;
- 80% of visitors were aged 16–34;
- 57.2% come once a month, 37% once a year, and 5.7% come every day;
- 77.1% of visitors stay more than an hour, 14.3% stay for 30 minutes to 1 hour, and 8.6% for 16–30 minutes;
- 80% of respondents said they were visiting one or other of the parks 'to admire and enjoy the environment', and 11.4% to eat/drink;
- no visitors came to the parks to exercise or play sports, as neither park had 'sport and recreational facilities like swimming pool, walking/running trail, table tennis or basketball court';
- 60% of respondents said they always felt secure in the parks. But 40%, mostly women, said they did not. 'Millennium Park's fences are failing and can be jumped easily, and Amora Gedel Park's fence is under construction,' writes Hailegiorgis. Also, the parks lack signposts and clear walkways, and guards are insufficient. Robbers can enter as visitors since the entrance fee is affordable, and park staff cannot distinguish them from other visitors. With only one lifesaver, the boat service is unsafe too.
- Neither park has a functional toilet, let alone one accessible to visitors with special needs.
- Neither park has an organised cafeteria; instead, they have a small private shop for biscuits, candies and soft drinks.

The entrance to Amora Gedel Park; visitors can be seen arriving by tuk-tuk. Photos supplied by YG Hailegiorgis.

More positively, she found that:

- 65.7% of the 315 respondents felt that park workers were welcoming, 54.3% thought them willing to help, and 51.45% thought they were able to answer their questions.
- Just 8.6% of the visitors interviewed found the entrance fee expensive, the rest finding it 'average' or even inexpensive. 'This means that the fees charged are perceived to be affordable', writes Hailegiorgis.
- What visitors did not want in the park, according to the researcher, was dumping of waste; people chewing khat or smoking; sexual activities; or children and adolescents 'who mistreat and beg from users'.

Lessons learned

This study is not tree focused, nor does it dwell on the identity, abundance, services or management of the park trees, which, in the case of Amora Gedel Park, include large *Vachellia* and *Senegalia* and *Ficus* spp. trees, according to online photos. Nevertheless, the study does a great service:

- Users, although likely mostly first-generation park goers, have a clear idea of what a park should be.
- Safety, particularly for women, is top of the hierachy of needs, with ease, comfort and cleanliness also important.
- Users seek seating, toilets, children's play

Calming verdant vistas in the parks under discussion show few visitors. If shortcomings were addressed, they would likely be more frequented. Photos supplied by YG Hailegiorgis.

areas, shelter, different sports areas, food and drink outlets, attractive landscape design, a place for recreation, and walkways, including for the disabled.

- Neither the park staff, seen as welcoming and helpful, nor the cost of entry, seen as affordable, were a barrier to park use. But both parks were underutilised.

Recommendations

- Improving the parks would raise usage, leading to more people gaining the health and social benefits of the green spaces. More people could visit for longer and existing visitors could also spend more time there and be more frequent.
- Security is paramount: 'A partnership between state, private sector and communities is necessary to ensure that people do not stay away due to insecurity,' she concludes.

Further reading

- https://thecityfix.com/blog/lessons-from-addis-ababas-corridor-development-initiative/
- https://www.longdom.org/open-access/recreational-parks-practices-and-challenges-in-hawassa-city-16036.html

For queries on this case study, email:
ygwoldster@gmail.com

'Like in Hawassa, we also found that city authorities need to take measures to protect and improve the quality of the open spaces.'

– DAVID OUMA BALIKOWA, LEAD AUTHOR OF THE CASE STUDY ON PUBLIC SPACES IN REGIONAL CITIES IN UGANDA.

CASE STUDY #21

Urban land surface cover dynamics and their impacts on land surface temperature 2011–21 within the municipal boundary of Hawassa City

Tikabo Gebreyesus, Kumlachew Yeshitila and Aramde Fetene from the Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University, and Cristina Herrero-Jáuregui of Complutense University of Madrid's Department of Biodiversity, Ecology and Evolution

'Rapid urbanisation in Africa leads to substantial land cover changes, exacerbating climate change impacts,' state the authors led by Tikabo Gebreyesus. They also state that 'the extent of green coverage required to mitigate rising temperatures in Ethiopia's urban centres remains poorly understood.' This is the question that they, as architects and builders, wanted to answer in this case study.

Hawassa is the capital of Ethiopia's Sidama National Region. Located 273km from Addis Ababa, the city sits at 1,680m above sea level on the shores of Lake Hawassa on the edge of the Great Rift Valley. It receives 1,000 to 1,400mm of rain a year. Rapidly urbanising,

A well-greened avenue in Hawassa. Man-made urban green spaces, largely developed through policy-driven initiatives, expanded in the city alongside urban growth, particularly into former farming areas that were predominantly bare land prior to 2011. Photo supplied by T Gebreyesus.

In a counterintuitive finding, despite an increase in built-up areas, because tree cover increased, temperatures did not increase as expected. Photo supplied by T Gebreyesus.

Hawassa's current population is estimated to be over 500,000. It was a good place to study the relationship between heat and trees.

Tikabo and colleagues particularly wanted to assess grey versus green coverage – grey being buildings, concrete and impervious surfaces through which water does not pass. They sought to detect changes in ground surface cover over the past decade and to analyse the impact of the change of land surface cover on land surface temperature between 2011 and 2021.

They did this by using satellite images to assess land surface temperature, with image preprocessing including radiometric calibration, atmospheric correction, and Normalized Difference Vegetation Index or NDVI. NDVI is 'used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health,' according to the US Geological Survey. Further, they applied the US Department of Agriculture Forest Service's i-Tree Canopy software to assess land surface and estimate canopy cover changes.

The results showed that in 2021, Hawassa's land surface was predominantly grey (40.6%), followed by green (36%) and exposed soil (23.4%). That may not sound good to those looking for trees, and indeed the impervious surface cover had increased by 24% between 2011 and 2021. Very importantly, however, the results of Tikabo and team also showed that urban tree canopy had increased by 9.8% during this time, and that this seems to have been enough to cause an increase in greenness (NDVI) from 0.17 in 2011 to 0.23 in 2021.

Online sources state that an NDVI of 0.1–0.2 is typically bare soil, while 0.2–0.3 indicates sparse vegetation, shrubland, and grassland with the presence of some photosynthetic activity. This a substantial shift.

At land surface cover unit level, the results revealed substantial variation in land surface temperature. As expected, built-up areas and barren land exhibited the highest mean land surface temperatures, with built-up areas at 29.10°C and barren land 29.85°C. In contrast, urban green spaces were cooler, with lower mean land surface temperatures of 27.24°C and moderately higher NDVI (greenness). This is a measurable cooling effect.

Many of the green spaces were the result of 'policy-driven initiatives', including Ethiopia's Green Legacy Initiative, an ambitious nationwide reforestation programme started in 2019 to plant billions of trees, restore 22 million hectares of degraded land, and enhance ecological resilience. The next year, the Green Legacy Initiative's 2020 tree-planting season was launched in Hawassa itself by Ethiopia's Prime Minister Abiy Ahmed and members of its national steering committee, who planted seedlings on the city's Tabor Mountain in a high-profile event. And, to mention another policy-driven initiative, as far back as 2016, Ethiopia's Policy Studies Institute planted thousands of trees in and around Hawassa.

Temporally, further statistical analysis of what was happening in Hawassa showed that the more tree cover there was, the lower the temperatures were. In fact, in Hawassa, the minimum land surface temperature increased by approximately 0.6°C, while the average and maximum land surface temperature declined by 1.67°C and 2.17°C, respectively, over the study period.

In so many ways, this increase in tree cover and drop in temperature are surprising. Typically, urban growth leads to a loss of tree cover and rising urban heat. But in Hawassa, a city that has grown by expanding into farmland areas that previously had scattered trees but also enjoyed official efforts to plant urban trees, there has been an increase in tree canopy cover and NDVI.

According to the authors, this reflects the integration of urban trees into residential areas as well as the creation of urban green spaces and the planting of street trees in the commercial and administrative areas of the city.

'Urban tree cover increased from 2011–21 despite rapid urbanisation,' said Tikabo, presenting his findings in South Africa. Clarifying further, he stated that 'the concurrent expansion of urban green space and urbanisation over the study period indicates deliberate planning efforts to integrate green areas into the urban core, consistent with the city's structural plans (2007–21). Man-made urban green spaces, largely developed through policy-driven initiatives, expanded in Hawassa alongside urban growth, particularly into former farming areas that were predominantly bare land prior to 2011.'

Active tree-planting efforts along a main road in Hawassa city, and one of the tree nurseries supplying seedlings. Photos supplied by T Gebreyesus.

Lessons learned

- Land surface temperature reflects differences in vegetation density and surface characteristics (bare, impervious and others).
- The temperature variation between vegetated and non-vegetated areas in Hawassa highlights the explicit cooling effect or 'urban thermal regulation roles' of urban green spaces.
- Vegetated areas were found to be 1.86°C cooler than built-up areas and 2.61°C cooler than barren areas.
- Former agricultural areas had minimal shrub cover. However, when converted to private residences and other types of building, owners created green spaces dominated by ornamental shade and fruit trees.

Recommendations

- Official drives to retain and grow trees need to be pursued intentionally in other cities in Ethiopia, given that the long-term cooling effectiveness of vegetation has been emphatically demonstrated in Hawassa.
- Cooling can be promoted by better integration of natural vegetation into city areas.

Further reading

Abel Feyisa, Mesele Negash and Yoseph Melka (2021). 'Urban green infrastructure affects woody plant diversity and carbon stock in Hawassa city in Ethiopia.' *Arboricultural Journal*, **https://doi.org/10.1080/03071375.2021.2014696.**

This study found that the city's green infrastructure included the main municipality urban forest; small forests in the city centre; trees in the large compounds of public offices, factories and private institutions including hotels and resorts; street trees on the central reservations, roadsides and traffic squares; and urban forests in the religious compounds of the Ethiopian Orthodox Church, which have unique species selection and management.

For queries on this case study, email:
45tikabo@gmail.com

The research we need: suitability of five indigenous trees for urban settings

In Addis Ababa, plant and biodiversity scientists from Addis Ababa University and CIFOR-ICRAF evaluated the performance of *Juniperus procera*, *Olea europaea* subsp. *cuspidata*, *Vachellia abyssinica*, *Hagenia abyssinica*, and *Afrocarpus falcatus*. For each, 100 seedlings were planted and monitored for 225 days. Mulching, weeding, and watering were conducted. Every 45 days, height, root collar diameter, death, damage, wilting, and defoliation were recorded: 18 *V. abyssinica* seedlings perished, and wild animals damaged 45% of *O. europaea* seedlings. But mean survival rates were 90.4% at 225 days.

'The study showed that Addis Ababa is a suitable site for the successful growth of the five indigenous species,' write the authors. Similar studies would be useful to identify 'candidate' indigenous trees for other African cities.

E Tenkir et al. (2024). 'Site Suitability, Early Survival, and Growth Performance of Five Indigenous Tree Species to Integrate in Urban Green Space of Addis Ababa, Ethiopia.' *Aboriculture & Urban Forestry*, **https://www.cifor-icraf.org/knowledge/publication/35695/**

CASE STUDY #22

Greening Rama: how trees are quietly transforming a dryland town in Tigray, Northern Ethiopia

Negasi Solomon Gebru, Lead Researcher in Ecology, Tigray Institute of Policy Studies, and Assistant Professor, Mekelle University

This case study arises out of research that set out to measure biodiversity and carbon storage in Rama's green spaces – parks, churchyards, schools, and roadside plantings.

Located in Tigray region, about 35km north of Adwa, the town began as a settlement in a place called *Enda Degele* or 'place of Degele grass'. It had extensive vegetation cover. When Italian soldiers arrived in 1946, the sand, stone and fragrance of frankincense reminded them of Rome. They called it Roma, which became Rama.

Since then, Rama has lost its forest due to human settlement, agricultural expansion, fuelwood extraction, grazing pressure, and recurrent droughts. Today it is a bustling town of about 7,824 people. Average annual rainfall is ~647mm, and temperatures rise well above 25°C.

Researchers sought to understand how urban green spaces perform, laying out 40 plots across the town, 10 each in parks, churches, educational compounds, and along roads. They measured tree height, diameter, and species type using GPS and calipers, and calculated carbon storage using established equations that estimate how much carbon is locked away in a tree's wood and roots.

They found a surprisingly rich mix of trees, recording 13 woody species from nine families. Seven species were indigenous: *Balanites aegyptiaca* (Mekie), *Parkinsonia aculeata* (Shewit Haggay), *Ziziphus spina-christi* (Geba), *Vachellia tortilis* (locally Ala), *V. bussei* (Gumero), *V. lahai* (Lahay) and *Anogeissus leiocarpus* (Hanse), while six were exotic: *Azadirachta indica* (Neem), *Mangifera indica* (Mango), *Citrus sinensis* (Aranshi), *Delonix regia* (Bush), *Jatropha curcas* (Jatropha) and *Moringa stenopetala* (Shiferaw).

Each green space type had its own story. In terms of individual trees (density) per 20x20m plot, churches recorded the highest mean values of 17 ±7.58, followed by educational sites at 15.8 ±3.8, and parks at 15.25 ±3.7. Roadsides had 13.6 ±3.66 trees per 100x1.5m plot.

For species variety, on the other hand, parks

Young boys gather under trees, trees next to a wall, and a mini café in tree shade along a street. Street trees are central to daily life in the small town of Rama in Tigray, Ethiopia. Photos: H Hadush.

had the most with seven species; churches and roadsides had five species but more mature trees; and educational sites had intermediate richness with six species.

Some species stood out as 'carbon champions', storing particularly large quantities: *Vachellia tortilis* – 806.9kg/ha; *Vachellia lahai* – 574.1kg/ha; *Ziziphus spina-christi* – 332.2kg/ha; *Balanites aegyptiaca* – 287.0kg/ha; *Azadirachta indica* (Neem) – 124.7kg/ha; and *Mangifera indica* (Mango) – 84.8kg/ha. With the exception of Neem, which is exotic, and Mango which is naturalised, all of these species are indigenous.

Vachellia tortilis, a fast-growing, coppicing, nitrogen-fixing native dryland species with thick bark and deep roots, is particularly adept at survival in this agroecological zone. Besides storing carbon, it is an invaluable source of fuelwood as well as fodder in Ethiopia: foliage and fruits form important browse, green as well as dry.

Due to their much larger size and diameter, trees planted along the sides of roads stored the most carbon by far – over 41Mg C/ha. Churches held around 11Mg C/ha and parks about 7Mg C/ha.

However, in urban green spaces in Rama, higher tree diversity did not necessarily store more carbon. This contrasts with the common global finding that more diverse forests, including **Ethiopian dry afromontane forests**, tend to be carbon richer. In Rama's harsh conditions, a few large species dominate, storing ample carbon but leaving little room for other species.

In Rama, churchyards are oases. The trees are young, but carefully protected, and culturally valued. Offering shade for prayer and gatherings, they anchor the town's green identity. However, they are less diverse than churchyards in rural Ethiopia, where tree stands are typically old, dense and dominated by naturally regenerated species that have developed over long periods with minimal disturbance. In urban churchyards, trees tend to be planted, not regenerated, their composition and structure strongly influenced by active management by church administrators who often prioritise space constraints and safety considerations, which limit species diversity and stand density.

In terms of carbon, parks are small but symbolic. They had the lowest carbon storage, mainly because they are open and contain younger trees. Yet their importance should not be judged by this. Parks are where people gather and children play. If better managed, they could evolve into powerful microforests.

One striking pattern was the role of community stewardship. Along roads, trees survived and grew large not because of official programmes, but because local residents watered and guarded them. This sense of shared ownership gives Rama's trees a fighting chance in a region where water scarcity and grazing threaten young plantings.

Lesson learned

- Roadside trees are Rama's most effective carbon sinks.
- Tree diversity was greatest in parks.
- Species *Vachellia tortilis* stored the most carbon per tree.

Recommendations

- Protect and expand roadside trees, and diversify church and school compounds to become biodiversity hubs.
- Invest in park and playground management: consistent care will help young trees mature.
- Encourage neighbourhood-level tree care.

Further reading

Tekleweyni Gebru, Negasi Solomon, Zenebe Girmay Siyum, Yirga Gufi, Tesfay Gidey, Solomon W. Newete, Ashenafi Manaye, Emiru Birhane. 'Evaluating urban green spaces for biodiversity and carbon sequestration in Rama town, Tigray, Ethiopia.' *Ecological Frontiers*, December 2025, **https://www.sciencedirect.com /science/article/abs/pii/S2950509725001145**

For queries on this case study, email:
negasi.solomon@mu.edu.et

CHAPTER 8

MADAGASCAR

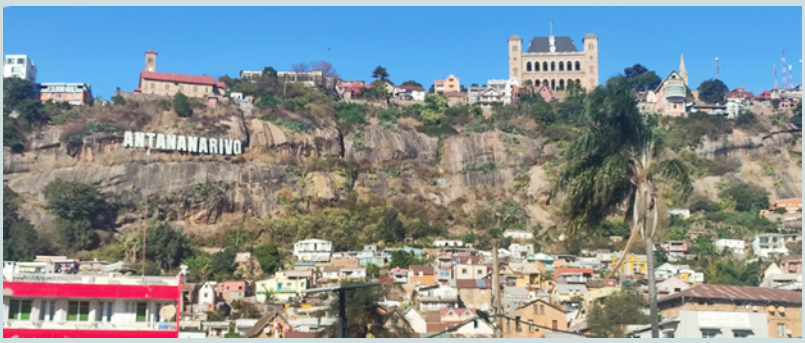
BACKGROUND

Not quite Africa, not quite Asia, and with a language that is Malayo-Polynesian, Madagascar is deeply unique. Thought to have split from Africa and India 88 million years ago, it is sometimes called a micro-continent or the eighth continent.

Its isolation led to its biodiversity evolving independently. One of the world's 17 'megadiverse' countries, over 90% of its flora and fauna are found nowhere else. This extreme endemism includes all lemurs, many unique birds and fish, and more than 11,200 plant species. A staggering 63% of endemic trees are threatened, however.

According to Botanic Gardens Conservation International, 'a shocking 320 native tree species are assessed as Critically Endangered, of which 59 are tagged as "Critically Endangered, possibly extinct in the wild".' Another 915 are assessed as Endangered, and 605 as Vulnerable. Could green spaces in Madagascar's cities be refugia for them? Could parks be mini- or even maxi-arboreta?

Some might argue that this is scarcely relevant: Madagascar is the fourth poorest country in Africa. The authors themselves comment astutely that 'green spaces are often perceived as providing passive benefits. Political priorities tend to focus on more immediate needs.' Read this case study, which recommends making 'all efforts to preserve and restore existing urban green spaces and create new ones.'



The Rova Manjakamiadana or Queen's Palace in the city Antananarivo. It sits on the highest hill of the Analamanga and was built between 1839 and 1841 by Frenchman Jean Laborde for Queen Ranavalona I, and was later re-covered in stone (in 1867) by Scotsman James Cameron. The route to the palace leads through the Jardin Historique d'Andohalo, the site of the former Andohalo palace where sovereigns were once crowned, today preserved as a public garden. Photo: A Ravelomanantsoa.

CASE STUDY #23

Urban green space management in Antananarivo, Madagascar

Alivony Ravelomanantsoa and Daulphin Razafipahatelo, PhD candidates at University of Antananarivo; Rui Han, PhD candidate at University of York, UK; Jessica Thorn, Imperial College London and University of Namibia

Since the 1950s, Madagascar, often called the Green Island, has lost an estimated 40–50% of its forest cover, with deforestation accelerating in the 21st century. Antananarivo, its capital, has not been spared, losing 80,000ha of tree cover from 2001 to 2024, equivalent to 26% of the tree cover area in 2000, and 42Mt of CO_2e emissions. Drivers include rapid urbanisation, land reclamation practices, and the expansion of built-up areas during this period (Global Forest Watch, 2026).

Before colonisation (pre-1896), Madagascar's Central Highlands, where the capital is today located, were largely an agro-pastoral mosaic of grasslands, rice lowlands and croplands with localised endemic woody formations such as Tapia woodlands dominated by *Uapaca bojeri* (Kull, 2002).

The case study looks at urban trees in Antananarivo. Australian trees Mimosa *(Acacia dealbata)* and *Eucalyptus* species were introduced by the French between 1897 and 1900, and many of the trees in downtown Antananarivo date from the later colonial period from the 1930s to the 1950s. Today, the capital is particularly dominated by jacaranda trees, while eucalypts, acacias and pines are still noticeable. To an extent, urban citizens are today diversifying this urban forest with fruit trees.

Despite the existence of a national management plan for protected areas aimed at forest conservation, urban forestry in Madagascar is still in its infancy. With no clear national policy promoting the development of green infrastructure in urban areas, the only legal reference is the Malagasy Urban Planning Code, which includes provisions on green spaces as part of the requirements for obtaining construction permits from the municipality.

The central place in Anosy public garden. Photo: A Ravelomanantsoa.

Mahamasina public garden, to which access is restricted. According to the green space officer at the municipality of Antananarivo, it is only open from 12 to 2 pm during national exams so that parents and students can rest and take their lunch, particularly those who come to town from far away. Photo: A Ravelomanantsoa.

Currently, green spaces in Antananarivo consist of parks, street trees, agricultural land, urban agriculture, sports fields, and open spaces. The municipality is primarily responsible for the development and implementation of green spaces and urban forestry initiatives. In Antananarivo, the municipality launched the 'Green Plan Initiative' in 2022, guided by the mayor. This focuses on the creation of new parks and restoration of existing ones, tree planting along streets, and the upgrading of public gardens and urban agriculture. (ONU, 2013. **Planification stratégique en matière de gestion des espaces vert et agricole de la ville d'Antananarivo.**)

Urban agriculture is present in a personal garden, the only green space in Isotry, a small administrative area or *fokontany* in Antananarivo, that experiences high levels of precarity and informality.

Urban trees and green spaces provide a range of benefits, including cooling services, erosion control, social wellbeing, food production and air quality improvement. In Antananarivo, urban trees are mostly found along major boulevards and avenues, in public parks, cemeteries, schoolyards, hospital grounds and in peri-urban forests, especially in the hills around the city. At present, access to green space, especially public parks, remains highly restricted, with parks usually only open during specific occasions, such as the official public exam period, for students to rest and have their lunch. Others may be closed due to vandalism or cleaning schedules; sometimes fees are required to enter. For green space, urban residents often have to go to the peripheral areas where it is more freely accessible.

Anosy public park is located near official buildings, including ministries and international organisations like the World Bank.

In public spaces like the Lake Anosy area, trees serve as both scenic backdrop and social refuge. Yet, many green spaces have been slowly encroached upon or degraded due to informal construction and lack of maintenance.

In Madagascar, the recent awareness of climate change and global warming has stimulated a growing number of civil society and community-based organisations (CSOs/CBOs), and citizen initiatives, such as the NGO Education for Madagascar, AKAMASOA Association, the Green Ambassador initiative by YMCA Madagascar, and Aika Alliance. Mostly led by youth and operating mainly in cities, including Antananarivo, these engage in

greening such as public gardening, restoration and tree planting, often in schools. Other CSOs, CBOs and NGOs are developing projects to restore the urban ecosystem through the practice of agroecology and urban agriculture. CBOs play a particularly important role in neighbourhoods where green spaces hold religious or cultural significance, such as sacred trees or cemeteries. Additionally, private entities including schools, religious institutions, and NGOs are actively involved in tree planting and tree maintenance in areas they control or in supporting households to set up plant nurseries.

Research is essential too. The Future Landscape Optimisation for Peri-Urban Resilience and Ecosystem Health in Africa (FLOURISH) project is currently supporting studies into the contribution of urban green areas to water quality and flood risks, and the role of urban vegetation and wetlands in reducing flood risks and filtering polluted runoff; the role of trees in mitigating air pollution in dense urban contexts, particularly vulnerable informal settlements, and the association between pollution exposure and respiratory health; the heat island effect and inequalities in access to the cooling benefits of green space, looking at its distribution across Antananarivo and modelling changes in green cover and their linkage to urban heat dynamics.

The dream is a cleaner, greener and healthier city for the upcoming generation and for Antananarivo to be acknowledged as 'the Blue

Top: A view of Ambohijatovo Garden, a green space well maintained by the municipality. Once called the 'democracy place' and a gathering point for strikes, it was transformed into a botanical garden in 2021 and re-opened to the public in 2022, but with restricted access. Above: Lake Anosy and the statue built in 1927 to commemorate Malagasy soldiers who died in World War I fighting for France. Photos: D Razafipahatelo, A Ravelomanantsoa.

forest region', or 'Analamanga' in Malagasy.

Urban forestry offers Madagascar a path toward inclusive resilience, blending tradition, biodiversity, and modern environmental planning. The people working on the frontlines are hopeful that with the right coalitions, they can green their cities, one tree at a time.

Lessons learned

- Cultural beliefs can be an obstacle: trees are believed to attract thunder so are often radically cut.
- Green spaces are often perceived as providing passive benefits. Political priorities tend to focus on more immediate needs, such as water and electricity access.
- Few urban planners or municipal staff members are trained in urban forestry.
- Decision-makers need economic, social and environmental reasons to integrate green spaces into city development.

Recommendations

- Make all efforts to preserve and restore existing urban green spaces and create new ones.
- Capitalise on the growing popularity of tree planting during national events like World Environment Day; the municipality's growing acceptance of urban agriculture and food trees; and the growing discourse around green infrastructure as a nature-based solution (NbS) to manage floods, air quality and heat.

Further reading

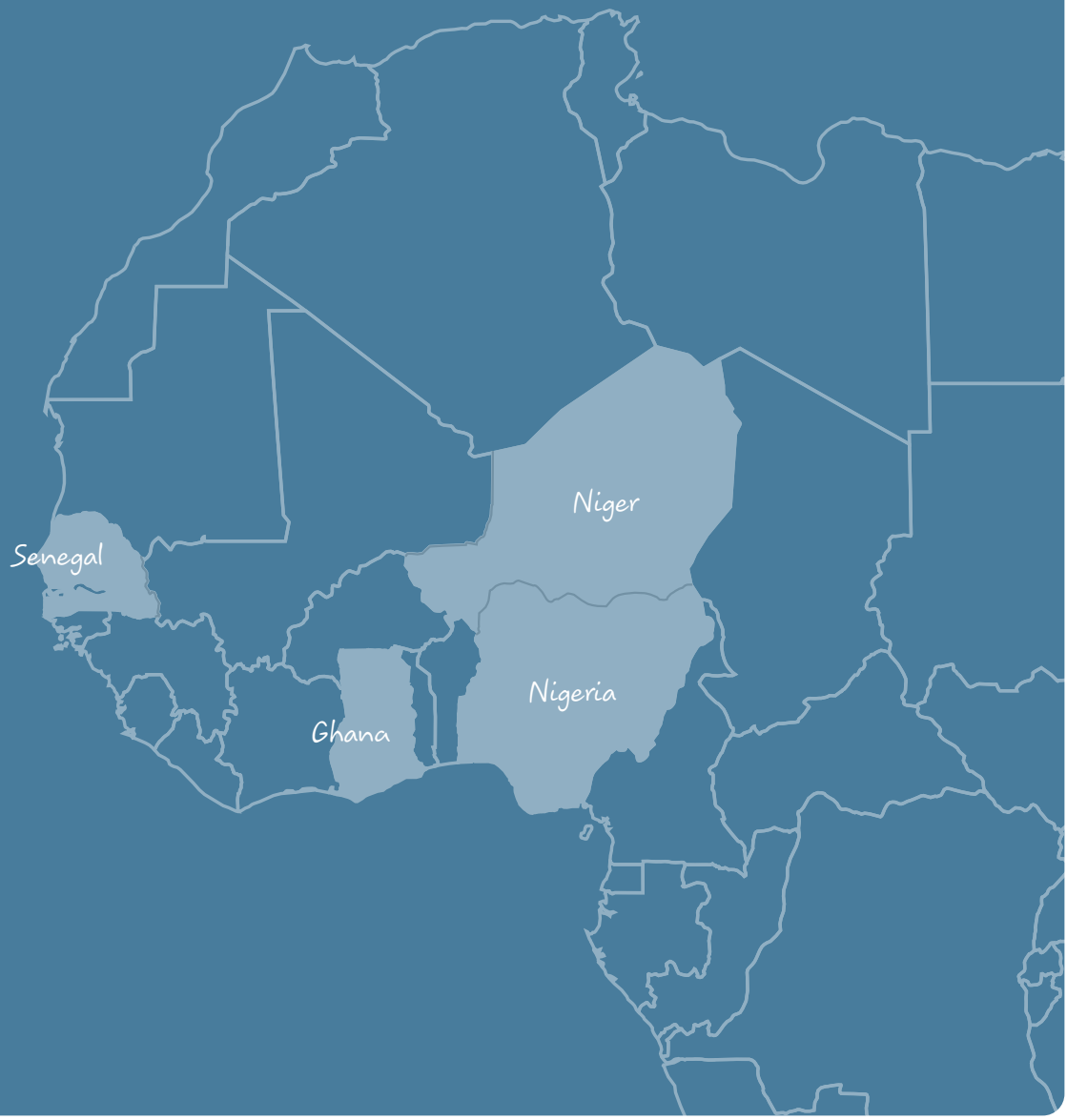
Han, R., Marchant, R.A., Thorn, J.P.R., 2025. 'Are vulnerable neighbourhoods left behind? Urban cooling disparities from greenspace inequality in Antananarivo, Madagascar.' *Urban Climate* 61, 102467.
https://doi.org/10.1016/j.uclim.2025.102467

For queries on this case study, email:
alivonyr@gmail.com

Top: Garden of the Faculty of Sociology, Economy and Management, University of Antananarivo. In 2005, this now well-managed green space was bare with just a few trees but more were introduced as a symbol of resilience. It is freely accessible to the public and used by thousands of students to relax and take pictures especially after a graduation ceremony. Below: Anosy public garden, calm inside but along a busy road and near public administrative buildings. Photos: A Ravelomanantsoa.

URBAN FORESTS IN

WEST AFRICA



CHAPTER 9

GHANA

BACKGROUND

History has it that Ghana's precolonial cities were composed of large rectangular gated homesteads, with big shade-giving trees in the middle of the compound where family meetings were held. In 1708, Danish clergyman Johannes Rask noted on arriving on the Gold Coast that areas of Accra inhabited by African communities had attractive treed streets that provided comfortable shade. Later, imperialists recorded trees in human settlements, including papaya, oil palm, *Ficus umbellata* Vahl and *Dialium guineense*.

Clearly, long before European merchants arrived, the urban forest was a feature in Ghana, from home gardens to woodlots, to sacred and spiritual forests, to cemeteries and large parks, as well as linear strips like street trees.

Today this urban forest is needed more than ever. Almost 60% of Ghana's population is now urbanised, and the country's largest cities are sizeable. Greater Accra, Sekondi-Takoradi metropolitan area, and Kumasi have 5.45 million, 1.16 million and 443,981 inhabitants respectively. Smaller towns are growing too.

Yet the state of Ghana's urban forest is not something to feel complacent about. Few urban areas in the country have adequate green cover and, for most cities and towns, it is diminishing.

- In 2017, Nero et al. calculated urban green cover to range between 20 and 40%, which is reasonable – 30% is an aspiration for cities globally. But 'Ghana's tree cover is uneven and consistently in decline,' they say.
- In 2019, Affriye et al. published a devastating map showing that 'urban sprawl' had gradually covered Kumasi's farms and forested areas from 1986 to 2006.
- In 2023, Oppong et al. published a spatial analysis of Accra, Cape Coast, Sekondi-Takoradi, Kumasi, and Tamale showing steep decline in forest cover from 1990 to 2020. They concluded that it was directly linked to the rapid expansion of built-up areas and that conversion of vegetated land to impervious surfaces, such as roads, was exposing urban areas to disasters, particularly flooding.

All this loss is even more concerning given climate change effects like extreme heat. Trees are key to addressing this often lethal phenomenon by reducing temperatures through shading and evapotranspirational cooling.

Contributing to the current perilous state of affairs:

- Tree cover was higher in European areas of Ghanaian cities, setting a pattern in which more affluent areas have more trees than poorer ones.
- The policy and institutional structures

upholding urban forestry today are inadequate. Urban forestry was originally the mandate of the Department of Parks and Gardens. But the department has become obsolete, with its oversight restricted to horticultural plants and urban gardening. This has led to the decline and loss of many urban parks in Ghana.

Collecting information on the loss of formal urban green space, Collins Adjei Mensah et al. researched 13 parks in Kumasi, finding only two in operation – Kumasi Zoo and KNUST Botanical Garden. About Jackson Park, founded in 1935, they write: 'not in existence, now a lorry park'. About Kumasi Children's Park, they write: 'abandoned to lose all its facilities'.

'Conflicting ownership rights, encroachment, and poor maintenance are major physical barriers,' they state in the *Journal of Geography* in 2017, recommending that additional parks and gardens should be created; brownfield sites converted into green spaces; quantitative standards incorporated into the provision of green spaces; and a green spaces award scheme institutionalised.

Fortunately, tree-growing programmes are underway in urban Ghana. Championed by NGOs, government institutions, the private sector, churches and others, some are part of the UN Decade for Ecosystem Restoration 2021–2030; the Pan-African Action Agenda on Ecosystem Restoration for Increased Resilience; Agenda 2063; and the African Forest Landscape Restoration Initiative (AFR100).

Jackson Park was built in 1935 'to serve the recreational interests of its immediate African Community,' to 'improve the general wellbeing of the town and its inhabitants, and allocated for football', according to social scientists Anderson and Lauterback, in whose 2025 ethnographic study residents today recall how the park was a place of relaxation surrounded by big trees providing shade and a windbreak. In a considerable loss of green space in 2016, however, the park became 'a versatile events space' and car park (see inserted photo) and was renamed Jubilee Park. Photos reproduced with permission of Eugenia Ama Breba Anderson. For more, see https://www.myjoyonline.com/creating-inclusive-urban-spaces-jackson-park-in-focus/ and https://journals.sagepub.com/doi/10.1177/00020397251330918

CASE STUDY #24

Study of restoration and maintenance of urban and peri-urban forest finds that street trees are more vandalised, need extra care

Bertrand F. Nero, Dorcas Frimpongmaa Yeboah, De-Graft Acquah, Department of Forest Resources Technology, Kwame Nkrumah University of Science and Technology, Kumasi

This case study looks at an ambitious tree-planting project. Led by environmentalist Mary Perpetua Kwakuyi, Goshen Global Vision (GGV) is a 'woman-led conservation non-profit organisation, working in Ghana's Western Region to build resilience through community-based natural resources management, increase tree cover while improving livelihoods, and focused on restoring urban, peri-urban and rural landscapes.' In 2019 it began a restoration initiative called 'Urban and Peri-Urban Forestry: Greening the Sekondi-Takoradi City', restoring biodiversity to promote smart agriculture.

Funded by the US Forest Service, it was one of West Africa's biggest attempts to green a city. GGV's 2024 annual report on the project shows an NGO increasingly comfortable with the botanical names of trees, fluent in the language of climate-smart agriculture and schoolyards, sophisticated in use of GIS and other tools for monitoring of planted trees, and constantly innovating. By 2024 it had incorporated beekeeping, village savings and loans, enriching natural science education in high schools, school coconut plantations, use of rabbit urine as a natural fertiliser and pesticide, and other agroecological practices in its programmes.

Project nurseries consistently produced 8–10 exotic fruit/food trees requested for urban home gardens, such as papaya, mango, guava, avocado, oranges, grapes, soursop, tangerine, jackfruit, coconut and sometimes moringa. They also produced seedlings of another almost 30 tree species, shrubs and plants. About 80% were exotic, but in 2022, out of 8,633 seedlings raised, 2,436 or 30% were indigenous, and included seedlings of the West African medicinal tree *Tetrapleura tetraptera*; African mahogany *Khaya ivorensis*; African timber trees *Terminalia ivorensis* and *T. Superba*; and *Synsepalum dulcificum*, famous for its berry that, when eaten, causes sour foods to taste sweet. In 2024, the indigenous African purple flowering

Left to right: US Forest Service and Goshen Global Vision (GGV) trees planted at Fijai Senior High School, and a thriving African mahogany *(Khaya ivorensis)* at a small hospital. Photos: GGV.

Without trees, school compounds are characterised by glaring light and heat. At Assorkor Junior High School, young *Terminalia ivorensis*, also indigenous as their name suggests, are flourishing and will soon cast shade. Photo: GGV.

and molluscicide-producing tree *Millettia thonningii* was also raised.

Since 2019, it has planted about 30,000 trees in Sekondi-Takoradi City, about 5,000–6,000 a year, a realistic annual number that is known to allow for monitoring and bodes well for survival.

After four years (2020–23), survival of the trees planted was found to be roughly 51% in Sekondi-Takoradi City compared to 66.8% in adjacent Subin Forest Reserve, where GGV was also supporting planting. And growth in the diameter, height, and carbon stocks of the urban trees was significantly lower than that of trees in this forest reserve.

There were also differences in tree performance according to where trees were planted in the city:

- Trees planted on vacant lots or derelict land had a survival rate of 58.3% and trees in institutional compounds a rate of 54.6%. However, only 36.8% of trees planted along streets survived.
- Trees planted on vacant lots or derelict land had an annual basal area increment of 4.15 m^2ha^{-1}, markedly better than those of street or institution trees which had annual basal area increments of 0.3 and 1.08 m^2ha^{-1} respectively. They also had a carbon sequestration rate of 2,021.25 $kgCha^{-1}$, while street and institution trees had annual carbon sequestration rates of just 35 and 904.5 $kgCha^{-1}$ respectively.

Lessons learned

- Conditions are much harder for street and urban institutional trees. They face vandalism, greater pollution, browsing by animals, and lower-nutrient and more compacted soil.
- Trees planted in forest reserves or in vacant lots grow relatively well. These could be favourable sites in which to grow more sensitive, rarer, and/or threatened tree species.
- The project can be commended for planting a wide range of species, including indigenous species like *Khaya ivorensis* and less well-known indigenous species like *Synsepalum dulcificum* and *Millettia thonningii* that have been very rarely planted, let alone in cities. NGOs like GGV deliver a great benefit by trialling them and others.

Recommendations

- Street trees need particular care. For excellent survival of street trees, see the methods adopted by the Keur Massar Nord project in Senegal.
- NGO GGV could experiment with the Miyawaki method of restoration to create highly diverse mini-forests.
- Better ground preparation, species site matching, and care, such as watering, weeding and fertilisation, are recommended as well to improve survival, growth and thereby climate adaptation and mitigation impact.

Further reading

- **https://www.aptnewsghana.com/index.php/2019/09/25/media-must-launch-crusade-against-urban-forest-depletion-k-k-sam/**
- **https://afr100.org/project/leaving-no-one-behind-ghanas-reforestation-journey**

For queries on this case study, email:
bfn8puo@gmail.com

CASE STUDY #25

Urban residential garden carbon stocks could mitigate household GHG emissions – the case of Obuasi municipality, Ghana

Bertrand F. Nero, Dorcas Frimpongmaa Yeboah, and De-Graft Acquah, Department of Forest Resources Technology, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana

Obuasi is a town in the Ashanti region of Ghana with one of the world's largest gold mines, the deposit discovered in 1897. Linked by rail with Sekondi since 1902, in 2021 the town had a population of 104,297. Obuasi has a semi-equatorial tropical savanna climate, with two rainy seasons bringing about 1,270mm of rain a year.

Set in Obuasi, this case study, by the same Ghanaian scholars as the previous one, looks at one component of the urban forest – residential gardens – and tabulates their potential to sequester carbon. It asks whether residential gardens might contribute to offsetting household emission of carbon dioxide, which is the most commonly produced greenhouse gas (GHG) and used as the benchmark for stating the global warming potential of all gases.

This is a useful question for the urban forest. If residential gardens can be said to capture and hold carbon in their trees, it is yet another reason, among the many, that trees around urban homes need to be encouraged and supported.

The study concludes that about 2–5% of the annual household GHG emissions in Obuasi can be offset by vegetation carbon sequestration in residential gardens. So what is a residential garden, how did they calculate that, and is that a good result?

The residential garden is a hugely important portion of the urban forest. It is described as an enclosed area of land associated with a domestic dwelling and usually devoted (at least in part) to a lawn, flowers, trees, fruits, vegetables and/or other useful plants (Delahay et al., 2023). It may include a home garden, which refers to a small area situated at the heart of the household green space, usually much less than 1ha, in the residential parcel. Home gardens are characterised by family use and are classically described as intimate multistorey combinations of various crops and trees (annual and perennial plants), often associated with domestic animals and sometimes associated with infrastructure such as ponds and greenhouses (Kumar and Nair, 2006).

A residential garden can be a household strategy to cool homes and reduce GHG emissions (Davies et al., 2011). It may also increase food security, offset household expenditure, harbour and conserve biodiversity, promote social cohesion, and improve nutritional status, human health and urban resilience.

A total of 240 households in Obuasi were surveyed for this study: 40% of the surveyed households had residential gardens. The average residential garden had at least two tree species with at least two individuals for each species, so at least four trees.

Residential gardens had about nine species in high-income neighbourhoods and six in the low-income neighbourhoods. The most common species were coconut trees *(Cocos nucifera)*, mangoes *(Mangifera indica)*, oil palm *(Elaeis guineensis)*, cooking banana/plantain, *Musa* x *paradisiaca*, *M. balbisiana*, and *Citrus* spp.

A treeless low-income neighbourhood in Obuasi and middle- and high-income homes with progressively more green. Photos: B Nero.

Other species like *Polyalthia* spp., ornamental palm *(Veitchia merrillii)*, and *Terminalia catappa*, the nuts of which taste almond-like and can be eaten raw or cooked and are a source of oil, were common in the high-income neighbourhoods.

In Ghana, per capita emissions in 2020 were approximately 0.77 tonnes of CO_2 equivalent (tCO_2e) from all sources including land use, land-use change, and forestry. Residential gardening can contribute to reducing this.

Until now, little has been known about how much residential gardens might offset household GHG emissions in cities and mitigate climate change in the Global South by class of neighbourhood. This case study looked at three household classes.

The study found an average tree density of 1,579 stems per hectare. Low-income neighbourhoods had the largest diameters at breast height (DBH) (DBH 28.8cm) but the lowest tree density, 1,119 stems per hectare. The highest tree density was in middle-income areas (1,876 stems per hectare). The lowest DBH was in high-income areas (DBH 24.8cm).

In residential gardens, the study estimated above ground carbon (AGC) of 8.99kg C/m^2 in low-income neighborhoods, 9.05kg C/m^2 in middle-income areas, and 8.49kg C/m^2 in high-income areas. These differences were not significant ($p>0.05$).

The mean carbon stock across all three neighbourhood types in Obuasi was 8.76 ±0.62kg C/m^{-2} – equivalent to 32.2 ±2.48 CO_2e/m^{-2}. Total CO_2e was highest in middle-income areas at 39.9 ±4.65kg/m^2.

The study also found, not unexpectedly, that neighbourhood type and household income were major determinants of CO_2 emissions: wealthier neighbourhoods emitted more while neighbourhoods with lower incomes emitted less.

Tree structural attributes and carbon stocks of residential gardens in Obuasi, Ghana

Neighbourhood class (kg/m^2)	DBH (cm)	Tree density (sph)	AGC (kg C/m^2)	Total CO_2e
Low income	28.83 ±2.18	1,119 ±108	8.99 ±1.71	39.6 ±6.29
Middle income	25.18 ±1.68	1,876 ±90	9.05 ±1.27	39.9 ±4.65
High income	24.80 ±1.20	1,742 ±202	8.49 ±0.88	37.4 ±3.23
Average	26.45 ±1.02	1,579 ±133	8.76 ±0.68	32.2 ±2.48

sph = stems per hectare

The transportation sector contributed more than 50% of emissions in all three neighbourhood classes, largely because urban dwellers live a considerable distance from their workplaces and have to navigate to work daily amid intense traffic congestion, either via public transport or in private cars.

'The Ghana urban forestry captured here reflects an activity in its infancy,' says Dr Bertrand Nero. 'Since residential gardening is not widely adopted yet in Obuasi, we believe that it can be massively scaled up, offering a way to reduce GHG emissions. From our estimates, residential gardens can offset 2–5% of annual HH GHG emissions in Obuasi municipality.'

Lessons learned

- Ghana's tradition of residential gardens bodes well for adaptation to and mitigation of climate change.
- Vegetation patches adjacent to dwellings, home gardens can store modest quantities of carbon and offset household GHG emissions.
- Although the residential gardens in this study were small, they were able to store carbon above ground and, although not measured, below ground in their roots and soil.
- As a strategy to meet the alimentary, shade, cool, recreational, environmental and social needs, residential gardens are powerful.

Recommendations

- Efforts are needed to widen the species of trees in residential gardens. Residential gardens can contribute even more with intensification and diversification.
- Appropriate policies and actions are needed to promote residential gardening for its other benefits, e.g. nutrition, biodiversity conservation, and overall contribution to resilience and sustainability of cities. For instance, Ghana's National Urban Policy and the National Building Regulations, 1996 (LI 1630), which are under revision, should give attention to residential gardening in their provisions.

Further reading

- Nero B. F., Callo-Concha D., and Denich M. 2018. 'Structure, diversity, and carbon stocks of the tree community of Kumasi, Ghana.' Forests, 9, 519.
- Nero B. F., Kuusaana E. D., Ahmed A., Campion, B. B., 2024. **Carbon storage and tree species diversity of urban parks in Kumasi, Ghana**. City and Environment Interactions 100156.

For queries on this case study, email:
bfn8puo@gmail.com

CASE STUDY #26

Urban forest structure and microhabitats in Greater Kumasi: insights for biodiversity-oriented management

Angela Beckmann-Wübbelt, Geography Department, Institute for Integrated Natural Sciences, University Koblenz, and Research Group Sylvanus, Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology (KIT); Shalom Daniel Addo-Danso, Forest and Climate Change Division, CSIR-Forestry Research Institute of Ghana; Sebastian Schmidtlein, Institute of Geography and Geoecology (IFGG), KIT; Somidh Saha, Research Group Sylvanus, Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology (KIT)

Greater Kumasi in Ghana was once known as the 'Garden City of West Africa'. Today, this image contrasts with the realities of rapid urban expansion, rising temperatures, recurrent flooding, and increasing pressure on green spaces. Home to roughly three million people, the city faces the challenge of maintaining and restoring urban trees that can simultaneously support the closely linked goals of human wellbeing, climate resilience, and biodiversity.

In 2022, a field survey was conducted across the city to better understand the structure, composition, and ecological functions of its urban forest. It investigated which tree species occur where, how the urban forest is structured, and to what extent the trees provide habitats for other organisms.

The focus was tree-related microhabitats (TreMs), distinct structures such as cavities (holes in the tree), exposed or decaying wood, crown deadwood, animal-built features like termite and ant nests, and epiphytes, non-parasitic plants that grow on trees for physical support. Examples of epiphytes include bromeliads, mosses, and ferns, which obtain moisture and nutrients from rain, air, and accumulated debris rather than rooting in soil.

These TreMs provide shelter, breeding sites, and feeding opportunities for birds, bats, insects, fungi, and many other organisms, and are increasingly indicators of biodiversity potential in managing urban forests. By focusing on TreMs, the study is one of the first comprehensive assessments of habitat provision in an African urban forest and provides insights that are directly relevant for urban forest planning and management across the continent.

While the city of Kumasi was still mostly vegetated in the 1960s, green spaces have since been lost, fragmented, or degraded with particularly pronounced losses since 2009. Impervious surfaces have increased, and remaining trees in many areas are subject to intensive management or removal. At the same time, expectations placed on urban trees continue to rise. They are expected to cool the city, reduce flooding, improve air quality, support food security, offer cultural value, and increasingly contribute to urban biodiversity.

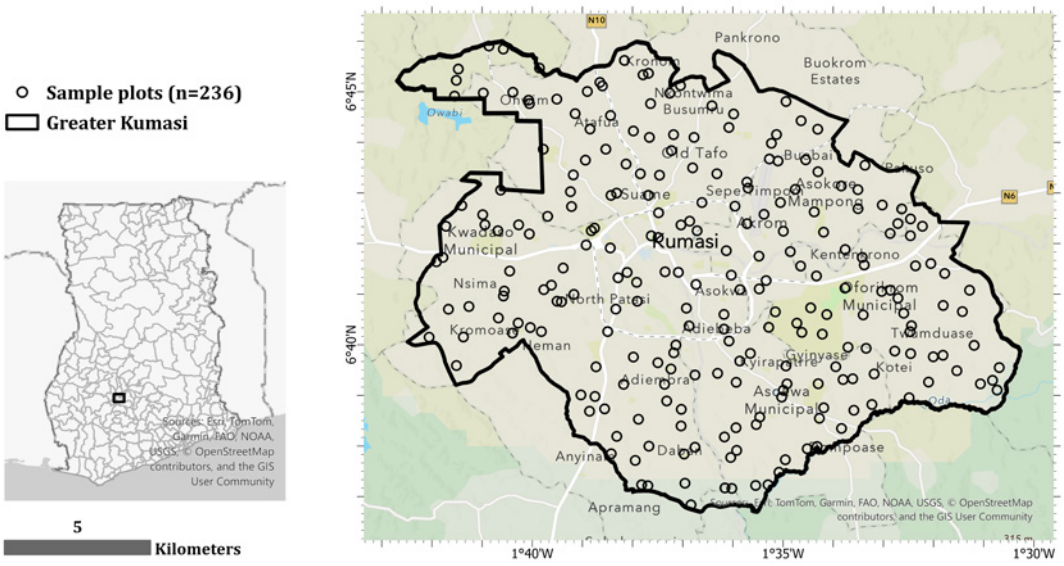
Despite this, urban forestry decisions are often made with limited ecological information. Few sub-Saharan African cities have adequate data on species composition, forest structure, and habitat functions of urban trees to translate policy ambitions into decisions or effective, locally adapted practices.

To address this gap, 236 randomly distributed circular plots of 0.04ha (or 0.1 acre) each were established across Greater Kumasi. Within each, all woody individuals were recorded, and their species, size, and structural characteristics documented. For larger trees with a stem diameter at breast height (DBH)

of at least 20cm, the presence and type of tree-related microhabitats were assessed. The study moved beyond simple tree counts for a nuanced assessment of how urban forests support biodiversity.

The study covered built-up areas and forest or semi-natural sites. The first included residential compounds, streets, institutions, and other predominantly impervious or heavily managed urban spaces. The second included forest patches, undeveloped green spaces, and vegetation-dominated sites that are not parks but represent remnants of semi-natural vegetation.

- 644 woody individuals representing 93 species from 31 families were recorded.
- Built-up areas were dominated by introduced fruit and ornamental species such as *Mangifera indica* (mango), *Persea americana* (avocado), and *Polyalthia longifolia* (Indian mast tree), and the indigenous African oil palm *(Elaeis guineensis)*, valued for food, shade, and aesthetics.
- Forest and semi-natural areas were characterised by species associated with plantation forestry or secondary vegetation, such as *Tectona grandis* (teak), *Senna siamea*, and *Leucaena leucocephala*. These non-native species are common due to timber production, fast growth, and their success in disturbed sites.
- Non-native species dominated, making up 75% of individuals in built-up areas and 66% in forest and semi-natural areas.
- Individuals of numerous native species were uncommon. For example, only two *Morinda lucida*, six *Millettia thonningii*, two *Borassus aethiopum*, one *Flueggea virosa*, and a single *Milicia excelsa* (an iconic timber species, iroko) were recorded in the study. The latter was excluded from the TreM survey due to its DBH being below 20cm.
- The scarcity of indigenous tree species is concerning, as they supported a higher number of tree-related microhabitats, which are associated with increased habitat complexity and biodiversity potential.
- Large-diameter trees, which are also critical in providing TreMs, were similarly scarce. In urban areas, species such as *Mangifera indica* accounted for most large trees; in



Left: Kumasi is located in the Ashanti region in South Central Ghana in a humid semi-deciduous vegetation zone. Right: For data collection, 236 circular plots with a radius of 11.34m were randomly distributed across the whole Greater Kumasi area. Source: A Beckmann-Wübbelt et al., 2025.

Tree-related microhabitats in Greater Kumasi include cavities, fungal fruiting bodies, epiphytes, bark pockets, ant nests, and injuries. Bark injuries provide direct habitat for insects by exposing softwood, and can initiate decay processes that create additional microhabitats over time. These small but ecologically important elements support a wide range of organisms and enhance biodiversity in the urban forest. Photos: A Beckmann-Wübbelt.

A tree with a large DBH, such as a mature *Ficus sur*, avocado tree or an old mango tree, could feature multiple cavities, patches of exposed wood, crown deadwood, and abundant epiphytes, offering habitat for birds, bats, insects, and fungi. Photo: A Beckmann-Wübbelt.

semi-natural areas *Cedrela odorata* or *Tectona grandis* (teak), both non-native, tended to be the large trees.

- Both built-up and natural areas were dominated by a large number of small trees of fast-growing, light-demanding species, which reflects recurrent disturbance – trees being frequently removed, replaced, or failing to reach old age due to urban development pressures.

Also, 45 types of TreM were identified. Cavities were the most common, followed by injuries with exposed heartwood such as limb breakages, cracks, or fork splits. Other TreMs were dead branches in the crown, fruiting bodies, epiphytes, mosses, liverworts and lichens, ivy, lianas, ferns, nests and microsoils – a thin layer of newly formed soil that accumulates on the trunk, in branch crotches, or on branches of a tree through the accumulation and decomposition of organic matter such as leaves and twigs.

- DBH was the strongest predictor of TreM abundance and richness, with larger trees supporting significantly higher numbers and diversity of microhabitats.
- Native species supported on average 25 TreMs per tree compared with about 15 for non-native species.
- Deciduous species supported a greater diversity of TreM types than evergreen species.
- Palms supported high numbers of injuries and epiphytes, but fewer TreM types overall than broad-leaved trees.

Lessons learned

- The urban forest of Greater Kumasi is diverse and ecologically significant, but its biodiversity potential is constrained by the dominance of non-native species and the scarcity of mature trees.
- Mature trees and indigenous trees play an important role in providing tree-related microhabitats for urban biodiversity.

- Management strategies that combine tree retention, thoughtful species selection, and careful maintenance of trees will strengthen biodiversity and improve the resilience and reliability of ecosystem services.
- As African cities continue to grow and densify, evidence-based and context-sensitive urban forest management will be crucial to ensure that urban ecosystems remain living systems supporting both people and nature over the long term.
- Biodiversity is not an abstract ecological variable but a functional property that underpins the capacity of urban forests to deliver ecosystem services and support biodiversity and human wellbeing.

Recommendations

- Protect existing large trees. Large trees are scarce but essential: doubling DBH nearly doubles the abundance of tree-related microhabitats.
- Preservation, not only planting, is necessary to safeguard habitat.
- Select species intentionally. Non-native trees provide social and economic benefits, but native species support higher TreM abundance and offer critical microhabitats such as epiphyte substrates.
- Planting strategies should combine native species of high habitat potential with culturally important non-natives.
- Adapt tree management practices, taking particular care with old mature trees. Cavities, deadwood, and epiphytes are often removed for safety or aesthetic reasons. Yet these are essential for biodiversity and likely pose low risk. Training and risk-informed management can help retain ecologically valuable features.
- Integrating TreM assessments into routine tree inspections can help operationalise biodiversity considerations in everyday urban forestry practice.

Further reading

'Tree size, species composition, and tree-related microhabitats: Implications for urban forest management in a Sub-Saharan African city', *Urban Forestry & Urban Greening* (2025). **https://doi.org/10.1016/j.ufug.2025.128994**.

For queries on this case study, email:
angela.beckmann-wuebbelt@kit.edu

A large mature mango tree in a built-up area of Greater Kumasi. Old mango trees combine social and ecological functions, providing shade, food, and structurally complex habitats such as cavities, crown deadwood, and epiphytic niches. Photo: A Beckmann-Wübbelt.

CHAPTER 10

NIGERIA

BACKGROUND

In Nigeria, urban forestry is gaining some traction but faces considerable obstacles such as the political elite closing zoos, wildlife parks, and conservation areas to create luxury estates. Nowhere has this been seen more clearly than in Ibadan, the home of Nigeria's first university, founded in 1948, and the Forestry Research Institute of Nigeria (FRIN), founded in 1954.

In Nigeria's commercial capital, Lagos, where the British planted exotics like *Delonix regia* (flamboyant), *Terminalia catappa* (tropical almond) and *Polyalthia longifolia* (mast tree) around government quarters and along major routes such as Marina Road and Broad Street, longstanding tree-planting, green corridor, and afforestation projects have had solid results.

- In 1990, the Nigerian Conservation Foundation set up the Lekki Conservation Centre, a 78ha reserve to preserve biodiversity in the face of Lagos' expansion.
- From 2008–15, the Greening Lagos Initiative led to colossal tree planting, including mangrove restoration in Ajah, Badagry, and Victoria Island.
- In 2012, the Lagos State Parks and Gardens Agency (LASPARK) was set up. It has taken on the maintenance of 327 city parks, which have received 288,681 visitors to date.
- In 2015–20 and 2020–25, as part of its climate action strategy, Lagos State passed legislation to institutionalise tree planting, making it mandatory along roads and in real estate developments.

These achievements show that it is possible to protect and build the urban forest even in a megacity of 16–18 million, which many, such as famed Nigerian author Chimamanda Adichie, characterise for its hustle and indifference to long-term planning and what others think. However, in Ibadan in Oyo state, two large and distinguished forested areas were felled in 2023 and 2024.

This was all the more shocking because the city is home to the country's oldest university and a seat of learning about forestry, land use and ecosystems (the University of Ibadan), and of FRIN. Both have long played a major role in urban forestry research, including encouraging the planting of majestic and ecologically significant West African trees such as *Milicia excelsa* (iroko), *Khaya senegalensis* (mahogany), and *Terminalia superba* (afara), moving away from the colonial planting of introduced species.

CASE STUDY #27

In a city famous for forestry research, an urban forest falls to elite housing estate

Oyinlola Abiodun Fasoro, lecturer, Department of Social and Environmental Forestry, Faculty of Renewable Natural Resources, and Eza Precious Chiom, student, University of Ibadan

Urban forestry can be a story of sudden massive tree loss. This case study looks at what happened prior to and after a 45ha forest was felled in Ibadan, and the lack of public consultation.

Established in the 1950s, Ogunpa Forest Reserve was one of Nigeria's oldest forest reserves, one of the first indigenous tree plantations in West Africa, and the first to grow *Terminalia superba* (white afara). A watershed for the Ogunpa River, helping to prevent flooding in Ibadan, it was also the habitat for a colony of an estimated 30,000 straw-colored fruit bats *(Eidolon helvum)*, a threatened keystone species that can fly over 200km in a night dispersing seed, and is crucial for the regeneration of species like *Milicia excelsa*.

In late 2023 to early 2024, however, despite opposition from the Forestry Association of Nigeria, Nigerian Conservation Foundation, Nigerian Environmental Study Action, West African Conservation Network and others; a peace walk; and public reservations about the authenticity of the Environmental Impact Assessment, the forest was entirely felled to build a new residential and commercial hub. The government claimed that the forest had become a sanctuary for criminals.

Then, in November 2024, the 1.3ha University of Ibadan Heritage Park was cleared to build a new building, despite other available land and widespread criticism from alumni, students and others about the ecological damage and loss of a historic and cultural landmark. Since then, the university has carried out multiple tree-planting projects. But the fact that the

Ibadan city and Ogunpa Forest Reserve as seen from Premier Hotel in 2021. Photo: NE Nkoro, Wikimedia Commons CC-BY-SA-4.0
Small photos from top to bottom: Ogunpa Forest Reserve cleared 2023–2024, and felled forest at Heritage Park, University of Ibadan. Photos: OA Fasoro.

city lost two forests of mature trees in a short period of time is etched on the minds of many.

Nigeria's Environmental Impact Assessment (EIA) Act of 2004 mandates 13 general principles, including transparency (e.g., public document display), public participation (e.g., stakeholder consultations, comment periods), and accountability (e.g., review panels, mitigation enforcement), and, in the case of Ogunpa Forest Reserve, an EIA might have preempted conflicts; however, it is unclear whether one was conducted despite the assertions of the state government.

Given this background, in 2025, Dr Fasoro and her 500-level student conducted a study on 'People's Perception of Ogunpa Forest Reserve Conversion to Baywood Housing Estate in Ibadan, Oyo State, Nigeria.' Selecting communities bordering the reserve, Ajibade and Mokola Hill, they used systematic selection to choose every third household and spoke with household heads. They also selected the area of the industrial fish farm known as Eja Wa, but residents were fearful to speak due to a legal dispute. In total, 100 respondents were interviewed.

Questions asked focused on the extent to which the residents around the reserve had been consulted about the project's potential social, economic, and environmental impacts and how they felt about it. The findings of the students' research showed that:

- 91% of those interviewed were not invited to participate in any public meetings related to the conversion of the Ogunpa Forest Reserve.
- The 9% of respondents who had participated in a public meeting said that they attended in order to deliberate on the issue, and not because government or any relevant authority had invited them.
- 95% believed that the opinions of residents had no influence on the planning and decision-making process, while 5% believed they did.
- 83% said that they were not informed or educated on the potential impacts of the development.
- 73% expressed dissatisfaction, 23% indifference, and 4% satisfaction about the degree of involvement of residents in the decision to convert the forest.

These findings, which are to be published in a scientific journal, highlight a significant gap in inclusive planning and decision-making. It appears that the voices of surrounding communities were not heard.

The city of Ibadan retains some green spaces, including Agodi Botanical Gardens, University of Ibadan Botanical Garden, and IITA Forest Reserve.

Tree species found in Ibadan metropolis include introduced trees *Mangifera indica*, *Polyalthia longifolia*, *Terminalia catappa*, *Psidium guajava*, *Azadirachta indica*, *Eucalyptus camaldulensis*, *Anacardium occidentale*, *Albizia lebbeck*, *Citrus paradisi*, *Cocos nucifera*, *Delonix regia*, *Gmelina arborea*, *Gliricidia sepium*, *Pinus caribaea*, *Tectona grandis*, *Alstonia boonei*, *Aquilaria malaccensis*, *Blighia sapida*, and *Terminalia mantaly*, and indigenous species *Terminalia ivorensis*, *Khaya senegalensis, Milicia excelsa*, *Parkia biglobosa*, *Ficus sycomorus* and *Elaeis guineensis*.

However, there is clearly a lack of consultation with the public, and even these remaining green spaces are at risk.

Lessons learned

- Governments often prioritise short-term economic gain from converting forest land. But the long-term cost, such as increased health expenses due to pollution and disaster recovery costs from flooding, outweigh the short-term benefit. Without urban forest, cities need to invest more in artificial cooling, drainage, and air pollution management.
- Government often fails to notify the public and key stakeholders prior to urban forest conversion; however, governments converting urban forest without public involvement appear opaque and untrustworthy. Allegations of corruption, favouritism, or policy manipulation for private gain can arise.

Recommendations

To fully reduce urban tree loss and harness the opportunities of the urban forest in Ibadan and Nigeria, there is a need to:

- develop and enforce Urban Greening Policies that mandate tree planting in residential, commercial, and industrial areas;
- strengthen EIA laws;
- implement policies that prohibit indiscriminate tree felling and mandate replacement planting for every city tree removed.

Further Reading

Adegun, O. B. (2020). 'Greening African cities: Urban green infrastructure planning in Nigeria.' Urban Forestry and Urban Greening, 48, 126568. **https://doi.org/10.1016/j.ufug.2020.126568.**

For queries on this case study, email:
oyinlola4christ@gmail.com

INTERVIEW WITH DR ROSALIE ANN MODDER-OYEFESO

Representative, Save Ogunpa Forest Reserve, Co-founder, Save Our Green Spaces

'IT HAPPENED OVERNIGHT'

'We started seeing WhatsApp messages saying "they are cutting down the forest". It happened overnight. We were shocked.

'On 19 December 2023 we protested. Some of us were beaten and our cars impounded. Then, on 20 December, the Save Ogunpa Forest Reserve Group, a coalition of 30 environmental bodies from all over Nigeria, sent an appeal to the Executive Governor of Oyo State. It was never answered, so we wrote again on 9 January 2024, conveying our wishes and reminding him that "this will remove the very last green area in Ibadan".

'We also said that the destruction "in the name of curbing criminal activities (was) extremely alarming taking place shortly after COP28 where our country was greatly represented". Finally, we reminded him of Ibadan's flood of 1980 during which hundreds died. The forest is essential to the city's flood protection. We have still not heard back.

'Today it's really hot. This was not the case when I was a child. I avoid going out in the afternoons. Tree-lined streets have gone. The avenue to University College Hospital was once lined with spectacular *Samanea saman* trees, a species loved by colonial planners. About a decade ago, the Chief Medical Director at the time, believing that they housed evil spirits, had them cut.

'The same species formed a "green cathedral" along Secretariat Road. In the 1980s, a driver of some importance crashed into one of them and died. That was the end of them. A few years ago, about five more *Samanea* trees in front of the Alliance française were cut down, and the huge roots burnt in broad daylight.

'Some people see iron and concrete as progress. Compounds are paved. They don't want leaves. On the other hand, environmentalists avoid areas where their favourite trees have been cut. And when they can't, they turn their heads away, as I do. It is heartbreaking to see those empty spaces.

'All the overwintering birds have disappeared, and we do not know where the 30,000 bats that roosted in Ogunpa Forest Reserve have gone. At dusk they filled the sky.'

CASE STUDY #28

From forest garden to climate and social inclusion infrastructure: GADEF Urban Forest Garden in Ado Ekiti

Akinyemi Akinyugha, Green Economist/Sustainability Professional; Olubunmi Olatilu and Tope Faboya, co-founders, Green to Abundance Development and Empowerment Foundation (GADEF); Faith Eriaremhien, programme officer, and Adeola Adeleye, grant officer, GADEF; Oliver Owen, lecturer, University of Oxford.

Ekiti State lies in southwestern Nigeria within the forest savanna transition belt of West Africa. Its climate is humid tropical, and its landscape is shaped by rolling hills, inselbergs, seasonal streams, and deeply weathered crystalline basement geology.

Ado Ekiti, the state capital, occupies a central position in this geography and has expanded rapidly since its designation as an administrative hub. A growing population of 400,000, real-estate development, road construction, and a concentration of universities and public institutions have transformed the land cover and intensified exposure to climate hazards. Like many medium-sized West African cities, Ado Ekiti faces rising heat stress, flash flooding, and seasonal water shortages – risks that increasingly demand nature-based responses embedded within everyday urban life.

This case study looks at GADEF Urban Forest Garden, a privately initiated public space created in Ado Ekiti in 2017 to confront accelerating deforestation, biodiversity loss, and reduced access to green space.

A project of Green to Abundance Development and Empowerment Foundation and founded by two retired government foresters, GADEF Urban Forest Garden occupies roughly 4.2ha opposite the Ekiti State University Centre for Continuing Education and amid residential neighbourhoods and transport corridors. It combines scientific forestry with participatory conservation and livelihood support.

- At the heart of the forest garden is the Memorial Arboretum, with more than 700 indigenous trees providing goods such as timber, fruit, medicine, forage and fibre, and services such as habitat for pollinators and natural pest controllers.
- GADEF Urban Forest Garden serves as a seed bank and propagation hub for urban and peri-urban greening. Restoration activities extend beyond the core garden through satellite plantings at community and institutional sites with partners such as the International Tree Foundation.

GADEF Urban Forest Garden offers a critical counterweight to the rapidly emerging risks in a context where regional warming and changing rainfall regimes are heightening thermal discomfort; roofs, asphalt, and compacted soils are replacing vegetated surfaces, reducing infiltration and increasing heat storage; deforestation on the urban fringe is weakening ecological buffers that once moderated microclimates and runoff; and limited formal green space planning is creating uneven exposure to environmental stress. Its layered canopies, mixed-species assemblages, permeable soils, and shaded understoreys resemble structures associated with urban cooling in tropical environments.

In addition, GADEF Urban Forest Garden addresses biodiversity loss by protecting and propagating species of high conservation priority on the IUCN Red List, such as *Afzelia*

africana and *Khaya ivorensis* (Vulnerable), *Milicia excelsa* (Near Threatened), and *Mansonia altissima* (Endangered). Their presence within an urban setting provides a rare genetic refuge amid widespread habitat degradation in West Africa. Alongside these hardwoods, the Urban Forest Garden team also raises culturally vital species such as *Garcinia kola*, *Parkia biglobosa*, *Chrysophyllum albidum*, and *Irvingia gabonensis*, strengthening links between biodiversity protection, food systems, and urban livelihoods.

Beyond microclimate regulation and biodiversity conservation, GADEF Urban Forest Garden:

- provides ecosystem services, sequestering carbon, intercepting rain, limiting erosion, and supporting pollinators and birdlife;
- functions as an outdoor laboratory for visiting students from regional universities such as the Ekiti State University and Federal University of Technology Akure, embedding environmental learning directly within the urban fabric;
- runs livelihood programmes, including one in 2024 supported by the Global Green Grants Fund, which compensated farmers on whose lands endangered indigenous tree species occur, for protecting the trees while engaging them in seed collection and nursery production;
- has a strong gender focus, with women benefiting from seedlings of species that produce non-timber forest products, a gender-responsive action that strengthens household incomes;

Aerial view of Ado Ekiti: Annual rainfall typically ranges between 1,300 and 1,800mm and temperatures between 21°C and 34°C, with hotter extremes becoming more frequent. Historically dominated by lowland rainforest mosaics, Ekiti's vegetation has become progressively fragmented by agriculture, fuelwood extraction, and rapid settlement expansion. Photo: N Awolowo (Rixel Studios).

- is a player in multi-actor coalitions that include civil-society organisations, faith-based institutions, government agencies, and international research bodies, increasing its technical reach and institutional legitimacy;
- functions as a nascent legacy ecological asset within Ado Ekiti's expanding urban matrix, enhancing the city's broader tree stock and inserting daily encounters with nature into routine urban life.

Yet, as with larger metropolitan forests elsewhere, its effectiveness ultimately depends on spatial integration. Street trees, pocket parks, riparian buffers, and institutional campuses planted with GADEF Urban Forest Garden-grown seedlings will disseminate the benefits of trees, such as shade and social inclusion, more equitably across the city.

Lessons learned

- Distributed networks of small but dense forest patches rather than reliance on a handful of flagship parks can moderate temperatures more widely, enhance biodiversity connectivity, and embed nature-based solutions into everyday landscapes.
- The GADEF Urban Forest Garden experience reinforces the case for expanding forest gardens across African cities.
- For medium-sized cities such as Ado Ekiti, forest gardens provide a cost-effective complement to engineered infrastructure, particularly where municipal budgets are constrained.
- Through shade provision, evapotranspiration, wind modulation, carbon storage, and stormwater interception, GADEF Urban Forest Garden is more than decorative: it is climate-regulating infrastructure.
- Indigenous species and diversity matter. Focusing on native trees – including those important to culture and diet – ensures that the forest is locally adapted and a reservoir of biodiversity.

'We have identified other forest fragments for potential preservation. We can replicate this model in other towns and cities across Ekiti and beyond.'



Left: Environmentalist Olubunmi Olatilu leads a tree-identification field session at the GADEF Urban Forest Garden, where local university students learn about indigenous species, conservation, and urban forestry in practice. Centre: A patch of remnant forest is of unquantifiable value, holding carbon and biodiversity and a learning opportunity and seed source. Right: A community member tends a sapling in the forest garden. Photos: GADEF Urban Forest Garden staff.

Collecting and processing tree seed, especially of rarer species, and propagating it in the GADEF nursery are major preoccupations of the forest garden, as well as incentivising farmers to collect seed from their farms. Photos: GADEF Urban Forest Garden staff.

- Relatively small forest patches embedded within neighbourhoods can yield disproportionate ecological and social returns, particularly in cities where green infrastructure is scarce.

Recommendations

- Favour native over exotic planting.
- Link to livelihoods, e.g., NTFP programmes and contracts with farmers.
- Promote nursery businesses, agroforestry, and urban farming as greening.
- Involve local stakeholders from the start for pride and stewardship.
- Encourage neighbourhood tree committees, school greening clubs, and groups to plant and care for urban forest.
- Collaborate and seek funding.
- Adopt city urban forestry strategies with quantitative canopy targets.
- Use green sites as open-air classrooms: insert tree planting into curricula.
- Incentivise private-sector greening of campuses, markets, office compounds.
- Mainstream green infrastructure planning.
- Communicate that disseminated green complements rather than competes with development.

Further reading

Agbelade, A. D. (2025). 'Analyzing the influence of urban vegetation cover on land surface temperature in southwestern Nigeria.' *Discover Environment*, 3, Article 10.

For queries on this case study, email:
yemi.akinyugha@gmail.com

'In just a few years, our small forest garden has regenerated endangered tree species, buffered local climate, and boosted communities' skills and income. More such multifunctional urban green spaces would improve liveability. In rapidly urbanising West Africa, nature is not at odds with development, but rather indispensable infrastructure: cities must make room for it. With indigenous trees, community empowerment and good governance, urban forests can create greener, cooler and more resilient places for all.' – AKINYEMI AKINYUGHA, GREEN ECONOMIST, SUSTAINABILITY PROFESSIONAL

CASE STUDY #29

Planting the MOWAA rainforest in the heart of Benin City

Tunde Morakinyo, Executive Director, Africa Nature Investors (ANI)

Benin City in Edo State, Nigeria, is famous for its ancient history and the fabled Benin Bronzes. However, modern Benin City with over 2 million residents can be stressful, with severe traffic jams and no green spaces where residents can unwind.

A new Museum of West African Art (MOWAA) is being built in the centre of Benin City on 14ha of derelict land that once held old government buildings. In 2023, MOWAA approached Africa Nature Investors (ANI) Foundation to see if the two organisations could establish an urban rainforest park around the museum and its upcoming galleries.

ANI is based in the same state and is working with Nigeria's National Park Service to protect Okomu National Park, a 202km^2 rainforest located about 45 minutes outside Benin City. It was agreed to establish Benin City's first urban park at MOWAA, and to only plant indigenous trees from the native rainforest that once covered the ancient Kingdom of Benin and the rest of southern Nigeria.

Top: Entrance to MOWAA. Photo: K Fowlds, Wikimedia Commons, distributed under the Creative Commons Attribution-Share Alike 4.0 International license. Bottom: Aerial view of the museum before planting: the ground is bare. Photo: Courtesy of MOWAA.

The team from Africa Nature Investors (ANI) Foundation planting already sizeable young trees, many of which have been transplanted from around Benin City where development was threatening them. Photos: ANI Foundation.

Reasons included:

- Nigeria has one of the world's fastest rates of deforestation and is losing its precious rainforest species upon which millions depend for a wide range of vegetables, fruits and medicine.
- The country is rapidly becoming one of Africa's most urbanised. However, few trees are being planted in its cities, and almost all that are planted are exotics that were imported into West Africa, mostly from Asia, by the British Colonial Forest Service before independence. Thus, millions of urban Nigerians have little knowledge of their indigenous trees and their uses.
- The beliefs of Benin's ancient culture were deeply intertwined with the plants and animals of the surrounding rainforest as reflected in its stories, prayers, legends and even the famous Benin Bronzes themselves.
- Benin City offers few open-access inner-city green spaces, which constrains the promotion of eco-tourism, healthy outdoor lifestyles, and diverse cultural life.

MOWAA and ANI agreed to establish an urban rainforest to remind visitors of this deep connection between culture and nature. It was also felt that the rainforest could awaken an interest among Nigerians in planting indigenous trees in streets and gardens in towns and cities, through access to its gardens and community tree-planting activities.

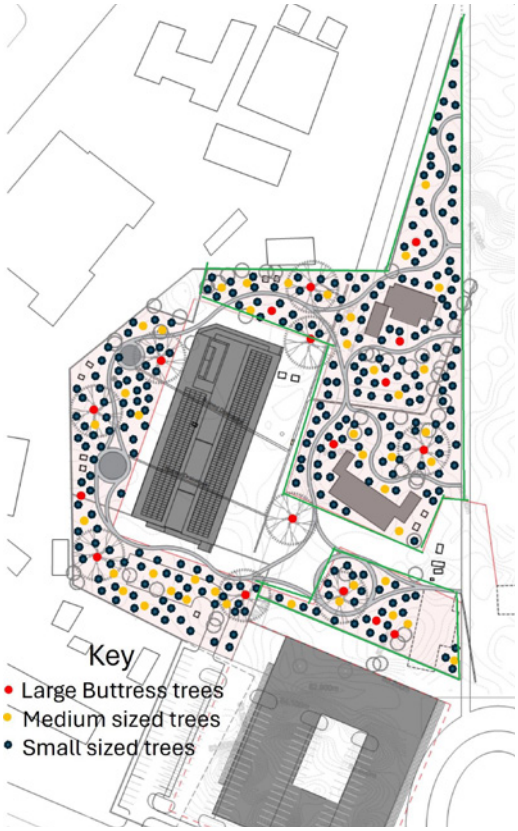
An initial inspection revealed that the land was overgrown with weeds and scattered with concrete foundations of abandoned buildings, soak-away pits, remnants of a tarmac road, concrete pathways, and exotic trees such as mango, ashoka tree *(Polyalthia longifolia)*, *Gmelina arborea* and *Terminalia mantaly*. Work began immediately to remove all rubble and hardcore as well as the smaller non-indigenous trees. It was decided, however, to leave the larger trees until the newly planted native ones grew tall enough so as not to create too much of an abrupt visual loss. Due to the historical significance of the site, MOWAA's archaeologist worked closely with ANI's specialists, ensuring that the preservation of cultural remnants were prioritised alongside the rubble clearance and transplanting efforts.

The next challenge was that almost all trees sold in roadside nurseries in Nigeria's towns and cities are exotics. After an exhaustive search, the team found nurseries with native species 200km away at the Forest Unit of the International Institute for Tropical Agriculture (IITA) and the Federal College of Forestry in Ibadan. It bought 700 saplings of over 30 species between 40cm and 2m in height, choosing native species for their fruit, timber, shade, medicinal and ornamental value, and a

range of species typical from pioneer to mature stage of the evolution of a forest.

Pioneer tree species selected included *Ceiba pentandra*, *Musanga cecropioides* and *Anthocleista vogelii*, species, usually with wind-dispersed seeds, which like to grow in full sunshine immediately after a patch of rainforest has been cleared. Selected species more typical of secondary and mature rainforest were bush mango *(Irvingia gabonensis)* and star apple *(Chrysophyllum albidum)*, which have heavier fruits dispersed by animals.

Said to harbour spirits and often depicted on the ancient bronzes, *Ceiba pentandra* (kapok or silk-cotton tree) is one of the rainforest's largest trees and produces clouds of fluffy seeds used to stuff mattresses. *Musanga cecropioides* or umbrella tree produces a liquid from its prop root that is used to cure the eye disease conjunctivitis. Tall forest tree *Irvingia gabonensis* (bush mango or ogbono) bears large fruits with a highly sought-after seed, which, when dried, crushed and added to



Top: A schema of how the trees should be positioned, with red dots representing large buttress trees, yellow medium-sized trees and blue smaller ones. Bottom: A futuristic view of the rainforest surrounding the museum. Photos: Courtesy of MOWAA.

Seedlings in bags awaiting planting, some sourced from large distances away due to the lack of nurseries raising indigenous species. Photo: ANI Foundation.

stews, makes them thick and delectable: a sack of the seed can be seven times more valuable than an equivalent sack of cocoa. Juvenile trees of *Anthocleista vogelii* bear leaves of up to 2.3m in length with wavey edges. Farmers often leave *Chrysophyllum albidum* standing when opening land. It can also be found on roadsides.

It was a logistical challenge to rent trucks and transport the 700 tree saplings along bad roads from Ibadan to Benin. At the site, the saplings were transferred to a newly established nursery and planted at 2m spacing. The team also transplanted semi-mature 3m tall native trees from building sites around Benin City that were about to be cleared for construction. All trees are regularly watered and weeded by gardeners. This will continue until they are established and grow tall enough to close their canopies, shading out weedy undergrowth.

Going forward, the team will collect seed of many additional species from remnant rainforest

'Some of the trees were rescued from communities in Ovia South West, where infrastructural development was taking place. The communities include the Iguoriakhi and Iwu. The MOWAA team and I approached the owners of the lands to request for the trees to be transferred instead of being logged or cut down. They gladly permitted us to move the trees.' – EMMANUEL BARDE ELISHA, RESEARCH COORDINATOR, ANI FOUNDATION

Left to right: Two recently planted young trees – a *Hildegardia barteri* and a *Ceiba pentandra* – establishing themselves well, and a dramatic shot of the team using a crane and earth-moving machinery to transplant a particularly large *Anthocleista pentandra*. Photos: ANI Foundation.

patches around the city to increase the diversity in the MOWAA rainforest. It may also rescue and replant semi-mature trees from rainforest patches facing conversion to farmland.

Over time, the forest will become a magnet for birds and bats who bring in other tree seeds in their droppings, naturally increasing plant diversity. The forest will be landscaped with pathways, and labels on trees will explain their scientific and local names and their cultural/economic importance. When the museum is officially open, the rainforest will be free of charge to students, young adults, and senior citizens. MOWAA plans to set up a learning nursery and sell indigenous trees with labels explaining their value, e.g., fruit, medicinal, shade. The hope is that the rainforest will inspire Nigerians to plant these trees on their streets and in their gardens. Besides naturally cooling the buildings of the new museum, the rainforest will be a place of great beauty and a much-needed green space in Benin City.

The species list also includes spectacular large, often buttressed trees *Pycnanthus angolensis* (cardboard tree), *Terminalia ivorensis* (black afara), *T. superba* (white afara), *Nauclea diderrichii* (opepe), *Triplochiton scleroxylon* (obeche), *Entandrophragma sapele* or *E. angolense* (mahogany), *Baillonella toxisperma* (mimusop), *Piptadeniastrum africanum*, *Tieghemella heckelii* (moabi), and *Bombax buonopozense* with big fleshy red flowers; medium-sized trees *Dacryodes edulis* (bush pear), *Cola nigerica* (cola nut), *Garcinia kola* (bitter cola nut), *Monodora myristica* (forest garlic tree) with nuts and orchid-like yellow flowers, and *Brachystegia eurycoma* (achi), a soup condiment, with bright red leaves after the dry season; and smaller trees *Spathodea campanulata* (African tulip tree) with red flowers, *Sclerosperma mannii* (a rare palm), fast growing, with leaves for thatching, *Dracaena mannii*, fast-growing, resembles yucca, *Trichoscypha acuminata* (bush plum), large red fruit bunches on stem, and *Treculia africana* (African breadfruit), football-sized fruits.

Lessons learned

- Native trees are rarely grown due to low demand.
- It takes effort to track down the required botanical diversity to reestablish a forest.
- Brown field sites (sites that have been built upon) may be colonised by hardy exotics but require considerable labour to prepare them to receive indigenous tree species used to forest conditions.

Recommendations

- Think about early succession and pioneer species when starting an urban forest from ground zero.
- Conserve and hold surviving rainforest patches as places of inestimable value: they will be seed sources for future urban forests.
- Plan forward to continue diversifying the urban forest. The initial list of 30 species represents a fraction of the tree species in southern Nigeria.
- Focus continually on public education such as labels on trees and free access to the park.
- Look for young native trees under threat from urban expansion to populate newly created parks.
- Normalise native trees as plantable.

Further reading

About the Museum of West African Art, **www.wearemowaa.org**

For queries on this case study, email:
tm@ani-nigeria.org

'At 70 metres tall, Silk Cotton (*Ceiba pentandra*) trees are often the tallest trees in the rainforest and are regarded as sacred across West Africa. They are easy to grow and make wonderful specimen trees for planting in urban parks.' – TUNDE MORAKINYO, ED, ANI FOUNDATION

Above: A Silk Cotton tree in Okomu National Park, Nigeria. Photo: ANI Foundation. Insert left: The famous Freedom Tree, also a *Ceiba pentandra*, in the centre of Freetown in 2007, demonstrating that large trees can be street trees. Over 300 years old and thought to have witnessed freed slaves returning from the New World, it collapsed in a storm in 2023 to the distress of Sierra Leoneans. Photo: C Trede. Wikimedia Commons, distributed under a CC SA 2.0 license.

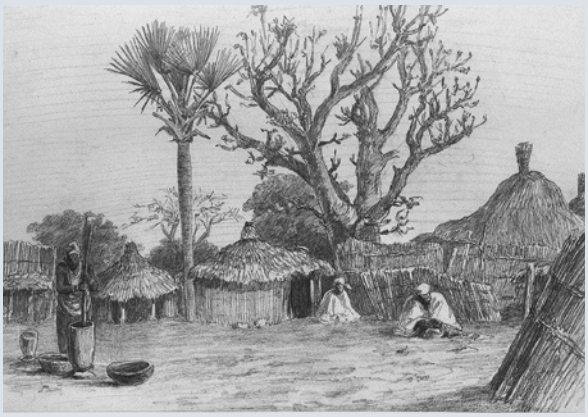
CHAPTER 11

SENEGAL

BACKGROUND

Senegal lies largely in the hot arid Sahel and has treed savannas, mangroves, and gallery forests. This natural endowment is threatened, however, by bush fires, desertification, drought, and immense extraction pressure for firewood, charcoal, and construction – all exacerbated by climate change.

Loss of tree cover is particularly significant in and around urban and peri-urban areas, and Senegal is urbanising fast. Dakar metropolitan region has an estimated 4 million people and a staggering 15,000 people/km^2. It is Africa's fourth most densely populated city after Kinshasa, Johannesburg, and Lagos. (UN Habitat Senegal Country Brief, 2023, Cities Today, 2025). In 2020, only 24.3% of Dakar's land area had more than 10% tree cover. Temperatures are rising. Dakar is in urgent need of trees.



As in Ghana, urban forest existed in Senegal before the arrival of Europeans. In one example, the villages of the Lebou, Dakar's original inhabitants, consisted of round-hut complexes arranged around a central sandy square with a small mosque and a handful of large trees, which were typically indigenous baobab *(Adansonia digitata)*, 'Platane du Sénégal' *(Sterculia setigera)* and kapok *(Ceiba pentandra)*. This precolonial tree planting pattern is still discernible today, and these species remain important.

During the colonial period, the French created tree-lined boulevards. But, unlike in many British colonies, where exotics like jacaranda were planted en masse, the French relied on African mahogany *(Khaya senegalensis)* in their grand avenues and even exported it to other imperial cities like Hanoi. Today, urban forests are struggling in Senegal. But there is hope as the city engages in the Great Green Wall and urban forestry projects succeed against all odds. Read the case study here.

Left: French naval officer Pierre Loti's engraving 'Dakar in 1873' shows a central village space surrounded by huts shaded by a baobab and tamarind trees, an urban design that persists to this day, according to Bigon and Adedeji, 2025. Photo: Pierre Loti. Wikimedia Commons, distributed under a CC 0 (Public Domain) license.

CASE STUDY #30

Urban reforestation in northern Dakar: '94% of our street trees survived the first year'

Alioune Badara Gueye, head of Planning, Natural Resources, and Sustainable Development, Keur Massar Nord municipality, environmental activist, and Senegal National Focal Point MAB Youth of the UNESCO MAB Programme

The commune or municipality of Keur Massar Nord is part of Dakar's expansion along the Cap-Vert peninsula. It offers many opportunities for the 224,765 people who live there, mostly migrants from the countryside. But with a staggering density of 17,058 people/km², it is dominated by buildings. Its minimal tree cover and scant green space have profound consequences for community and individual physical and mental wellbeing.

In 2023, the Mayor's Environmental Commission, the central government's Water, Forests and Soil Conservation Department (DEFCCS), and community associations banded together to create a greener town by planting 15,000 street trees by 2027. During 2023 and 2024, more than 1,917 trees were planted and protected along 5km of roads, in 22 schools, and in front of public infrastructure, houses and shops. This case study stands out for the relatively low number of trees planted compared to projects like Greening Soweto; the care given to the planted saplings; the extent to which the project went to ensure that the trees were safe and growing; and the unusually high survival rate of its trees.

Between 27 July and 14 November 2023, a total of 700 trees were planted. Except on an outlier event when 225 trees were planted, the average number planted at any event was 34. Categorised as shade trees, they were all protected with iron and wire mesh protection and gabions and sometimes with tires and brick. Cement and concrete were placed around the trees to prevent theft.

In another set of plantings with Keur Massar Nord's Municipal Development Agency (ADM) over three days in six different locations in 2024, a further 309 trees were planted, an average of 51 per site. And finally, later in 2024

Top: Map of Senegal, with capital city Dakar seen at the most westerly point, protruding into the Atlantic Ocean. Bottom: The Keur Massar area clearly visible north of Dakar. Maps: Amitchell125. Wikimedia Commons. Licensed under Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA 4.0).

Left to right: A reforestation day at a school with students planting a *Peltophorum africanum* under the supervision of the technical team, and a *Delonix regia* on the main street of PA Unit 12 neighbourhood of Keur Massar Nord, the photo taken during a follow-up visit to trees planted in 2024. Photos: AB Gueye.

an average of 41 trees were planted in each of 22 schools for a total of 900. The most planted in any school was 100, the lowest was 25.

The average height of the seedlings planted was 1.3m, which made them in effect saplings. This is much taller than most planting material used in restoration projects.

All the seedlings were supplied by the Mbao Water and Forestry Nursery, located inside Senegal's largest urban forest, the Mbao Classified Forest, which borders Keur Massar Nord to the south. It has a dedicated nursery plot to supply the municipality.

A total of 1,237 indigenous and 590 exotic trees were planted. Indigenous species included *Khaya senegalensis*, *Adansonia digitata*, *Senegalia senegal*, *Faidherbia albida*, *Balanites aegyptiaca*, *Calotropis procera*, *Tamarindus indica*, and *Ziziphus mucronata*, as well as *Cordia sinensis* and *Saba senegalensis*, which are increasingly used by local populations as pergolas or hedges in homes, while *Adenium obesum* or desert rose is grown on balconies. Exotics included *Delonix regia*, *Gmelina arborea*, *Senna siamea*, *Terminalia mantaly*, *Hura crepitans*, *Cordia sebestena* and *Cocos nucifera*.

To ensure survival and good growth of the trees planted, a protocol was followed.

Any request for trees was first studied by the project team, then a field visit was conducted by the Forest Department and the municipality's Environmental Commission to explore the location, meet with the potential beneficiary community, and verify the layout.

One or two days before planting, a 'drilling' team was sent with the necessary equipment of a shovel, pickaxe, wheelbarrow, jackhammer (for streets with slabs or difficult to dig), and cement and brick to anchor a metal protective structure.

This team would dig holes with the required dimensions (on average 25cm in depth and 15cm in diameter). Spacing was 6m apart for planting on main streets.

On 'reforestation day', the water and forestry officials, members of Keur Massar Nord

environmental commission, and local residents (neighbourhood chief, local associations, women and youth) would plant the trees and install the metal protectors around them.

Next, a 'sponsor' at the house closest to the tree would be designated to follow the tree, monitoring and watering it regularly. A total of 186 men and 311 women became sponsors. Their average age was 47 years.

For trees planted at schools, monitoring is entrusted to students and teachers. On major roads far from residential areas, the project team regularly visits to water and maintain the trees.

Finally, the saplings are georeferenced using the Kobocollect mobile app, and information is collected using a questionnaire prepared in advance on the Kobo platform, including species, neighbourhood, street, and name and phone number of the tree's sponsor.

All of these steps, as well as the modest number of trees planted and the use of the rather larger seedlings/saplings than is customary in most urban forest efforts, coupled with an ongoing awareness campaign from start to finish, were effective in achieving a 94% survival rate in the first year after planting.

It is noteworthy that such a high first year survival rate was achieved in such a dry and sandy locale. Also noteworthy are the metal protectors. Made by local artisans, they cost approximately $15 each. Some trees are protected by bricks and mortar.

There were challenges, of course. Although the public wants trees, it was hard to please all the people all the time, and public apathy was widespread.

Some inhabitants were indifferent and did not participate. Others were unwilling to monitor the trees entrusted to them as sponsors. Some preferred species that were unavailable or too expensive. Yet others criticised the positioning of the the trees in relation to their shops. Illegal street vendors and kiosk owners sometimes tampered with the young trees.

Left to right: President of Senegal's Environment Commission, Thierno Diallo, in 2025 during a follow-up visit to the trees planted in 2023 in the PA Unit 4 neighbourhood of Keur Massar Nord, and tree sponsor Mr Kobar standing next to his African mahogany *(Khaya senegalensis)* at the same site. Photos: AB Gueye.

Evidence that urban forestry is a well-established practice in Africa, a single large tree provides shade and cooling on Gorée Island, which for centuries was the gateway through which slaves were forcibly transported to the New World. Lying 3.5km off Senegal's coast, opposite Dakar, it is now a UNESCO World Heritage site with numerous large trees. Photo: W Pike.

Densely populated Keur Massar Nord is also physicially constrained. Space for new trees and green space is hard to find in cramped alleys and where informal buildings can spring up in public spaces and new infrastructure is under construction.

Other challenges were poor planning, informality, lack of capital improvement, animals such as goats and sheep foraging freely, seasonal flooding, and stagnant water and/or rising water tables rotting the seedlings and leading to the invasion of bulrush *Typha australis*. Finally, funding was a constraint.

Still, urban forestry is a priority in Senegal's Nationally Defined Contribution to the 2015 Paris Climate Agreement. And the municipality will continue to collaborate with the Dakar Greenbelt Alliance to create a green belt to prevent a conurbation from forming between the two large cities of Dakar and Thiès, and protect the urban fringe from unsustainable development.

Lessons learned

- No matter how intense the 'community engagement', street trees will be predated by livestock, and some people will vandalise them.
- Planting trees that are closer in size to saplings can indicate seriousness of purpose; these trees can also be hardier.
- The concept of a tree sponsor for a single tree is appealing but lacks the social and collective aspect of the 'Friends of' model, which has been shown in myriad places to achieve results.

Recommendations

- Plant a modest and manageable number of trees.
- Invest in metal or even brick and concrete tree protectors if possible.
- Be visible. Visit the trees regularly.

For queries on this case study, email:
aliouneggueye@gmail.com

Clockwise: Trees have always been part of Senegal's urban fabric: a *Balanites aegyptiaca* grows in the courtyard of a historic house on the island of St Louis, which was assumed into the global economy in 1659. Trees have also always been associated with its smallest settlements: trees can be inside the fences of a village in Kaffrine, while two baobabs offer shade and products just outside. Trees are an existential need. One of Africa's ten Sahelian countries, Senegal could experience warming of over 4.3°C under the high-emissions fossil-fuelled development climate scenario. Photos: C Watson, AB Gueye.

CHAPTER 12

NIGER

BACKGROUND

Niger sits in the Sahel, but 80% lies within the hyper-arid Sahara. The remainder and almost all its urban centres are in the Sahelian savanna biome in the south, which receives more rain and is better for tree growing but still challenging.

Further daunting, Niger has one of the world's highest population growth rates and fastest growing urban populations. In the capital, Niamey, daytime temperatures average 32–42°C.

Increasing urban tree canopy is clearly a matter of urgency. Managed natural regeneration, bringing back trees from rootstock is an option, but not easy. Towns lack the tree stumps found in fields.

On an upbeat note, Nigerien scholars have identified tree diversity in cities: 86 species in Niamey and 91 in Maradi is a good start. (See Further Reading.) But exotics represent 52% of species, and neem, which was introduced in 1965 during the creation of the Green Belt of Niamey with 2,500ha planted to fend off desertification, about half of all stems.

Among what must be done is increasing the planting of native species, they say. A second is increasing human capacity. 'There is a lack of urban forestry education,' says botany lecturer Moussa Soulé. A third is finding niches to plant. Read Soulé's case study about the currently underutilised potential of land around mosques.

See **https://news.mongabay.com/2025/05/urban-forests-in-nigers-schoolyards-serve-climate-resilience-and-education/**

A man on a shady, well-treed street in Maradi, and a mosque with ample space for additional trees. Photos: M Soulé.

CASE STUDY #31

Trees in mosque courtyards, an urban forest typology to conserve biodiversity and combat climate change: the case of large Friday prayer mosques in Maradi

Moussa Soulé, lecturer and researcher, Department of Biology, Faculty of Sciences and Techniques, University Dan Dicko Dankoulodo of Maradi

The typologies of trees that make up 'urban forests' are laid down clearly by FAO in its 2016 classic *Guidelines on urban and peri-urban forestry*. 'Urban forests can be defined as networks or systems comprising all woodlands, groups of trees, and individual trees located in urban and peri-urban areas; they include, therefore, forests, street trees, trees in parks and gardens, and trees in derelict corners,' says this easily downloadable book that needs to be on every urban forester's desk.

Getting more specific, the **Guidelines** state that 'a key action in the planning, design and management' of the urban forest is 'to create green spaces around public buildings (e.g. schools, hospitals and municipal buildings), religious buildings (e.g. churches, mosques, synagogues and temples), and cemeteries.'

This case study looks at the urban forest in urban mosque yards in Maradi, which has a population of 270,000 people and is Niger's second largest city. It holds that this important potential urban green space is under-addressed in the urban forestry literature, a glowing exception being Fattah and colleagues' **study** of the courtyards of Al-Aqsa Mosque in Al-Quds (Jerusalem).

Extending over 14.4ha, these courtyards hold 1,042 trees and shrubs of 30 species, 70% exotic and 30% indigenous. Individuals of three exotic species – European olive *(Olea europaea)* (550 individuals), evergreen cypress *(Cupressus sempervirens)* (274), and Aleppo/Jerusalem pine *(Pinus halepensis)* (85) – make up 87% of the trees.

In this case study in Maradi, the examples of Sahaba Mosque and Djingulé Mosque were used to highlight the tree species diversity and ecosystem services rendered by this type of assembly of trees. Both are Friday mosques, which Islamic architectural writings define as the main congregational mosque in a city, specifically designated to host the important weekly Friday noon prayers for the entire community, serving as a central hub for religious, social, and sometimes political life, and a vital public space for gathering, learning, administration, and information exchange.

In Sahaba Mosque, six tree species were recorded, distributed among six families. Among these species, five were exotic. The most abundant (44% of individual trees) is the mango tree *(Mangifera indica)*, followed by the neem tree *(Azadirachta indica)*, constituting

A camel browses on a tree outside a private home. Photo: M Soulé.

Neem and a smattering of other trees visible inside the entrance to Djingulé Mosque. Photo: M Soulé.

25% of the trees. The other recorded species, all exotic, were *Terminalia catappa, Moringa oleifera* and *Citrus limon*. The sole indigenous species found was the fruit-bearing tree *Syzygium guineense*.

In Djingulé Mosque, 10 tree species belonging to eight botanical families were recorded. *Azadirachta indica* made up 92% of individual trees, and *Eucalyptus camaldulensis* 3%. Both are exotic to the tree flora of Niger. The balance of 4% of trees consisted of three indigenous species – *Lannea microcarpa, Vitex doniana* and *Sclerocarya birrea* – and five further exotics: *Mangifera indica, Moringa oleifera, Tamarindus indica, T. mantaly* and *Calotropis procera*.

Estimates across Sahaba Mosque show a carbon stock of 1.85t/ha, which represents an opportunity for climate change mitigation projects in the urban mosques. The survey showed that the user group of the mosque yard urban forests is predominantly male (90%). An analysis of user perception, based on interviews with 40 people, confirms that the trees at both mosques are highly appreciated. Shade, fruit production, and improved air quality are the main benefits cited.

Lessons learned

- Large mosques present an immense opportunity for tree species conservation, even though the characterised flora of the two mosques were dominated by exotic tree species.
- Large mosques also present an opportunity for atmospheric CO_2 reduction.
- Smaller mosques also present an opportunity for both.

Recommendations

- Indigenous tree species should be 'massively' grown in the large (Friday) mosques as well as smaller mosques in Maradi city for sustainable biodiversity conservation and ecosystem services, and to mitigate and adapt to climate change.
- Species choice should focus on multipurpose indigenous tree species such as *Prosopis africana*, which has myriad local uses (food, medicine, timber and source of tannins) but due to overexploitation is disappearing from extensive parts of the Sahel and Sudan savannas.
- Species choice should also include indigenous fruits such as *Lannea microcarpa*, *Parkia biglobosa*, and *Vitex doniana* for cultural and nutrition purposes, and large trees like *Ficus* spp. and hardwood *Khaya senegalensis*, both of which are important for shade.

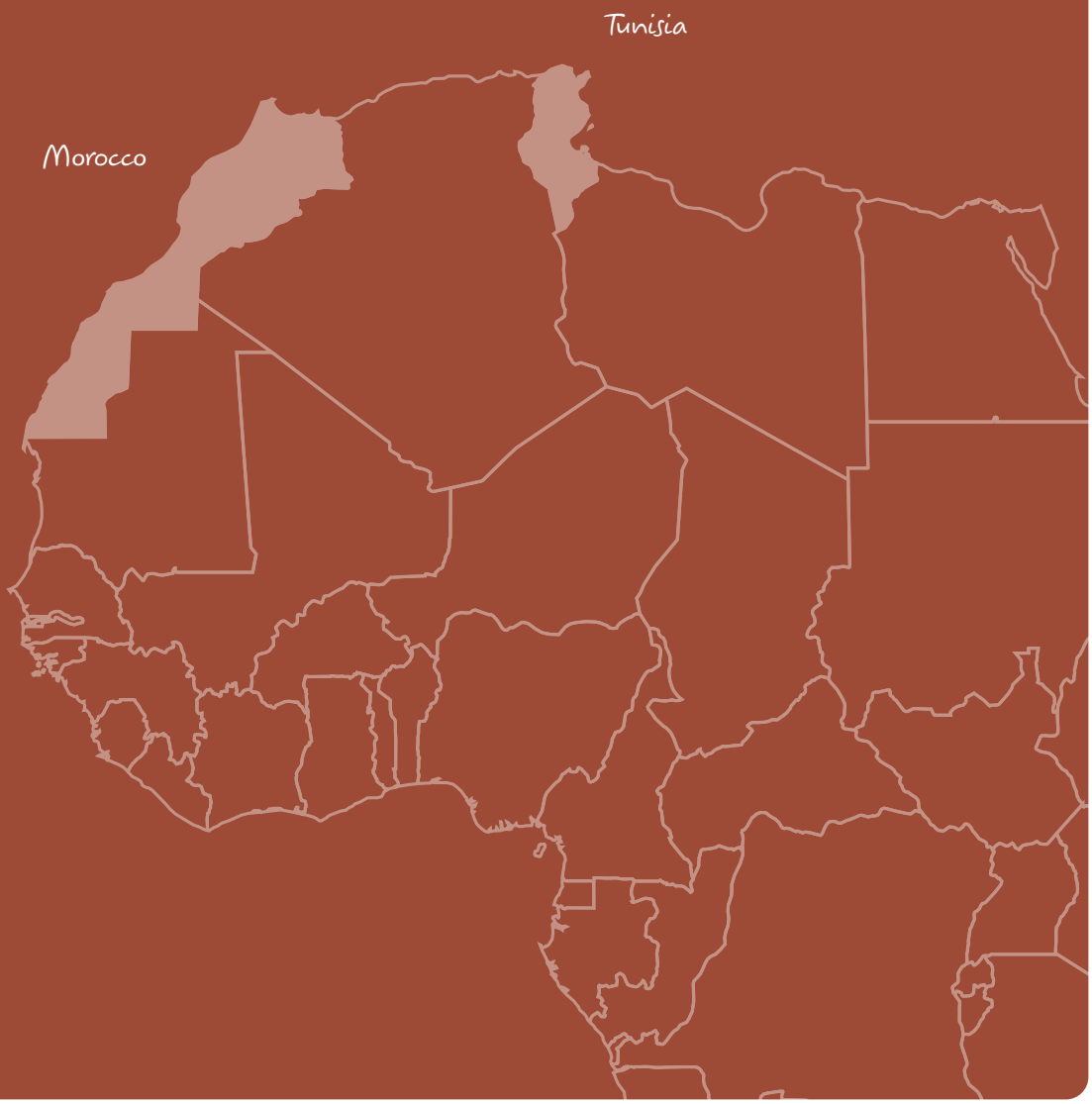
Further reading

Moussa Soulé, Shem Kuyah, Boateng Kyereh, Tougiani Amadou Abasse, and Mahamane Saadou. 2020. 'Diversity and Structure of Urban Forests of Sahel Cities in Niger.' *Urban Ecosystems*: 1–14. **doi:https://doi.org/10.1007/s11252-020-00984-6 Diversity.**

For queries on this case study, email: s.moussa@futminna.edu.ng

URBAN FORESTS IN

NORTH AFRICA



BACKGROUND

Foreign journalists often describe vegetation in drier parts of Africa as 'scrub'. What they are likely seeing is a degraded landscape that has lost its tall trees. Scrub is a technical term for a low-stature ecosystem associated with mild, moist winters and hot, dry summers. In Africa, it is primarily found in the North African or Magreb countries along the Mediterranean, where it is called Maquis, and in South Africa, where it is called Fynbos. Dense, often aromatic and tangled, dominated by hardy bushes, shrubs, and small or stunted trees, it is vital for biodiversity, hydrology, preventing erosion, and other ecosystem services as well as products.

This chapter contains one case study from Tangier in Morocco and two from Tunis in Tunisia. All three refer to indigenous Maquis trees. These tend to be evergreen and drought-resistant with leathery water-retaining leaves. Including kermes oak *(Quercus coccifera)*, mastic tree *(Pistacia lentiscus)*, and Aleppo and maritime pines *(Pinus halepensis, P. pinaster)*, they are likely unfamiliar to readers from other African biomes. But what will be familiar are the issues of exotics. The case study on Belvedere Park, for example, describes *Eucalyptus* spp. as more vulnerable to climate change than indigenous carob *(Ceratonia siliqua)*.

The Tunis case studies focus on parks, both stressing how the parks have survived thanks to the role played by NGOs or community associations. An overall lesson emerging from this compendium is that co-management of green spaces by citizen groups and municipal authorities is a prerequisite for them to succeed.

The Tangier case study reports on the influence of a park on heat. It concludes that 'large urban forests offer strong and reliable localised cooling', but 'distributed greenery often surpasses large parks in lowering average urban temperatures.' Clearly, also essential for Africa's cities are parks and trees dotted throughout – it is both, not either/or.

View of the Mediterranean Sea from the highest point of Rmilat Park. Clearly seen is the scrub vegetation of the coast of North Africa with its hardy drought-resistant species including indigenous pines. Photo: A Kamana.

CHAPTER 13

TUNISIA

CASE STUDY #32

The Belvedere Park in Tunis: From historical heritage to climate resilience in Tunisia

Ichrak Klai, lawyer, founder, Bamboo Consulting for Sustainability

Created in 1892 in an English landscape style by a famous French landscape architect, Belvedere Park in Tunis is a public garden with a storied history that resonates profoundly with Tunisian culture and history and the private lives of its residents.

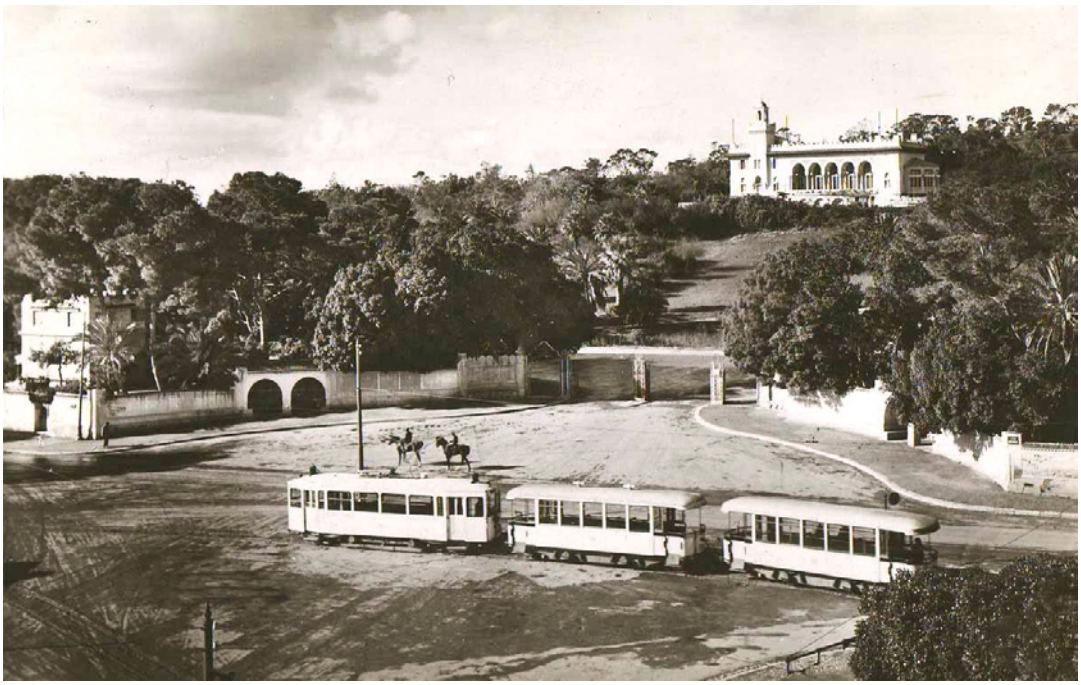
Originally a traditional olive grove, Joseph Laforcade, who was the chief gardener of Paris, designed it for strolling. 'Belvedere Park reproduces a nature mastered by the human hand, a subtle play of groves and clearings that create deliberate perspectives over Tunis and its lake,' writes the senior Tunisian professor of architecture Imène Zaâfrane Zhioua.

This case study examines this 110ha green space, which is both a 'green lung' – a critical part of the survival infrastructure of Tunis in a time of climate crisis – and an open-air museum. It houses masterpieces of Muslim art such as the Kobbet El Haoua (Pavilion of the Winds), built in the 17th century under Hammouda Pacha, and its Midha (ablution hall), both of which were displayed at the 1900 Paris Exposition. It also has a Neo-Moorish style Casino built in 1910.

The park hosted concerts in the 1950s, by the legendary lute player Farid El Atrache among others, but also bears the scars of World War II, during which it was the headquarters of Germany's Afrika Korps.

It is a 'non-stigmatised' setting for couples and offers a breath of fresh air for families and a sanctuary for fauna and flora, hosting bats and numerous migratory and resident bird species. Its 13ha zoo receives nearly one million visitors a year, and the park has over 230,000 trees of more than 80 species. Local tree species, such as Aleppo pine and olive trees, co-exist with monumental Australian exotics like *Ficus macrophylla* (Australian banyan/Moreton Bay fig) and *Eucalyptus*.

Tunis has approximately 1,062ha of green space, providing around 14.65m² of green space per inhabitant, which meets the WHO's recommended minimum of 9m² per person. Still, this is less than what many northern cities seek, and some well-informed Tunisians say that say their capital and this iconic park are now under threat: the city experienced a reduction in green spaces from 23% in 2000 to 20.9% in 2020 – 'Our results demonstrate that the green layout in Tunis has become more



Historic photo of the tramway at the entrance of Belvedere Park.
Photo: B Bouret. Wikimedia Commons. Distributed under a CC 0 (Public Domain) license.

fragmented, and the size of green spaces has become smaller,' say researcher Khouloud Ben Messaoud and colleagues – while the park is suffering a decline in its plant heritage due to water stress.

Lower than usual rainfall and falling groundwater levels are depriving century-old trees of the water they need. This is causing visible dieback of the crowns, particularly in Aleppo pines and eucalypts. This biological weakening makes the urban forest vulnerable to parasites and fungi, which put the canopy – the capital's indispensable 'urban heat island' regulator – at risk.

The park bears the full brunt of intensifying heatwaves. Fire risks increase. Extreme temperatures alter plant metabolism and hinder the natural regeneration of certain species, while the zoo's wildlife suffers intense physiological stress.

In parallel, soils hardened by drought absorb less water during torrential rain episodes, triggering violent runoff that erodes slopes and degrades the park. This instability, combined with biodiversity loss, weakens the site's overall equilibrium.

Finally, the park is overrun with plastic and other waste, and insecurity and spatial degradation are major social problems. Failing lighting is making some corners insecure, and an obsolete fence and porous boundaries encourage vandalism and harm the overall estate.

'Belvedere Park is currently facing unprecedented urban pressure and a degradation of its landscape and architectural components that threaten its very identity as a place of sanctuary,' states a 2018 report, *Étude de protection et de mise en valeur du parc du Belvédère: Rapport de la Phase 1,* by the General Directorate of the Environment and Quality of Life in the Ministry of Local Affairs and the Environment.

The park is managed by the Green Spaces Department of the Municipality of Tunis under the oversight of the Ministry of Environment.

But also, very critically, it enjoys the support of the Association of Friends of the Belvedere (AAB), which has long been its defender and watchdog.

'AAB was born in 1986 to oppose a mega road infrastructure project that would have bisected a unique historical park in the city of Tunis,' says ABB's latest Moral and Financial Report. Since then, it has ensured the preservation of this unique natural and cultural heritage, while meeting the needs of its users.

In March 2023, a Facebook post from NGO Tunisie Ecologie announced: 'Spring is here! AAB is offering an urban agriculture workshop at its premises in Belvédère. Learn how to create a productive garden, prepare the soil, dig, plant, and prune, and about the medicinal and culinary uses of marjoram, sage, wormwood, and lesser-known plants. Everyone welcome. Join the AAB.'

An NGO with 400 members and 3,000 supporters, AAB is described by an EU portal as working in the fields of citizenship, urban environment, and participatory democracy, and regularly welcoming school groups to its Environmental Education Space.

For 2024–26, AAB would like the park to become a 'Living Lab of resilience' where new modes of civic management are invented through the training of eco-mediators, who will be trained to 'welcome and guide visitors and raise public awareness about the fragility of the park's ecosystem.'

It further calls for the park to be officially classified as a 'National Cultural Landscape'. Believing that the park's survival is a shared responsibility, it holds that the way forward is participatory governance where civil society is a strategic actor.

Clockwise from top left: The entrance to the park, volunteers set out to clean the park, children learn about the botany of the park by pressing plants, and an organised nature walk. Photos: Association of Friends of the Belvedere (AAB).

Belvedere Park's central lake. Photo: D Jarvis on Flickr.

Lessons learned

- AAB, like 'Friends of' groups for parks and forests in many countries, is important to the park's survival because, among other things, it reminds city residents and decision-makers that 'to protect the bark of the trees is to protect the memory of Tunis.'
- Belvedere has survived in part because of its multifunctionality. Combining historical heritage, leisure, climate regulation and biodiversity conservation, the park survives urban pressure because society is invested in it.
- In Belvedere Park, introduced species have proven extremely vulnerable to climate change, while indigenous plantings, such as olive and carob *(Ceratonia siliqua)* trees, show much greater resilience.

Recommendations

- Adopt hybrid management for city parks to thrive. Shift management of such ecosystems from a municipal task to a co-construction between public authorities, experts, and civil society.
- Make a return to local plants.

Further reading

- K.B. Messaoud, Y. Wang, P. Jiang, Z. Ma, K. Hou, F. Die. (2024). 'Spatial-temporal dynamics of urban green spaces in response to rapid urbanisation and urban expansion in Tunis between 2000 and 2020.' **https://doi.org/10.3390/land13010098**
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- Imène Zaâfrane Zhioua. (2005) 'Point de vue: Entre sauvage et artifice.' *Archibat* (10), page 55.

For queries on this case study, email:
ichrak.klai@gmail.com

CASE STUDY #33

The Nahli–Sidi Amor peri-urban forests, Greater Tunis: a strategic ecosystem under climate and urban pressure

Sondes Fkiri, assistant professor, University of Carthage, Laboratory of Management and Valorisation of Forest Resources, National Research Institute of Rural Engineering, Water and Forests (INRGREF); Higher Institute of Social Sciences and Education of Gafsa (ISSSEG), University of Gafsa, Tunisia

Tunis, the capital of Tunisia, features a zoo, 23 urban parks, and myriad small green pockets, including in the city's Medina. These play a key role in supporting biodiversity and providing critical green spaces for city dwellers. Despite this, rapid urban and demographic expansion in North African cities is exerting increasing pressure on green spaces and urban and peri-urban forests, thereby threatening their ecological integrity and long-term sustainability. In this context, urban parks and community-based sustainable initiatives can play a critical role in safeguarding urban forest from land-use change, wildfire risk, and biodiversity loss.

This case study about the Ennahli and Sidi Amor peri-urban forests in Greater Tunis, about 15km from the city centre, illustrates how institutional protection and collective local action can jointly contribute to the conservation of species-rich forest ecosystems under intense urban pressure.

The Ennahli peri-urban park, established within the framework of Tunisia's National Urban Parks Programme (PNPU) and managed by the National Agency for Environmental Protection (ANPE), secures approximately 210ha of peri-urban green space under formal protection.

GDA Sidi Amor is a non-profit associational structure focused on natural resources, and official descriptions show that it is an NGO mobilising local residents around site valorisation and sustainable resource management in the Sidi Amor area, working in partnership with public authorities like the Ministry of Agriculture and the Environment.

Sidi Amor Forest is located adjacent to and downstream of the Ennahli (Nahli) forest, forming part of the same continuous peri-urban forest ecosystem north of Tunis. Local government, public authorities and GDA Sidi Amor jointly co-manage the Nahli–Sidi Amor peri-urban forests. Their joint efforts have been significant and noteworthy, leading among other things to a reduction in environmental pollution through green waste composting, and the construction of a wetland for waste water treatment, which now provides about 500m^3 of waste water per day, supporting the irrigation of 3,200ha for peri-urban agriculture practises by GDA Sidi Amor.

Earth stabilisation conducted by the NGO has reduced landslides and subsidence, helping to protect communities from the impacts of heavy rains. Expansion of vegetation and reduction in forest fragmentation is contributing to carbon sequestration and conserving local biodiversity.

All told, the GDA Sidi Amor has contributed to the restoration and conservation of approximately 10.3km^2 of degraded forest area by promoting agroforestry practices, reforestation with indigenous species, erosion control measures, and fire prevention. This has helped restore vegetation cover and reduce ecosystem vulnerability, with particular emphasis on conserving ecologically important species such as *Pistacia lentiscus*, a drought-

resistant evergreen shrub known for its strong post-fire resprouting capacity and its key role in soil stabilisation and ecosystem recovery.

The NGO has also generated socioeconomic benefits, notably by supporting women involved in the initiative, whose promotion of local forest-based products has been recognised with gold medals at international events.

By regulating access and limiting land conversion, the Ennahli peri-urban park acts as a buffer against urban encroachment. This helps, in turn, to maintain species richness and ecological connectivity within the peri-urban landscape.

It also conserves forest stands characterised by important and diverse species, including Aleppo pine *(Pinus halepensis)*, olive *(Olea europaea)*, Mediterranean cypress *(Cupressus sempervirens)*, carob *(Ceratonia siliqua)*, mastic *(Pistacia lentiscus)*, the common caper *(Capparis spinosa)*, and asparagus *(Asparagus acutifolius)*, that provide habitat for bird species such as the partridge, rock pigeon, chaffinch, and nightingale, as well as mammals including the hare, jackal, wild boar, and fox.

Finally, the Ennahli–Sidi Amor ecosytem is particularly important as its topography and vegetation have high landscape value. Among other things, it is linked to the Lake of Tunis and the Sebkha of Ariana, a critical urban wetland of shallow, saline, and temporary lagoons. The Sebkha provides essential ecosystem services, including flood regulation and habitats for migratory birds, and is increasingly employed for nature-based solutions, such as constructed wetlands, to treat stormwater and sewage, enhancing ecological and environmental quality.

Clockwise from top left: A sustainable pilot project established in the forests of Sidi Amor. Fires near beehives in the peri-urban forests of Sidi Amor: mobilisation of GDA members to fight the fire. Peri-urban forest of Sidi Amor. The entrance to Ennahli Urban Park. Photos: GDA Sidi Amor.

Lessons learned

- Peri-urban parks and sustainable initiatives can collectively counteract the pressures threatening peri-urban forest ecosystems.
- Despite this being true, the Ennahli–Sidi Amor ecosystem remains subject to multiple and intensifying pressures.
- Uncontrolled urban expansion and infrastructure development have progressively reduced and fragmented the forest. Building density in the area increased from 30 buildings/ha in 2004 to 50/ha in 2021 (Institute for Human Rights and Business, 2026).
- Recurrent wildfires, exacerbated by prolonged droughts, heatwaves, and human activities, represent one of the most severe threats to forest structure and biodiversity: 59 hectares of forest cover were destroyed by fire in June 2014.
- In North Africa, the relationship between cities and surrounding natural vegetation is particularly strong. Many urban green spaces have historically relied on native Mediterranean woody species originating from nearby maquis ecosystems, while others were shaped by colonial-era landscaping practices that introduced exotic trees. Today, urban forests and parks in the region reflect this dual legacy: they combine indigenous drought-adapted species with introduced ornamentals, and they increasingly face pressures from climate change, water scarcity, and urban expansion. Understanding the ecological characteristics of native maquis vegetation is therefore essential for interpreting current urban greening practices and assessing their long-term resilience.

Recommendations

- The not-for-profit CSO GDA Sidi Amor should be supported to continue to counteract the pressures threatening the peri-urban forests to the north of the city of Tunis. Such community-led initiatives translate conservation goals into practical, locally anchored action, linking biodiversity conservation with social inclusion and environmental stewardship.
- Government should continue to provide its leadership, including in legal protection and spatial planning.
- Donors can step up to support this integrated approach, which enhances the capacity of peri-urban forests to withstand demographic pressure, reduce fire risk, and preserve their rich species diversity.
- All parties need to be vigilant and take action against illegal tree cutting and dumping of waste, soil erosion, quarrying activities, and fires, some of which are deliberately set, and all of which undermine ecosystem resilience and recovery capacity.
- Other African cities facing similar urbanisation and climate challenges can take note of this prioritisation of peri-urban parks in Tunis: it offers transferable lessons.

Further reading

https://www.mdpi.com/2673-4834/2/4/48

For queries on this case study, email:
sondesfkiri@gmail.com

CHAPTER 14

MOROCCO

CASE STUDY #34

Localised cooling, citywide relief: how large urban forests and distributed green spaces jointly mitigate urban heat – evidence from Rmilat Park and the urban landscape of Tangier

Alanda Kamana, architect, urban researcher, PhD candidate at Mohammed VI Polytechnic University; Samah Lamaizi, landscape architect, Postdoctoral researcher, Cadi Ayyad University; Carey Duncan, immediate past president, IFLA Africa, landscape architect, founder and CEO at Carey Duncan Design; Adnane Labbaci, affiliate professor at UM6P-CITINNOV for Integrated Territorial Planning and Smart Cities

Rising temperatures, prolonged droughts, and increasing water stress are reshaping the urban climate risks across North Africa. In Morocco, intensifying heatwaves increasingly interact with rapid urbanisation to amplify the urban heat island (UHI) effect, with direct consequences for thermal comfort, public health, energy demand, and urban liveability.

These dynamics are particularly pronounced in expanding metropolitan regions, where the natural dissipation of heat is limited by land sealing, vegetation loss, and urbanisation (Kamana et al., 2023). Urban forests are nature-based solutions (NbSs) for reducing UHI through shading, evapotranspiration, and airflow regulation. But their cooling performance is not uniform or automatic. Instead, how well they cool cities depends on the type of urban forest, where the 'green' is in the city, its size, canopy structure, how the urban forest is maintained, and the local climate. It is important to understand where, how, and under which conditions urban forests are effective in cooling, particularly in African and Mediterranean cities, where climatic stress is rising faster than the amount and type of green infrastructure available.

This case study tells the story of Tangier's relationship with its main urban forest, Rmilat Park, and how the physical features of the land, such as hills, the influence of the sea and ocean, and the structure of the forest, interact to shape urban cooling. This case study builds on an assessment conducted in 2025 across three Moroccan cities: Tangier, Rabat, and Marrakesh, which were selected for their contrasting climates, urban forms, and urban

Street trees and garden near the Cathedral of the Immaculate Conception in Tangier. The garden is part of the former Christian cemetery connected to the Mendoubia Garden in the lower area. Photo: A Kamana, 2019.

forest structures.

Cooling worked differently for each of them. In Marrakesh, a network of smaller dispersed green spaces embedded within a dense urban fabric contributes to broader citywide temperature moderation. In contrast, Tangier and Rabat rely more heavily on large, consolidated urban forests that generate strong but spatially localised cooling effects. Similar differences have been observed in other arid and Mediterranean regions.

Located where the Atlantic Ocean meets the Mediterranean Sea, Tangier experiences a temperate Mediterranean climate influenced by, among other things, sea breezes. The average summer temperatures are lower than those in inland cities such as Marrakesh. However, this advantage is offset by rapid urban expansion, land-use change, and increasing surface imperviousness. Urban growth in Tangier has followed the pattern of coastal development, hillside expansion, and infrastructure-led fragmentation. This has resulted in uneven green space distribution and strong spatial inequalities in heat, with some areas being much hotter than others despite the sea breezes.

In Tangier, Rmilat Park, also known as Perdicaris Park, is a legacy ecological asset. Created in 1870 by a notable Greek American, it became state property in 1956. Rmilat Park covers approximately 70ha and is Tangier's largest continuous urban forest. On high ground approximately 5km west of the city centre, the park forms part of a broader corridor linking forested hills to the Atlantic shoreline, marked by the famous Cap Spartel, facing the Strait of Gibraltar.

The western entrance of Rmilat Park, Tangier, with the caretaker's house. Photo: A Kamana.

Vegetation is dominated by Mediterranean pine species *(Pinus pinaster* and *P. pinea)*, eucalyptus stands, and dense shrub layers, producing high canopy cover, vertical stratification, and limited soil sealing. In this study, daytime surface temperatures during summer heat within the forest core were consistently 3–5°C lower than those in the surrounding built zones. The cooling intensity declined rapidly 300–500m from the forest edge. This 'spatial decay' reflects well-documented distance effects, whereby building density and surface materials limit the propagation of park-induced cooling.

A defining characteristic of Rmilat Park is its relationship with the winds of Tangier: airflows enhance cooling through advection, turbulence, and cold-air drainage, achieving temperature reductions of 1–2°C along downwind corridors extending from the park during peak afternoon hours. Urban forests aligned with prevailing winds can significantly amplify cooling, particularly in coastal cities, where ventilation plays a central role in heat dissipation. In Tangier, this partially offsets daytime heat accumulation and cools the night. However, urban development has begun to obstruct these airflow pathways, reducing the reach of forest-driven cooling.

Rmilat Park delivers robust microclimatic benefits to Tangier, which are reinforced by sea temperatures and breezes; however, its location on the edge of the city limits its ability to mitigate heat across the metropolitan area. Rmilat Park, therefore, illustrates both the strengths and limits of large urban forests as NbSs to urban heat problems. Among its strengths, the ecological integrity and canopy density of Rmilat Park allow it to function as an effective thermal refuge during heatwaves, thereby improving local thermal comfort and air quality. Its mature and well-maintained forests provide stable and resilient cooling services under climate stress. However, its forests cannot completely counterbalance heat accumulation in a rapidly densifying city such as Tangier.

In short, major green assets, such as Rmilat Park, that are decoupled from everyday living environments are limited in their contribution to reducing population-wide heat exposure. This underscores the importance of street trees and smaller green spaces, such as pocket parks, green courtyards, and trees around riads and schools, which are disseminated across cities. It also reinforces concern about 'flagship green spaces' when they are not embedded within a broader green infrastructure network.

Tangier highlights the role of urban form as a mediating variable. Wind corridors, slope orientation, and building layouts determine whether forest-generated cooling remains confined to a specific area or propagates into the surrounding neighbourhoods. Therefore, the effectiveness of NbSs cannot be evaluated independently of planning and zoning decisions.

Finally, the case underscores a governance challenge: legacy ecological assets such as Rmilat Park often fall outside contemporary climate adaptation strategies despite providing measurable mitigation services. Integrating these spaces into formal urban climate policies is essential for long-term resilience.

Lessons learned

- Large urban forests offer strong and reliable localised cooling, particularly when canopy density and soil permeability are maintained.

- However, distributed greenery often surpasses large parks in lowering average urban temperatures.
- The location of green areas can significantly influence the reduction of average urban temperatures more than the total green area itself, especially in hot, inland climates.
- Size alone is insufficient.
- The spatial integration of urban forests within the urban fabric determines whether cooling benefits extend beyond park boundaries.

Recommendations

- Complement large parks with distributed green spaces.
- Develop smaller, strategically located urban forests and shaded public spaces within dense neighbourhoods to extend cooling throughout the city.
- Protect large trees and enhance the ecological integrity of urban forests.
- Limit soil sealing, prevent canopy fragmentation, and prioritise native species to sustain evapotranspiration under increasing drought stress.
- Reinforce wind and green corridors: preserve and restore ventilation pathways connecting urban forests to inner-city districts through linear parks, tree-lined streets, and height-sensitive zoning.

Further reading

Kamana, A. A., Radoine, H., and Nyasulu, C. (2023). 'Urban Challenges and Strategies in African Cities: A Systematic Literature Review.' *City and Environment Interactions*, 21 (December 2023), 100132. https://doi.org/10.1016/j.cacint.2023.100132

For queries on this case study, email:
alanda.akamana@gmail.com

Hafa Café, famous for attracting artists and celebrities, demonstrates 'disseminated green' with its multiple trees. Photo: E Sauvé.

CONCLUSION

As we wrap up, all who are connected with this compendium – and we number in the 100s – feel a quiet satisfaction.

'I like to think of it as *The State of Urban Forests in Africa*, a first continental baseline,' says JCPZ's Ayanda Roji, head of environmental education and research.

We have addressed 14 African states, ten with multiple case studies.

We have addressed diverse urban forest typologies: ten case studies refer to parks, 15 to street trees, and 14 to greening around urban fixtures such as landfills, schools, mosques, churches, hospitals, homes, and rivers.

We have highlighted projects intentionally planting large saplings, deploying metal protectors, removing invasives, linking trees to mental health, monitoring pests with Google Street View, assuaging fears of omens, paying residents for labour and seedlings, and capacitating tree stewards.

We have highlighted research that others might want to replicate in their urban forest.

And we have shown the universality of urban tree challenges.

'The book highlights clear parallels between Africa and Latin America,' wrote Marinez Ferreira de Siqueira from Rio de Janeiro's Botanic Garden. 'Many of the themes align with our efforts to quantify, qualify, and value ecosystem services associated with urban flora.'

'This is a wonderful book. These African cases can contribute to knowledge,' wrote Hong Kong University's Wendy Y Chen, whose essay on China in *Urban Forests: A Global Perspective* (FAO, 2023) covers issues that resonate equally in Africa, such as park area per capita.

'This book describes challenges that we see in India too,' says urban resilience specialist Soubrada Devy of ATREE.

Finally, we have brought urban forestry to life.

'Given the limited literature on urban forestry in Africa, the compedium does incredibly well showcasing on-the-ground work,' wrote Rhodes University's Nanamhla Gwedla. 'Due to the long-standing perception of vast disinvestment, my biggest learning is that there is extensive urban greening.'

'It represents a commendable effort to democratise the concept of urban forestry and make it a more routine consideration among urban planners and other actors,' say UN-Habitat experts Joy Mutai and Mark Ojal.

'The case studies are at a great level of detail for replicable lessons,' says Jad Daley, President of restoration NGO, Terraformation.

Urgent topics remain untouched, however, such as:

- What institutional arrangements might work best for urban forestry in Africa? Should cities awaken Parks Departments?
- Where might urban forestry education fit in Africa? As a module within a forestry or landscape architecture degree? What about training of arborists?
- Can the continent adapt global urban forestry practices while generating its own? Do Global North rules like '10-20-30' need a rewrite given Africa's greater tree diversity?

We are deeply grateful to the many experts who gave us feedback.

They called for rethinking current approaches and anchoring urban forestry in Africa's cultural realities: 'African cities should reflect African ecological identities.' 'Rather than replicate external models, urbanisation needs to integrate socio-ecological systems.'

They criticised top-down planting-heavy approaches and extolled ones that bestowed ownership and protected and rebuilt ecosystems: 'The central lesson is that urban forests persist where cities move from tree planting to tree governance, from reactive restoration to proactive protection, and from technical design to shared public ownership.' 'Urban forestry in Africa must move beyond tree planting as an isolated activity and focus instead on ecosystem services.' 'Our urban forestry needs to shift from tree planting to protection of existing green space; social legitimacy; and citizen ownership.'

And they pronounced indigenous species to be a given: 'We need a native species strategy rather than exotic legacy systems.' 'Indigenous species should be central.'

As this volume goes online and into print for dissemination, Roji is profoundly optimistic, saying: 'If it has shown anything, it is that Africa is not starting from scratch.'

Meanwhile the message of JCPZ Executive Manager for Environmental Conservation Lombard Shirindzi is one of buckling down. 'Now it is up to us all – city leaders, practitioners, researchers, communities, and traditional knowledge owners – to move from insight to implementation, from scattered effort to systemic change.'

A new era has begun.

For more about the compendium and the next African Forum on Urban Forests, contact **aroji@jhbcityparks.com** and **cathyhwatson@gmail.com**

LEARNING RESOURCES

From the FAO elearning Academy, An introduction to Urban and Peri-urban Forestry This free certified course amounts to 2h 30m of learning and introduces the concepts of urban and peri-urban forestry. It considers the important ecosystem services provided by urban forests, which help countries to achieve their SDGs, and the challenges that must be navigated during their planning, design and management.
https://elearning.fao.org/course/view.php?id=1118

From the Polytechnic of Milan, Nature in the city: turning knowledge into urban forestry practice Free online, and with a 50-hour workload, this course results in a certificate. On completion, the learner will be able to inter alia identify urban and peri-urban forestry categories; recognise ecosystem services provided by urban forests; understand the concepts of forest ecology and management, tree inventory, and forest monitoring; and identify ways to fund urban forestry.
https://www.pok.polimi.it/course/view.php?id=6

From eLearn Urban Forestry at the University of Georgia A free, self-led, online, distance learning programme for beginning urban foresters and professionals such as foresters, landscape architects, and city officials. Participants receive a certificate upon completion and it is good for credits from the International Society of Arboriculture. Its ten modules include Site and Tree Selection and Assessing and Managing Tree Risk.
https://citizen-forester.elearn.sref.info/

From the UK's Arboricultural Association Free weekly webinars October to February. See also the archive of previous webinars which has hundreds of hours of content. https://www.trees.org.uk/Training-Events/Webinars. For other resources, such as a free Introductory Guide to Young Tree Establishment, see:
https://www.trees.org.uk/Help-and-Advice

From American Forests Free monthly webinars on Tree Equity, i.e., ensuring consistent tree canopy across all neighbourhoods; access to nature and green space within 300m of all homes; using tools to identify low-canopy, high-priority, low-income, or marginalised areas; and involving residents in planning.
https://www.americanforests.org/project/coaching-network/

From India's Amenity Tree Care Association (ATCA) Training coming soon on topics such as tree health assessment, pruning techniques, retaining trees in construction, and risk-informed strategies to preserve mature trees on development sites.
https://arbindia.com/training

From Myerscough College, UK, a part-time online Level 2 Certificate in Arboriculture (6–8 hours/week) and foundation, honours, and master's degrees Particularly for international professionals is the three-year online MSc in Arboriculture and Urban Forestry. Objectives include learning how to maintain and manage trees as part of green infrastructure.
https://www.ucmyerscough.ac.uk/courses/postgraduate/arboriculture-treeswoodland/msc-arboriculture-and-urban-forestry-online/

From Rhodes University in South Africa, undergraduate and graduate modules on urbanisation, urban greening and forestry Offered by the Department of Environmental Science, these draw students from all faculties. Some of the curricula cover sustainable development, ecosystem services, and biodiversity management in urban settings. https://www.ru.ac.za/environmentalscience/

From Bangor University in the UK, a distance learning MSc-level module on urban forestry Available as a standalone or as part of the MSc Tropical Forestry or MSc Agroforestry & Food Security, both of which are available via Commonwealth distance learning grants. https://www.bangor.ac.uk/sens/course-information

From the University of British Columbia (UBC), a four-year Bachelor of Urban Forestry and a 13-month Master of Urban Forestry Leadership Funding from Mastercard Foundation can be available. https://mastercardfdn.org/en/

From the International Union of Forest Research Organizations An opportunity to bring Africa's urban forest into IUFRO Unit 6.07.00, its research group dedicated to global urban forestry. Contact: Prof Wendy Y Chen at wychen@hku.hk

From New York City and the city of Windsor, Canada Model urban forest management plans With tree canopy of 19% in Environmental Justice (EJ) Areas and 26% in non-EJ Areas, New York City aims to catch up the first and increase it to 30% citywide. https://NYC-Urban-Forest-Plan-2026.pdf. Windsor city's urban forest management plan, meanwhile, has five goals: Know more about Windsor's urban forest; Maintain a healthy, safe, and functional urban forest; Protect the urban forest; Replenish, expand, and enhance it; and Engage everyone.
https://www.citywindsor.ca/UFMP-Strategy ActionPlan.pdf

The Johannesburg Declaration (2025)

We, the participants of the 2nd African Forum on Urban Forests, gathered in Johannesburg from the 18th to 21st March 2025, under the theme 'Greening Horizons – Shaping the future resilience of African cities through urban forests' to reaffirm the critical role of urban forests and green spaces in strengthening African cities against global climate challenges and in creating healthier, more inclusive, equitable and resilient communities.

Our commitment

Building on the momentum of the **2018 Call for Action** from the First World Forum on Urban Forests, the **Washington Declaration (2023)** from the Second World Forum on Urban Forests, the **United Nations Agenda 2030**, particularly **Sustainable Development Goals 11, 13, 15, and 17** and **Agenda 2063: The Africa We Want** of the African Union, **aspirations 1 and 3**, we recognise the urgent need to expand the urban canopy and create climate-resilient cities and communities. Additionally, we align with **Global Biodiversity Framework Target 12**, and the **Paris Agreement** which calls for expanding access to green and blue spaces in urban and peri-urban areas.

Why urban forests matter

Despite the unprecedented scale of urbanisation, growth of informal settlements, climate change effects, and land degradation and deforestation in Africa, we are certain that carefully designed, implemented and maintained green spaces such as urban forests can: strengthen social cohesion, heritage and sense of belonging; promote spatial equity to improve public health and wellbeing; create employment, entrepreneurship, and local development for all; generate ecosystem goods and services; provide quality space for tourism and recreation; support biodiversity; build capacity to adapt to climate change while mitigating extreme heat, flooding, biodiversity loss, and pollution; and serve as places for environmental education and traditional learning.

While the benefits of urban green spaces are increasingly recognised, their distribution, quality, and access remain unequal. Bridging this gap is essential for creating more sustainable, resilient, and inclusive urban environments across Africa.

Our call to action

We urge decisions-makers, urban planners, foresters, ecologists, botanists, architects and landscape architects, engineers, the health sector including traditional healers, civil society, and all community members as well as development financiers and partners and the private sector to work together to ensure that green spaces including urban forests are:

- **Inclusive:** Designed for diverse physical, social, and cultural needs, safe, well-maintained and equipped with necessary facilities, and developed with local residents in the planning and maintenance to ensure that they meet community needs.
- **Well managed:** Aiming for optimal outcomes and overcoming legislative, political, financial, institutional, land-use planning, cultural, social, and psychological barriers, minimising trade-offs and ecosystem disservices.

- **Equitably distributed:** All communities regardless of income, race, gender or locality have access to quality green spaces, enhancing environmental and support health and wellbeing.
- **Multifunctional, resilient and sustainable:** Supporting recreation, livelihoods, education, biodiversity and habitat connectivity.

Our specific recommendations

Particularly, we recommend collaborative implementation of urban greening and forests across multiple sectors that:

- **Mobilises diverse funding,** such as municipal budgets, carbon markets, public-private partnerships and insurance, and positions urban forests as economic assets linked to local employment and ecotourism.
- **Addresses governance,** taking decisive steps to develop inclusive policies, leverage indigenous systems, enforce regulations, land tenure, and build long-term political commitment that reimagines urbanism.
- **Focuses on environmental and climate challenges,** selecting diverse native species, restoring water catchments and healthy reservoirs, investing in waste management, and addressing historic inequalities and environmental injustice, urban agriculture and climate-proof green infrastructure.
- **Prioritises research and monitoring,** strengthening standardised metrics, establishing tree inventories, coordinating feedback, facilitating data sharing, and increasing funding for research and development.
- **Engages communities,** centring local voices in planning and management, improving participatory decision-making, working with traditional authorities to protect sacred sites, and facilitating knowledge exchange across cities.
- **Builds capacity of cities,** creating green spaces as learning labs, and providing training for elected officials, local technicians, community leaders, women and youth.

The road ahead

We strongly believe in the **power of collaboration** and meaningful partnerships to conserve, preserve, restore, and expand urban forests, green spaces and nature-based solutions, ensuring that they benefit all.

To support our future work, today we launch the **Afrika Mazingira Collective**, an African nature-based solution community of practice within the **Centre on African Public Spaces (CAPS)**. This collective will connect urban stakeholders across Africa and beyond to promote, implement, and scale up nature-based solutions for city climate resilience, biodiversity, and liveability. This Community of Practice will contribute to the FAO Green Cities Initiative. Together, we can create cities where the **built environment, people, and nature thrive.**

Second African Forum on Urban Forests – 20 March 2025

‘Every tree planted in a township that was historically denied green space is an act of spatial justice.’

– THANDUXOLO MENDREW
MANAGING DIRECTOR,
JOHANNESBURG CITY PARKS AND ZOO