



Sub-Saharan Africa's Urban Water Blueprint

SECURING WATER THROUGH WATER FUNDS AND OTHER INVESTMENTS IN ECOLOGICAL INFRASTRUCTURE

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The Nature Conservancy

Lead authors

Colin Apse and Nathan Karres

Contributing authors

Misty Herrin, Frederick Kihara, Daniel Shemie, Margaret Southern and Cory Zyla

Editor

Sonja Mitchell, Yellowbrick Marketing

Designer

Jeff Walker

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Executive summary

Africa's urban population is expected to double over the next 20 years, posing an immense water challenge for cities. Growing demand from a booming population and continued economic growth will further stress already scarce water resources. Many cities source their water from rural landscapes which are increasingly affected by unplanned development and poor land management practices. A city's water security is at risk if the health of its watershed degrades. Unhealthy watersheds can contribute to pollution in rivers, lakes and reservoirs, potentially reducing water supply availability and increasing delivery costs. Nature is also under threat, as aquatic life suffers from lower water quality and drying rivers while wildlife loses critical habitats and food supply. It is imperative that African cities and businesses become wise stewards of the land where their water comes from to ensure a sustainable and affordable supply of water.

In this report we investigate the status of Sub-Saharan Africa's urban water sources and the potential for catchment protection to benefit cities, rural livelihoods and nature. Protecting water catchment areas is a smart investment opportunity for government, civil society and business leaders across Africa. Beyond improved urban water security, nature-based solutions provide multiple benefits for people and nature, such as reducing flood risk.

Identifying priority watersheds

Three-quarters of large cities in Sub-Saharan Africa source at least half of their public water supply from surface water sources, amounting to an estimated 3.5 billion cubic meters annually. In this report, authors from The Nature Conservancy identify 30 cities primarily dependent on surface water supply that have the potential to significantly benefit from watershed conservation practices. Land use change is a key factor affecting the health of all their watersheds. These 30 cities source water from 84 catchments accounting for more than 67 million hectares – an area 26 times larger than their urban footprint. On average across these cities, 38 percent of catchment areas have been developed for agriculture with potential impacts on water quality for downstream users.

Water sources at risk

Understanding the condition of catchments is important for cities and other water users. Catchment land development – while not wholly predictive of water quality impairment – is a major factor in water security. One-fifth of source catchments assessed may be impacted by degraded water quality – often the result of increased soil erosion and high nutrient loads from excessive fertilizer use. In cities primarily dependent on surface water supply, one in every five residents (more than 17 million people) may face water security risks due to highly impaired water quality.

Ongoing catchment degradation comes at significant financial cost every year. For example, in the Upper Tana River catchments that serve the water supply system of Nairobi, Kenya, water treatment costs have been estimated to increase by more than 30 percent following heavy storms due to high sediment loads. Likewise, a proposed hydropower project on the Ruzizi River, located between Lake Kivu and Lake Tanganyika and shared by Rwanda and the Democratic Republic of Congo, estimates a 10 percent decrease in power generation capacity as a result of sedimentation from cultivation on steep slopes.

Land use change has an equally damaging impact on nature, including fisheries. Some 5.8 million hectares of priority biodiversity areas are potentially at risk within the identified source catchments which face the greatest development pressure.

Catchment conservation potential

In this report we estimate the potential for conservation actions – forest protection, reforestation, riparian restoration and agricultural best management practices (BMPs) – to reduce sediment and nutrient loads. We identify 28 cities that can achieve appreciable reductions in sediment or nutrients through such conservation activities. For 16 of these cities, avoided treatment costs could offset at least 25 percent of total conservation costs. Half could potentially offset the entire cost of catchment conservation through avoided treatment costs alone (where treatment savings exceed conservation costs).

Implementing agricultural best management BMPs, such as the use of terraces and cover crops, has the broadest applicability across our sample of cities, potentially improving water quality for 85 million people. Forest protection and restoration – while spatially more limited in applicability as compared to agricultural BMPs – could achieve reductions in pollution that would benefit up to 52 and 11 million people, respectively.

Importantly, the benefits of catchment protection also extend outside city boundaries by supporting the protection of landscapes important for wildlife and rural communities. We identify 13 cities where conservation practices can achieve pollution reduction and protect wildlife habitat in priority conservation areas. For seven of these cities, water treatment savings could offset at least a quarter of conservation costs. We highlight the potential for catchment protection to have far-ranging benefits beyond water quality and biodiversity for these and other cities in Sub-Saharan Africa.

A path forward

The implementation of programs to support catchment conservation has been slow to develop, despite their significant potential to achieve multiple benefits for people and nature. The most recent survey identified just eight operational programs in Sub-Saharan Africa. Limited local governance capacity and insufficient investors are some of the primary barriers to implementation.

Overcoming these challenges requires a mechanism for collective action and sustainable financing. A proven model – water funds – presents city leaders with a platform to achieve sustainable catchment conservation at scale and to provide significant returns to both people and nature. Water funds bring together diverse water users from the public and private sector to jointly invest in targeted, scientifically guided conservation interventions to protect the water resources they rely on.

The Nature Conservancy's first water fund was established in Quito, Ecuador, in the year 2000. Today, the Conservancy is involved in more than 60 water funds, both in operation and in the planning phase, across four continents. Water funds have proven to be an effective tool for unlocking new sources of funding previously unavailable to cities by providing water users and public funders with a stable and transparent means to proactively invest in the long-term health of catchments.

Our sample of the largest cities in Sub-Saharan Africa represents only a fraction of the region's overall potential for source catchment conservation. The Nature Conservancy is committed to the rapid advancement of water funds in priority cities that are in urgent need of improved water security and biodiversity protection. We are seeking to create a coalition of partners from the private sector, government and civil society that are interested in working together to harness the enormous potential of this proven model. Water funds offer the promise of a transformative and lasting approach – through innovative finance and governance – to secure the health and productivity of water sources that are fundamental to sustainable growth and prosperity.

Introduction: protecting water for people and nature

Overview

For many cities, source catchments – the land surrounding rivers and lakes where water runoff is captured – are critical to water security.[1] In healthy catchments, forests, grasslands and well-managed agricultural areas help ensure the availability of clean and sufficient drinking water. In this way, "natural infrastructure" or "ecological infrastructure" is essential for sustaining the livelihoods and well-being of city dwellers.

Cities face significant threats to their water sources where source catchments have been impacted by poorly managed land development. Increased sediment often pollutes rivers and lakes as catchment health degrades and can potentially reduce water availability during drought.[2,3] This pollution results in greater water *insecurity*, making it more difficult and more expensive to provide clean water to urban residents. The prospects of increasing urbanization – where 50 percent of Africans will live in cities by 2030 – combined with the implications of changing climate, will further exacerbate this water insecurity.[4,5]

In this working paper, we describe the potential for catchment protection to support improved management of water resources for cities. Cities can reduce water supply costs and uncertainty by investing in catchments that protect water resources *before* they reach the pipes and reservoirs that cities depend on. Importantly, the benefits of catchment protection also extend outside city boundaries by supporting improved livelihoods and well-being for those living within source catchments, and conserving landscapes to protect fish and wildlife.[6]

Beyond describing the value of catchment protection, we propose a model for cities to realize this potential. *Water funds* establish a governance and financial mechanism that permits public and private water users to fund and implement catchment protection. This study provides the foundations – through technical analysis of catchment protection potential and documenting the success of the water funds approach – to enable African leaders from government, business and civil society to leverage the potential of catchment areas to benefit both people and nature.

Approach

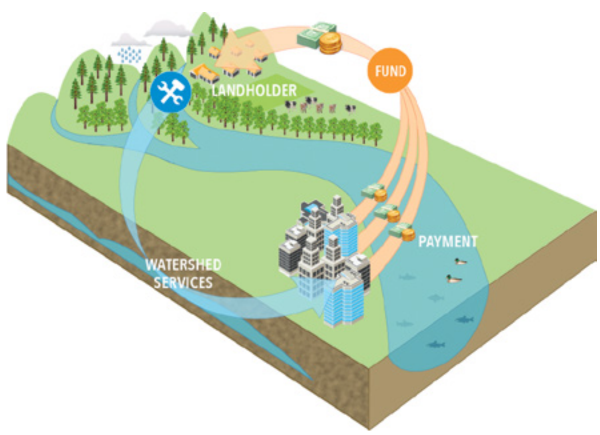
The Nature Conservancy has previously mapped the global potential for addressing the growing urban water challenge through nature-based strategies.[1] The *Urban Water Blueprint* focused primarily on the world's 100 largest cities and found that more than 700 million people globally could benefit from improved water security from catchment conservation. Here, we build from this analysis in three significant ways:

- We focus our perspective on Sub-Saharan Africa (SSA), constructing a roadmap for source catchment conservation that leverages the Conservancy's growing program in SSA focused on collaborating with government, the private sector and other NGOs on conservation solutions.
- The potential benefits of catchment conservation extend beyond urban water security alone. This analysis emphasizes another dimension critical to our mission: the potential benefits for natural areas and wildlife.
- While the Conservancy's global report highlighted great potential to mitigate sediment and nutrient pollution – one in every four cities could realize cost savings from catchment conservation – it did not provide a definitive mechanism for implementation. Water funds are proposed here as an evidence-based approach for achieving catchment protection at scale.

Water funds

Urban source catchments are not only critical for cities' water supply, but also for rural communities and nature. As a result, catchment conservation represents unique opportunities to achieve multiple benefits for many different stakeholder groups.[1] Effective conservation efforts require the coordination of these different stakeholders. In its absence, conservation funding is often inadequate, efforts may be duplicated, and efficiencies are lost, posing a significant risk to both upstream and downstream users.[7]

Figure 1. Water funds model



Conceptual diagram of water funds model. Figure excerpted from Forest Trends, "Gaining Depth: State of Watershed Investment 2014".[8]

Water funds provide a solution – whereby downstream water users directly or indirectly compensate upstream parties for activities that deliver water benefits to the payer (Figure 1). From South America to East Africa, there is growing precedent for beneficiaries from the public and private sector to invest jointly in a water fund. The water fund establishes a financial and governance mechanism to direct funding toward targeted, scientifically guided investments in catchment protection. Investors can pool resources sufficient for achieving results at scale by investing collectively. Such an institutional arrangement also serves an important governance function, providing a forum for evidence-based collective planning and decision-making while also giving investors and rural communities a voice in how water catchments are managed.

The Nature Conservancy is currently involved in more than 60 of these water funds, where public and private water users come together, often alongside local government, to invest collectively in conservation of the catchments that provide their sources of water supply. A third of these water funds are already in full operation, mostly in Latin America, but the model is now spreading across four continents. Once an opportunity is identified, a growing body of research and tools now exist to help water users decide where in the catchment to invest.

Where cities source their water

Through a recent effort completed by the Conservancy, we surveyed the drinking water sources – such as surface streams, groundwater wells and desalination plants – for more than 500 cities across the world, including the 30 cities in SSA assessed here.[1] We were further able to estimate the amount or volume of withdrawals attributable to these different water source types for many of these cities.

Where prior efforts have considered water resource risks relative to a city's location, this new data set presents the opportunity for evaluating urban water resource risk relative to the actual location of water sources, which can be far from the city center. Understanding the actual water sources for cities is critical for more reliably assessing water challenges and opportunities.

Groundwater can be an important source for many African cities, and source catchment protection can have significant benefits to groundwater quality and quantity, including facilitating recharge by slowing the movement of rainwater through the landscape. However, the complexity of underground water processes and paucity of data makes continental analyses difficult.[23,24] While this assessment focuses on cities that depend primarily on surface water sources, we do

Case study: The Upper-Tana Nairobi Water Fund

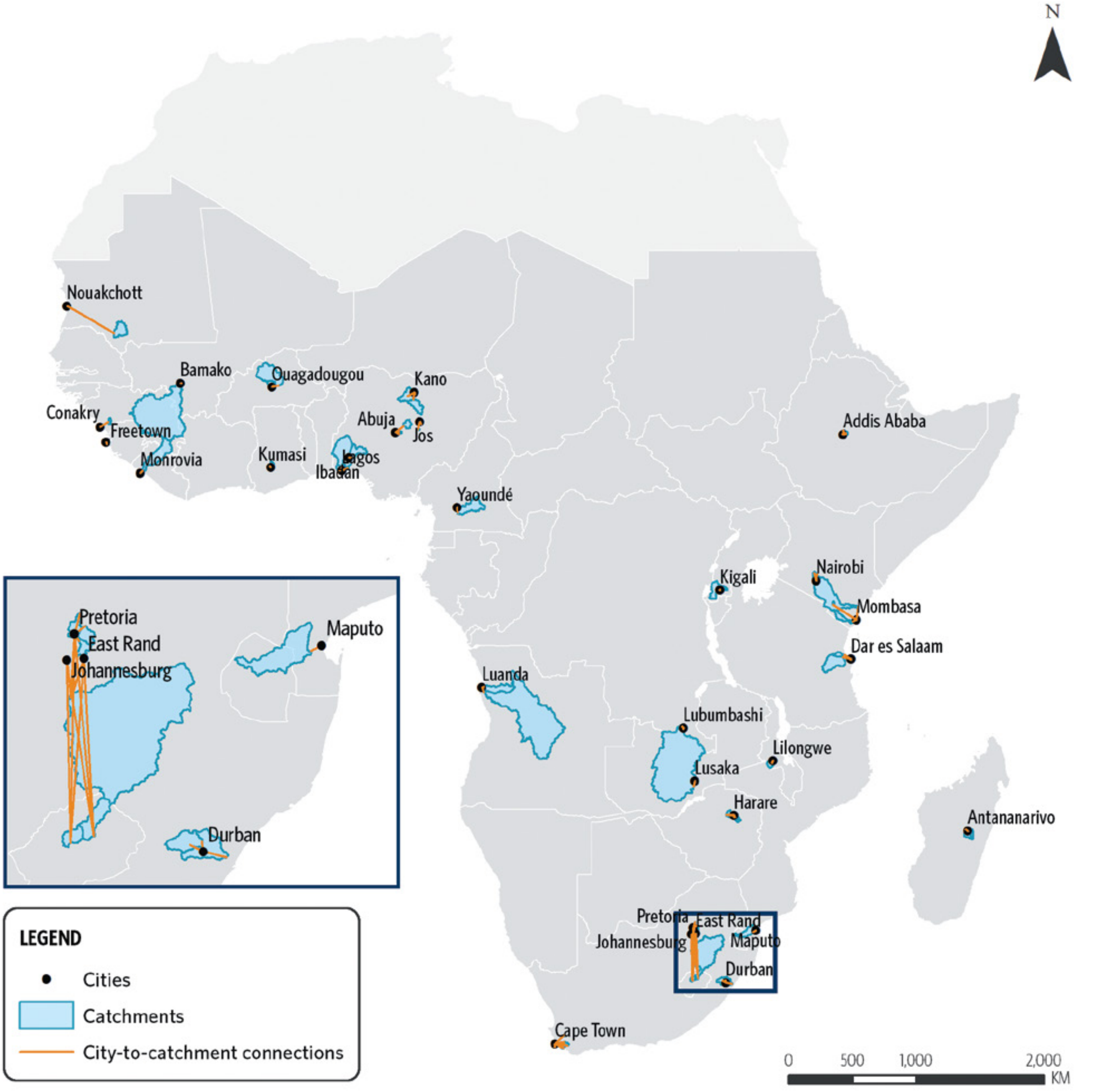
Insufficient investment in water resource management can exacerbate the economic impact of droughts and floods. For example, in Kenya from 1997–1998, drought impacts such as reduced industrial output, impaired municipal supply, and reduced hydropower output resulted in economic losses on the order of $3 billion USD – an estimated 14 percent of GDP during the period.[22]

Besides catastrophic drought and flooding, ongoing water resource degradation comes at a significant financial cost every year. Poorly managed land activities can send increased amounts of soil or other pollutants into streams and lakes, with adverse effects – and increased costs – for downstream users.

In Kenya, pollution and catchment degradation are estimated to cost at least 0.5 percent of GDP each year, equaling $32 million USD or Kenyan shillings 3.3 billion.[22] For example, in the Upper Tana catchments that serve Nairobi's water supply system, water treatment costs have been estimated to increase by more than 30 percent following heavy storms due to high sediment loads.[9] This high sediment has led to significant impacts on the operation of dams for the generation of electricity. Reservoir storage capacity for two reservoirs on the Tana River has been reduced by 10 to 15 percent in the last three decades. High sediment loads also increase the frequency of stoppage and servicing of the hydropower generation systems, which have led to power generation losses. In more extreme cases, this has led to very costly reservoir dredging and has the potential to require construction of additional dams to compensate for the lost storage capacity due to sediment filled reservoirs.

This evidence highlights the systemic nature of current and future water challenges. More than ever, new ideas and solutions are needed in order to maximize returns from limited financial resources. Such a viewpoint requires optimizing across water resource infrastructure types – including both constructed "gray" infrastructure such as pipes and reservoirs and natural "green" infrastructure – in order to provide the greatest returns for SSA cities and countries.

Figure 2. Cities and their source catchments



Surveyed cities and their surface water catchments (denoted by orange lines), where several cities can withdraw from the same source

take into consideration the relative importance of groundwater with regard to overall supply.

Three quarters of large cities in SSA draw at least half of their drinking water supply from surface water sources, amounting to an estimated 3.5 billion cubic meters annually. Living within these cities are more than 100 million people whose health and well-being are directly connected to the sustainability and security of these surface water catchments.

These data reveal that upstream catchment landscapes play a critical role in determining the water resource outcomes for downstream cities and their urban residents (Figure 2). While the spatial footprint of individual cities may be comparatively small, the 84 source catchments for the 30 cities assessed here account for more than 67 million hectares – an area 26 times larger than the footprint of these cities themselves. Collectively, these cities represent key stakeholders with considerable interest vested in the sustainable management of these landscapes. Their interests are matched by the millions of people living in rural communities that are dependent on these catchment areas for their home and livelihoods.

Catchments and ecosystem services

Healthy catchments are not only important for cities that withdraw drinking water, they also sustain environmental functions that benefit local communities and wildlife alike.[2] Critical habitat for fish and wildlife, healthy soils for agriculture, reduced flood risk, timber and non-timber forest products, and a safe and secure water supply are just a few of the important benefits provided to those living within healthy catchments.

Agricultural production in these areas – equal to 140 million hectares – depends heavily on ecosystem contributions such as sufficient water and nutrients for crops.[2] Most (80 percent) of this agricultural production likely takes place on smallholder farms, where agriculture remains a critical income and subsistence source for households, particularly within poorer countries and regions of SSA.[28] For catchment protection, including the Upper Tana-Nairobi Water Fund (see inset box on page 4), improved productivity for smallholder farmers is an important goal.

Many catchments are also key areas of biological significance. Considering only the cities surveyed in this report, urban source catchments overlay with portions of freshwater and terrestrial ecological regions (ecoregions) that represent an estimated 6,000 terrestrial mammal species and 4,800 fish species – approximately 53 and 61 percent of identified species in SSA, respectively.[23,24] In Tanzania, for example, the Ruvu River catchment of Dar es Salaam encompasses the Uluguru Mountains, critical habitat for several endangered bird, amphibian and mammalian species.[27]

Threats to urban water sources

It is critical to assess the state of source catchments given their importance for cities, rural populations and nature. Understanding the drivers of catchment impairment – and identifying opportunities for mitigating some of these threats – can support cities as they work to ensure robust and sustainable water supply systems.

Cities and water (in)security

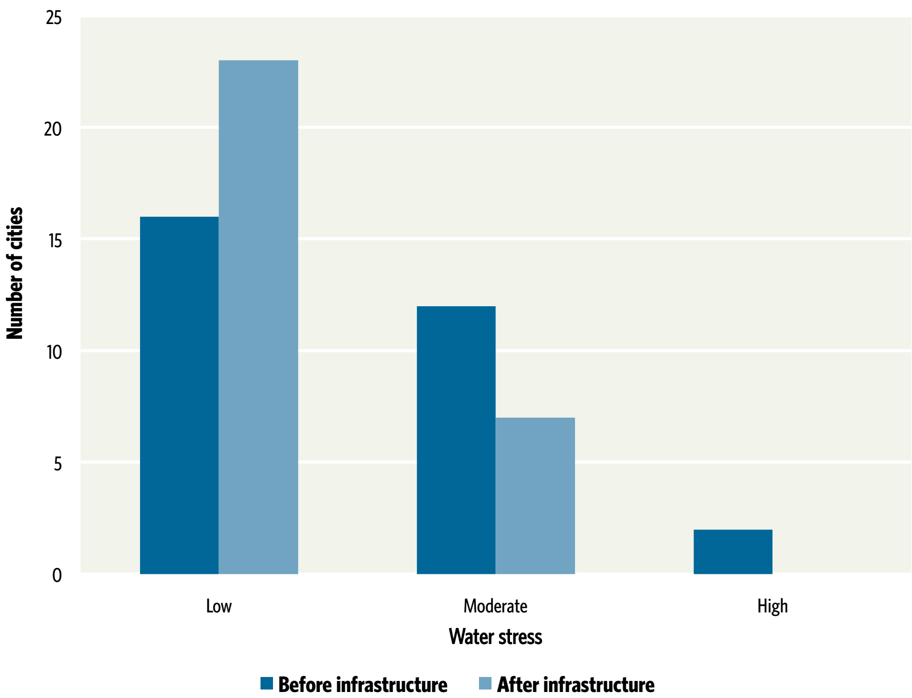
Cities and their water utilities face a significant challenge: ensuring safe and sufficient supply within a context of great uncertainty. Population growth, economic fluctuations and global climate change all further exacerbate existing challenges due to natural climatic variability.[29] An optimized portfolio of gray and green infrastructure is critical for ensuring resiliency in the face of such uncertainty.

For the 30 cities we analyzed, the development of built infrastructure has proven key in securing adequate water resources. On average, these cities withdraw water from a distance of more than 50 kilometers, with some cities transferring water several hundred kilometers. For example, Pretoria, South Africa, depends heavily on a series of inter-basin transfers – from the Senqu River basin in Lesotho to the Vaal river system in Gauteng Province – in order to deliver adequate supply to its residents.[1] By transferring water, cities are able to expand their effective catchment area. An estimated seven cities have been able to reduce potential water stress by increasing the extent of their water resources through infrastructure investment (Figure 3).

There are, however, limits to how far cities can extend their reach to secure adequate water supplies. The costs of such infrastructure are significant: The Lesotho Highlands Project[i], which transfers water to Pretoria and other cities in South Africa, came at a total cost of $4 billion USD.[30,31] Not all cities can afford to move water vast distances to meet the needs of people and industry, as evidenced by the relative reliance on local water sources over inter-basin transfer by lower income cities.[1,32] Beyond costs, there are other constraints that limit the feasibility of inter-basin transfers, including geographic proximity to water resources and potential transboundary governance challenges.[32]

For these reasons, it is imperative that cities successfully manage existing water resources to ensure sustainable supplies – not just the quantity of water, but also its *quality*. Where water quality is impaired, cities could face the prospect of increased treatment costs, thereby reducing their ability to invest elsewhere within water supply systems. In addition to these opportunity costs, water too polluted to safely drink reduces the overall volume of useable supply. Water pollution can also impact the lifespan of existing infrastructure. Sedimentation reduces the storage capacity of reservoirs, affecting hydropower generation and other reservoir management objectives.[2] For example, a feasibility study for a new hydropower project on the Ruzizi River, between Lake Kivu and Lake Tanganyika, projected a 10 percent decrease in power generation capacity as a result of increased sedimentation due significantly to cultivation on steep slopes over the past 20 years.[33] Consequently, maintaining water quality – and the stewardship of upstream source catchments – is critical to the water security and fiscal sustainability of cities.

Figure 3. Cities and water stress



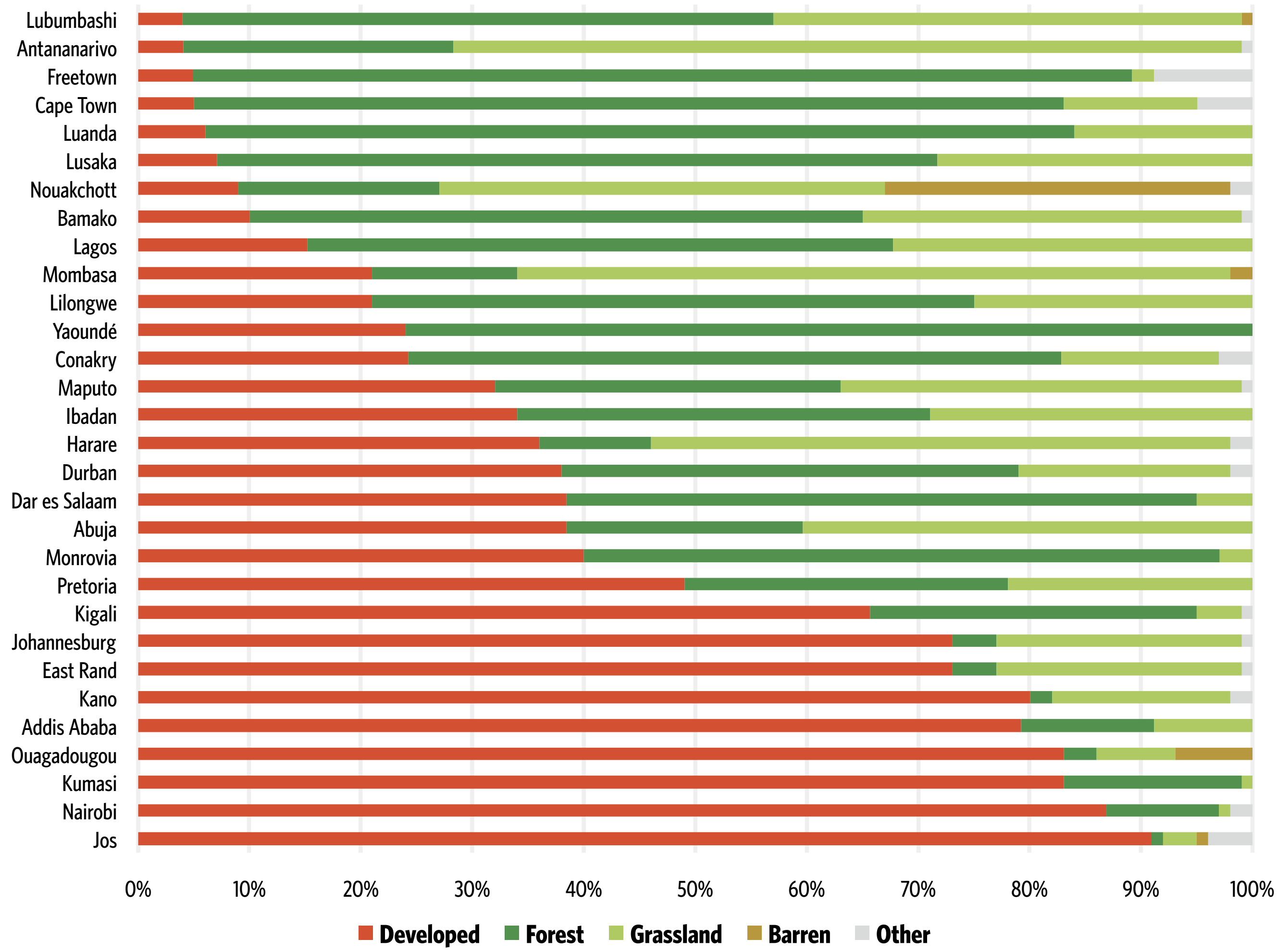
Comparison of estimated water stress (withdrawal to availability ratio) before and after water infrastructure is considered. The "before" scenario considers only catchment areas upstream of city boundaries whereas the "after" scenario considers actual withdrawal locations (both within and outside of city boundaries).

Implications of land development for water supply

Activities that alter landscapes can often have profound effects on the timing, quantity and quality of water resources.[1,34] Natural ecosystem functions can be impaired when

i In addition to water conveyance infrastructure, Phase 1A and 1B of the Lesotho Highlands Project include construction and related costs for hydropower facilities.

Figure 4. Land use in assessed source catchments



Average land use classification within source catchments, where the "developed" category includes cropland and urban areas.

land is converted from natural forest or grassland areas to working landscapes such as agriculture or range land. For example, where previously forested slopes may have retained soil sediment and moisture, conversion to agriculture may send sediment and agricultural pollutants into streams and reservoirs, and also reduce dry season stream flows.[35] Cities which rely on such surface water sources face increased supply uncertainty and risk, incurring additional costs as a result.

Overall, our analysis demonstrates that urban source catchments face significant land development pressures. On average across the 30 cities, 39 percent of their catchment areas have been developed for agriculture or urban settlements (Figure 4). For nine of these cities, such developed landscapes are the dominant land use type. While the effects of land use on water supply are site specific – for example, production of the same crop type can have disparate effects based on local conditions and production practices – these data clearly indicate that human activities play a major role in determining water outcomes for many cities.[36]

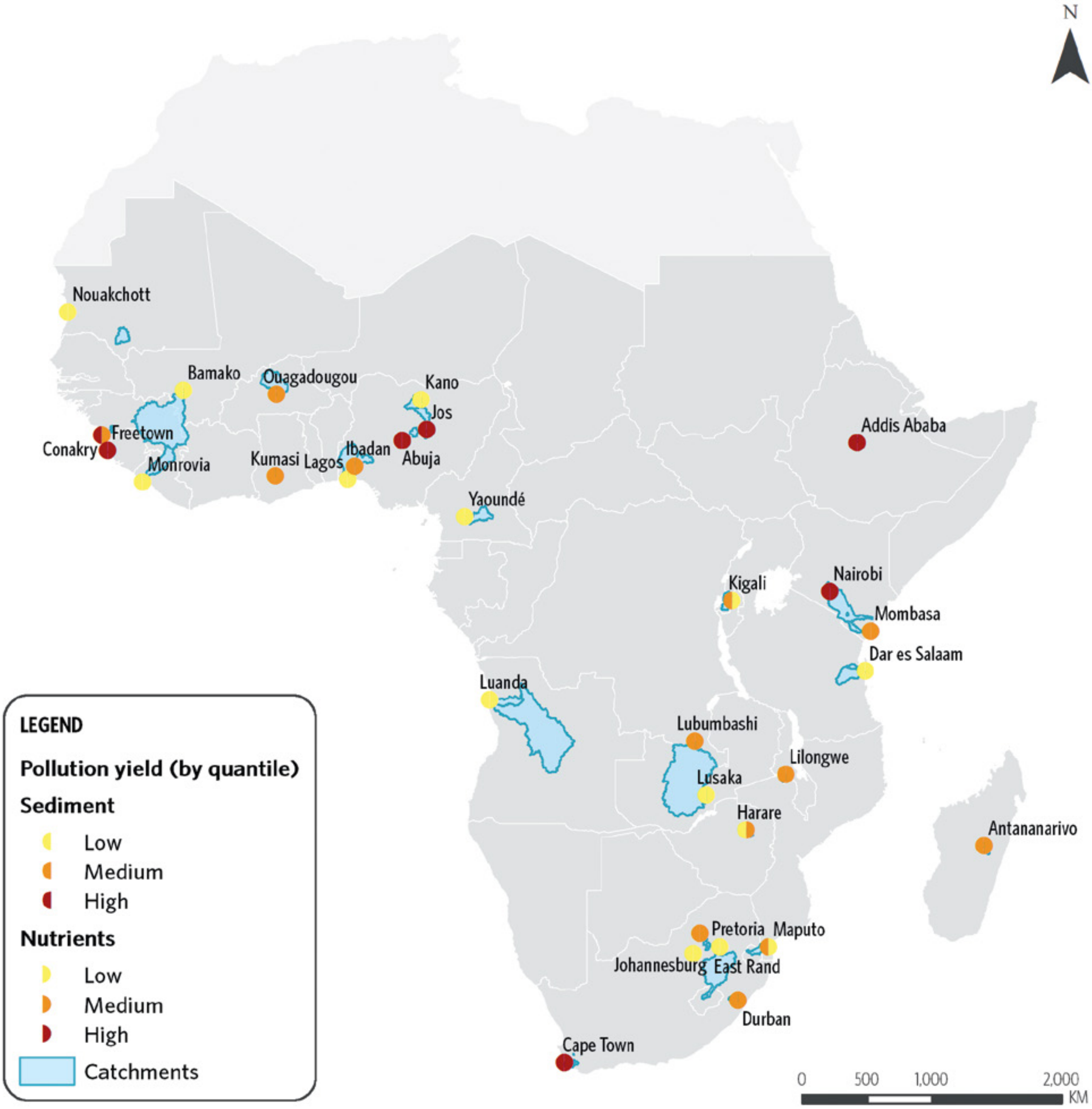
Catchments and pollution

Land development alone is not wholly predictive of water quality impairment.[37] The environmental conditions of a particular catchment – such as rainfall patterns and soil types – also determine the impact of land practices on streams and lakes. We used a previously developed approach to estimate these cumulative land use effects focusing on two major pollutant types: sediment and nutrients (nitrogen and phosphorous). Sediment and nutrient are closely coupled to land use changes and practices, and have significant implications for water security.[1,38,39] Using a modeling approach allows for comparison across broad geographies and provides a good first approximation of water quality conditions in these catchments.

Land use related pollutants present a significant challenge for many cities in SSA. Of 30 surveyed cities, seven face potentially high levels of sediment and six face potentially high nutrient[ii] levels (Figure 5). The scale of the challenge can be better

ii In practice, phosphorus and nitrogen loading are highly spatially correlated, meaning that if one occurs it is likely that the other will as well. Given this correlation, results in this report focus on one nutrient, phosphorus, but the conclusions and recommendations based on this analysis apply to both nutrients

Figure 5. Cities and catchment pollution



Estimated annual pollution yield within source catchments, categorized into equal groups, or quantiles, relative to all cities surveyed globally using a consistent modeling approach

understood in terms of people at risk (Figure 6). One in every five urban residents of cities primarily dependent on surface water supply may face water security risks due to high sediment or nutrient loads (approximately 17 million people from our sample of 88 million total). The potential impacts of unchecked land development – and the number of people at risk within rapidly growing cities – are expected to increase in the future, with Africa expected to experience the greatest expansion of cropland globally by 2050.[7,40] However, there is a significant opportunity to implement new models of land management toward smarter development – balancing shared interests to reduce the threats, and long-term costs, of future growth.

Impacts for people and nature

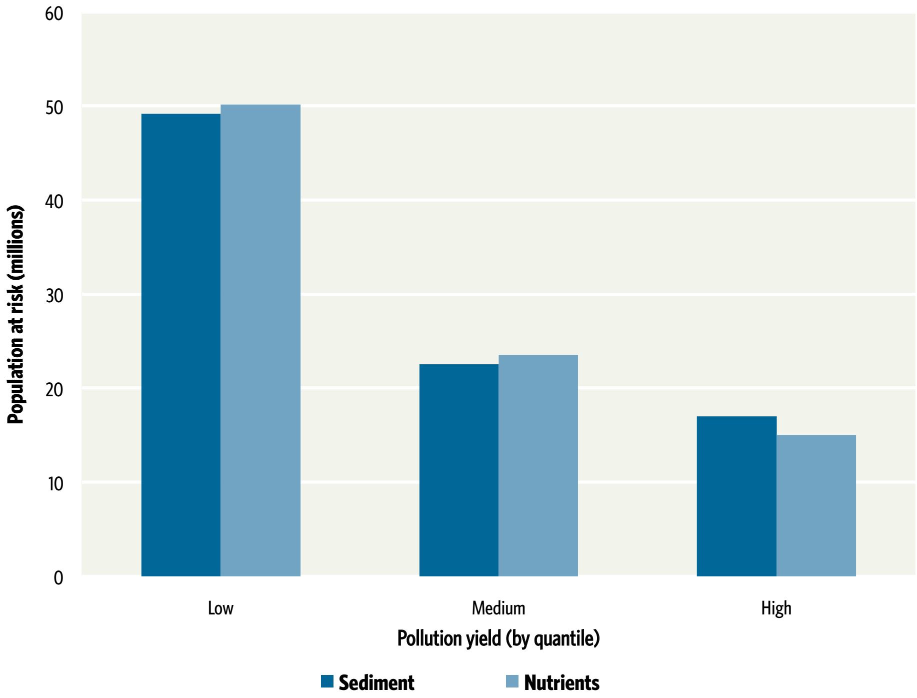
The implications of our assessment are significant: catchment pollution driven by land use change already affects many cities. The consequences of this catchment pollution are damaging for both people and nature alike. For example, one-fifth of source catchments within our sample of cities may be impacted by high[iii] sediment or nutrient loads. As a result, urban residents face elevated water insecurity, and fish and other aquatic species dependent on the streams and lakes within these catchments face increased environmental stress that can reduce species abundance, decrease fish catch, and negatively impact biodiversity.[3] In Lake Tanganyika, for example, disturbed

iii As assessed by estimated pollution yields relative to all cities surveyed globally catchments have been found to be associated with decreased fish and other aquatic biodiversity in adjacent lake nearshore areas.[41]

Land use change also impacts terrestrial species and their habitats, including grazing animals, butterflies and birds. Case examples from Eastern and Southern Africa demonstrate that the loss of natural land cover due to increasingly intensive land use activities can be detrimental to plant and animal biodiversity.[42,43] Where landscapes are poorly managed, terrestrial habitats become degraded with a loss of ecosystem functions. In East Africa, the loss of natural landscapes to cropland and livestock grazing has resulted in a cascade of effects: changes in soil health have affected native plant species, and this change in natural vegetation has reduced the number and diversity of wildlife.[42] Within the catchments assessed here, at least 5.8 million hectares of priority biodiversity areas have likely been impacted such land conversion (Figure 7). Future inappropriate catchment conversion is likely to further impact priority wildlife conservation areas across the region.

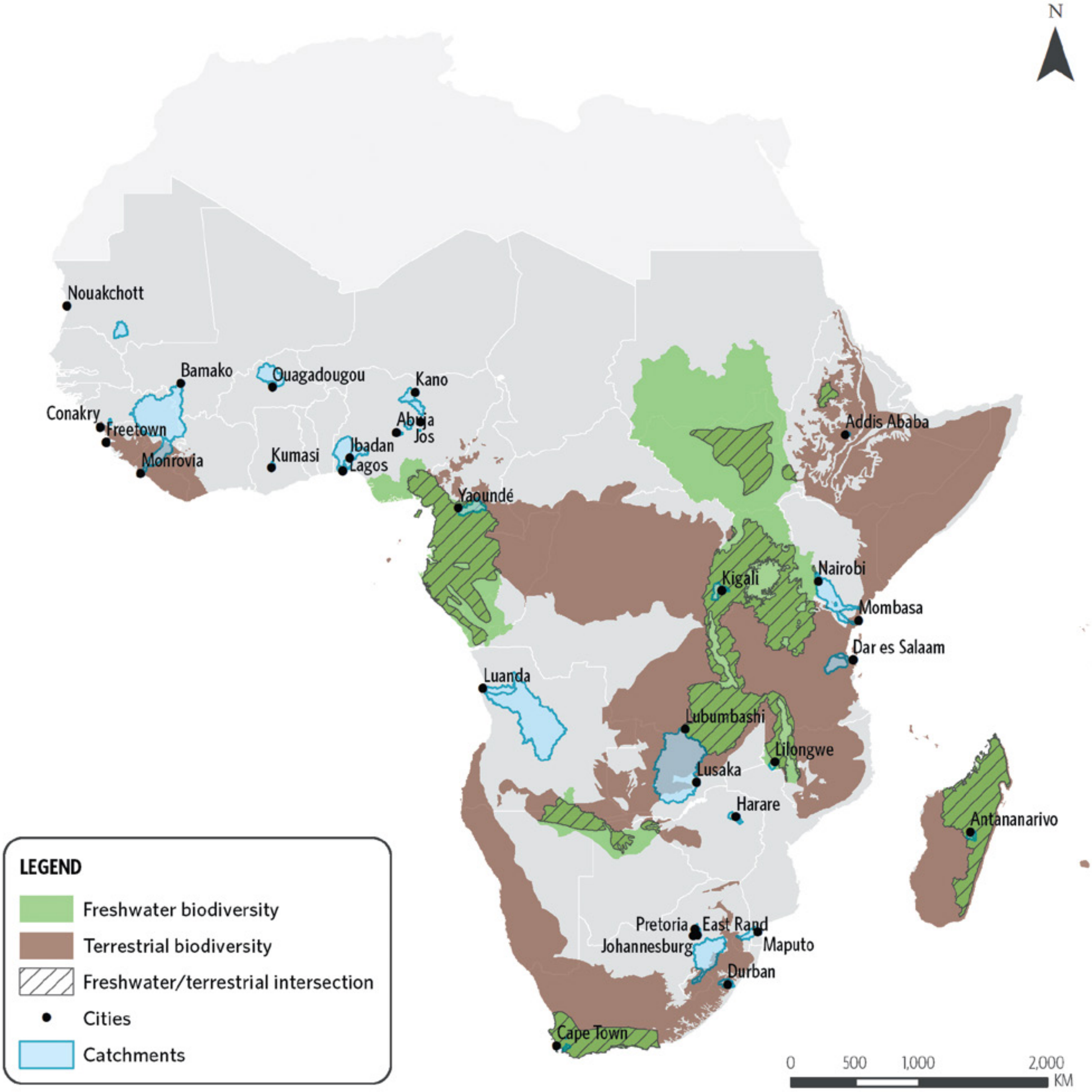
Where land use practices are more sustainable, human well-being can be positively impacted along with environmental quality.[2] The Machakos District of eastern Kenya is a well-known example of significant investments in agricultural innovation leading to improvements in both land health and livelihoods.[44] The widespread adoption of new farming practices supported an increase in farmer productivity and long-term agricultural viability, while also reducing sedimentation. Investments in source catchment protection have similar potential to support the livelihoods of those living within these catchment areas.

Figure 6. Cities and potential population at risk due to pollution



Total urban population for cities within each pollution category

Figure 7. Catchments and biodiversity significance



Overlay of catchments on top of freshwater and terrestrial ecoregion most significant for freshwater (green) and terrestrial (brown) biodiversity as assessed by The Nature Conservancy

The value of catchment conservation

As described previously, the growth of cities in SSA will require increased investment in water resources. Such investments have primarily been in built or "gray" infrastructure, including reservoirs, distribution pipes and treatment plants. The connection between downstream urban water security and upstream catchment integrity highlights an additional and complementary approach: source water protection through land management or "green" infrastructure. In this section, we present a blueprint for the potential impact of source water protection activities toward maintaining or improving water quality.

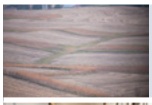
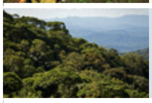
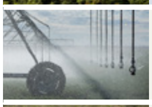
Protecting natural and working landscapes

Source water protection includes a wide range of land management practices that support improved water quality and quantity outcomes. Figure 8 presents a selection of such conservation practices that have been utilized by The Nature Conservancy and partners for projects across the world, including SSA. We developed approaches to assess the potential for such conservation practices to reduce pollutants and improve water supply outcomes, building from our analysis of catchment pollutant risks for sediment and nutrients. These global models enable us to target conservation activities to the most vulnerable, highest polluting land areas, following the Conservancy's general approach for optimizing conservation interventions for the greatest returns.

Of the 30 cities assessed, we identify 28 that can achieve appreciable reductions in sediment or nutrients through such conservation interventions. Each conservation practice type has a different opportunity scope according to its spatial applicability and local pollution mitigation potential for a given catchment. Looking across all practices, we see that agricultural best management practices (BMPs) demonstrate the broadest applicability for our sample of cities, potentially benefitting some 85 million people, largely due to the fact that cropland comprises 40 percent of catchment areas.

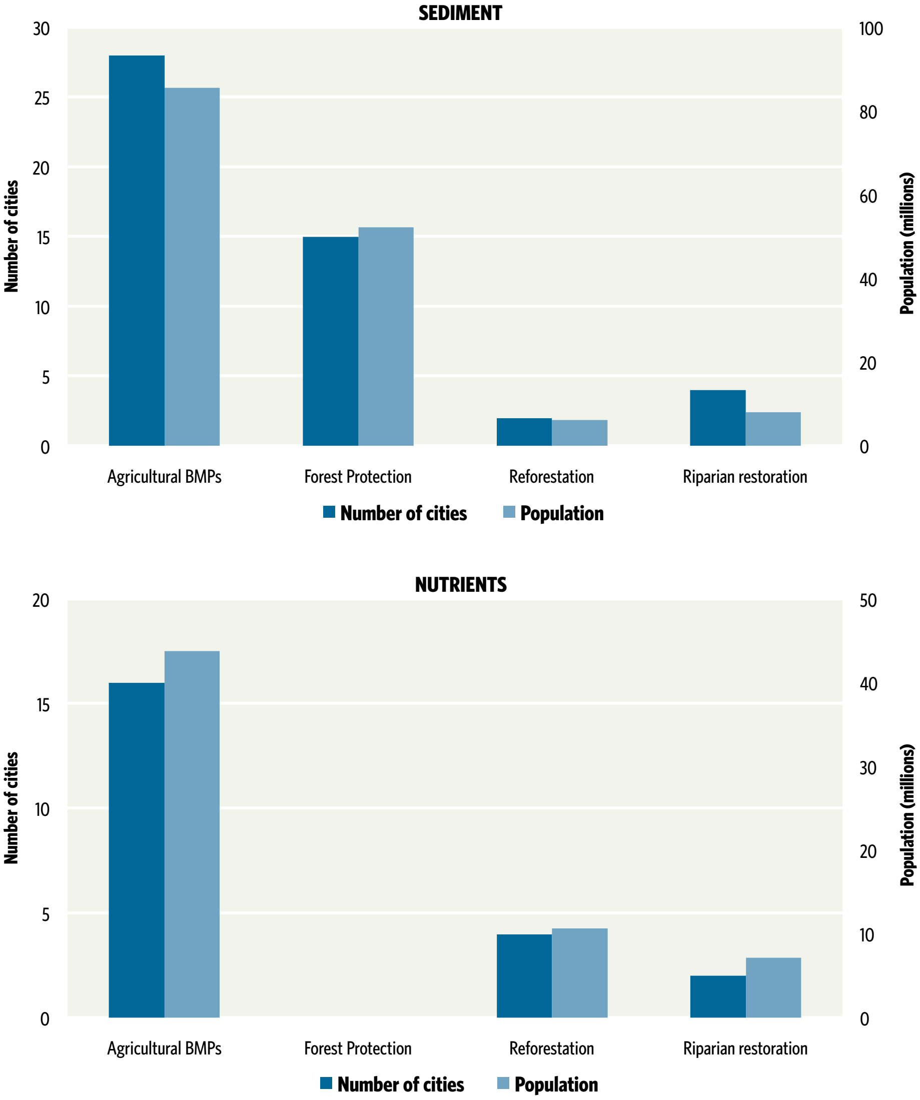
Conservation practices within natural landscapes also hold great potential for mitigating sediment or nutrient pollution for urban water supply (Figure 9). Forest protection and restoration – while more limited in spatial applicability as compared to agricultural BMP – are nevertheless important strategies in Africa, achieving pollution reductions for the benefit of up to 52 million and 11 million people, respectively. Importantly,

Figure 8. Source catchment conservation strategies

	Strategy	Description
	Agricultural Best Management Practices	Implementation of cover crops, contour farming to prevent sediment and nutrient runoff
	Forest Fuel Treatment	Conducting controlled burns or mechanical treatment to reduce wildfire severity and related sediment and ash pollution
	Forest Protection	Purchase of easements, land rental, conservation agreements, fencing and funding for park guards to maintain naturally forested areas
	Irrigation Efficiency	Shift from flood to variable rate and precision irrigation, and lining irrigation canals to reduce leakage and net water consumption
	Ranching Best Management Practices	Reduce cattle-related land degradation with silvopasture practice, rotational grazing and fencing as well as livestock waste disposal to protect water quality
	Reforestation	Restoration and planting of native trees and shrubs in critical areas to reduce erosion and related sediment transport
	Riparian Restoration	River bank restoration and protection to reduce erosion and improve water quality
	Road Management	Construction of sediment traps and culverts along roadways and resurfacing of dirt and gravel roads to reduce sediment runoff into waterways
	Wetland Installation	Conversion of portions of farmland to constructed wetlands to trap nutrient runoff

Multiple conservation strategies can be applied across a range of catchment landscape types to improve water quality and quantity management. Strategies highlighted in blue were assessed in this report.

Figure 9. Potential scope of catchment conservation strategies



Number of cities and total population that could benefit from each catchment conservation strategy

these results describe the conservation potential for individual practice types. With more detailed and local planning information, outcomes could be optimized across practices or even across catchments and cities where overlaps occur.

Valuing catchment conservation costs and returns

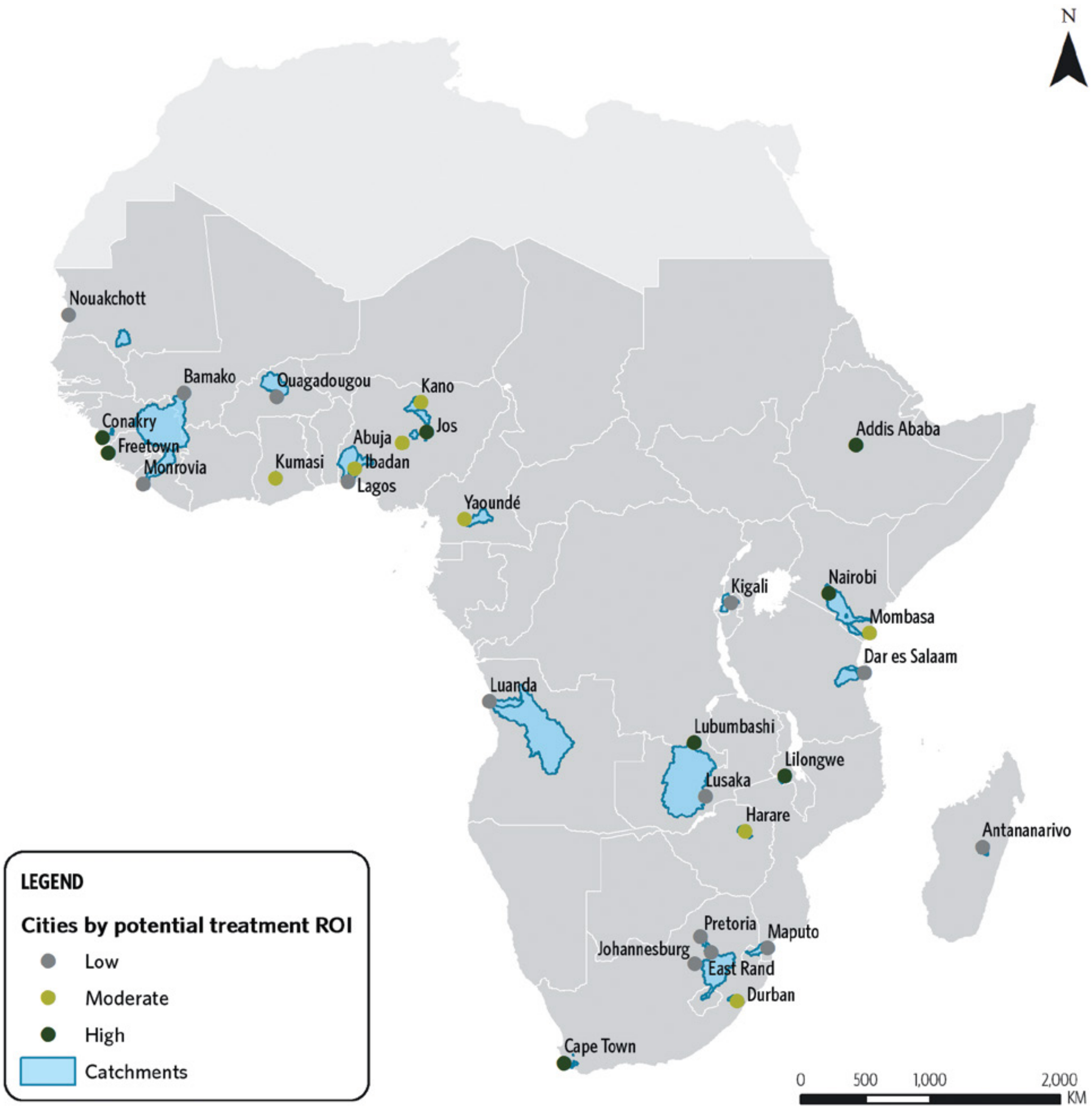
While conservation activities can achieve pollution reductions for many African cities, these benefits come at varying levels of investment. These variations in costs result from differences in the applicability and efficacy of each practice. For example, in the source catchments of Mombasa, forest protection requires the least conservation area – and the lowest overall costs – to achieve the same relative pollution reduction. In contrast, for Addis Ababa, agricultural BMPs are likely the best conservation strategy in terms of implementation area required. Then the cost of conservation is, at least in part, a function of the area required to reach a given pollution reduction threshold. Utilizing regional estimates for implementation costs, we estimate cumulative costs of catchment conservation at scale for each city to allow for relative comparison.

For further comparison, we also estimate the possible economic returns for cities as a function of the potential cost savings resulting from water treatment operating expenses – higher quality intake water results in lower treatment costs (see the *Urban Water Blueprint* for additional details on the approach).[1] By comparing the costs of conservation against the value of avoided treatment costs, we can assess the potential cost savings resulting from catchment conservation. Given the underlying assumptions of this approach, cost savings should be interpreted as suggestive of investment potential rather than definitive estimates.

In all, we identify 16 cities where avoided treatment costs could offset a significant portion (at least 25 percent) of total conservation costs (Figure 10). Of these 16 cities, half could potentially realize investment returns beyond offsetting avoided treatment costs alone, i.e. treatment savings exceed conservation costs. Importantly, this assessment of potential economic returns does not evaluate avoided capital costs or the multitude of other benefits that result from conservation. This is a particularly important consideration for cities identified here with lower potential returns. Our analysis of source catchments for Mombasa, for example, indicates modest savings from avoided treatment costs relative to conservation costs. If we include the value of other ecosystem services or benefits, such as increased dry season flows or increased agricultural productivity, we might expect the overall value of conservation returns to be significantly higher.[2]

Therefore, the valuations here likely underestimate the potential benefits – financial and social – of catchment conservation.

Figure 10. Potential investment returns from catchment conservation



Potential return on investment (ROI) as estimated from avoided water treatment costs alone. Valuation of other economic returns or benefits would likely indicate even greater potential. High (>1), moderate (>0.25) and low (<0.25) potential treatment ROI categories are estimates – more detailed analyses would be necessary for definitive appraisal.

Implementing catchment conservation

Investments through collective action

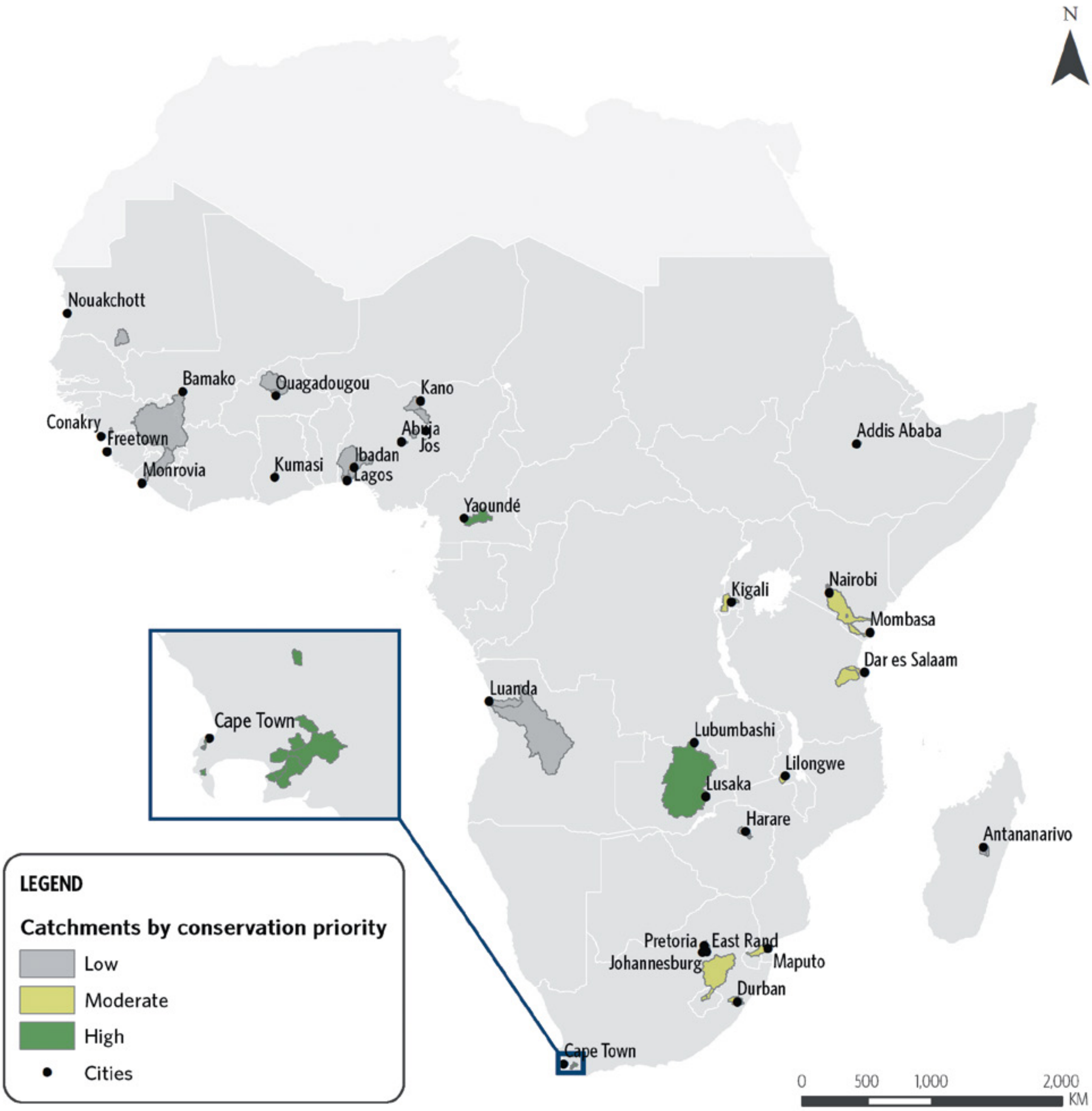
These results illustrate that for many SSA cities – particularly those with high reliance on surface water sources – catchment conservation can be an effective solution for mitigating pollution. Further, for one in every five cities, the costs of implementing conservation can be offset entirely or in part through reduced operating costs for water suppliers.

Importantly, a broad range of stakeholders stand to benefit significantly from investments in catchment protection activities. Industrial and commercial businesses can benefit from reduced operating costs and greater operational certainty. Investments to improve agricultural practices often benefit the farmer as much, or more, than downstream water users. One water-related program in Tanzania's Uluguru Mountains has demonstrated the potential for a "tenfold increase in incomes linked to increased crop productivity." A feasibility study for Nairobi's Upper Tana basin indicates the potential to increase farmer revenues by $68-479 USD per year, depending on the crop type, through improved agricultural BMPs as part of a water fund.[9]

Cumulatively, the combined benefits for cities and stakeholders resulting from catchment conservation could be significant: one African survey of catchment investment programs found that every dollar invested in catchment conservation results in a potential savings nine times greater.[8] In 2013, catchment-related programs were estimated to return benefits valued at a staggering 23 times the original investments. While these figures are approximate and drawn from limited data sets, the available evidence indicates that water treatment cost savings are just one of several important benefits resulting from catchment conservation.

The evidence reported here and elsewhere supports a strong financial argument for source catchment conservation. Despite the significant potential, implementation of programs to support catchment conservation has been slow to develop. The most recent survey (prior to the launch of the Nairobi Water Fund) identified just eight operational programs in SSA, with the bulk (99 percent) of landscape activities taking place within South Africa's Working for Water program.[8] A combination of financial, legal, institutional and political barriers are, at least in part, to blame. New approaches are needed to overcome these barriers – especially organizing key partners across sectors and catalyzing critical early-stage funding – in order to realize the potentially significant benefits for people and nature.

Figure 11. Priority catchments for biodiversity conservation



Surface water catchments that intersect priority conservation areas – as identified by the Conservancy – where source water protection actions are most likely to result in long-term benefits for nature. High priority catchments contain both freshwater and terrestrial priority conservation areas, moderate catchments contain either freshwater or terrestrial areas, and low priority catchments do not contain these highest conservation priority areas.

Identifying source water protection priorities

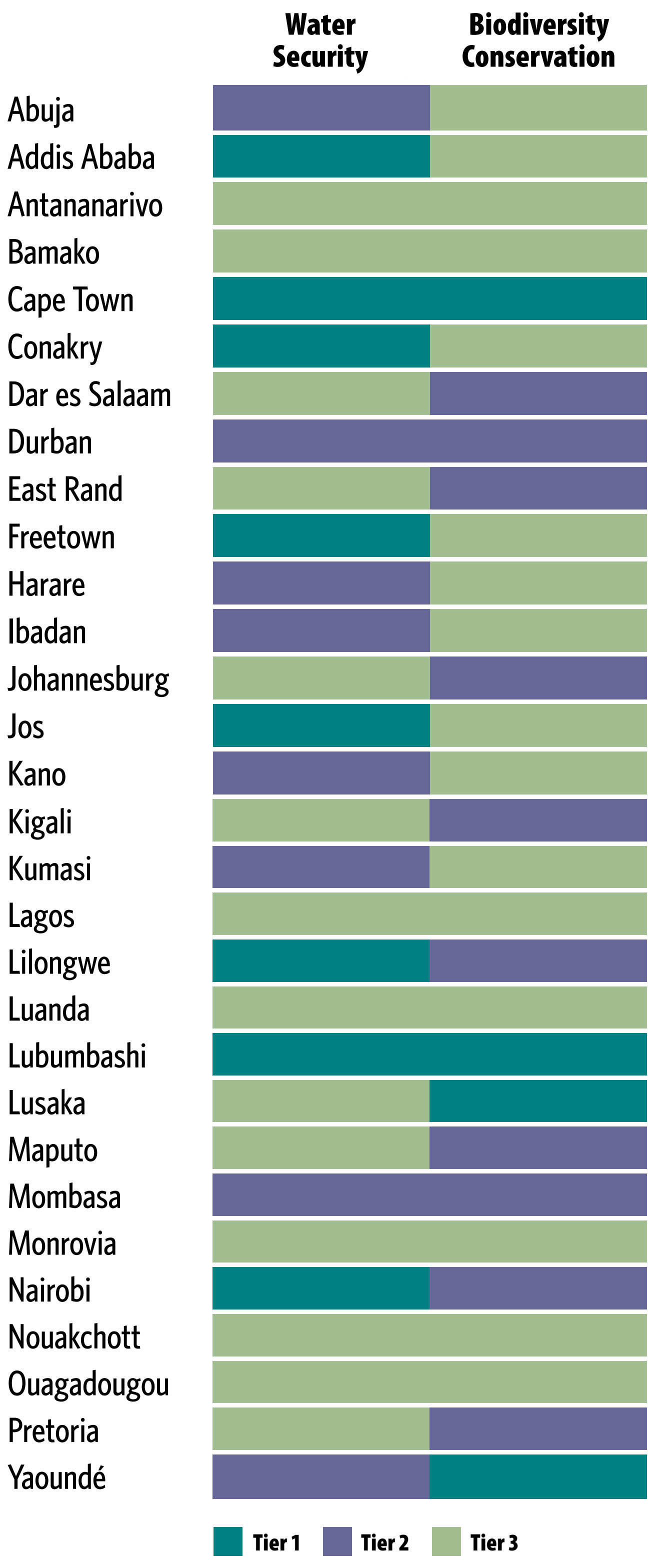
The results of our analysis, and the initial success of the Upper Tana-Nairobi Water Fund, demonstrate that catchment conservation can be an effective and feasible solution for many cities in Africa.

Previously, the Conservancy completed a continental prioritization effort to identify the most important areas for conservation across Africa.[45] This work considered not only biological significance but also identified where conservation projects would most likely lead to measurable and sustainable benefits for nature and people.

We used this spatial information to determine which source catchments intersect these priority conservation areas (Figure 11). This enabled us to identify 13 cities where conservation practices can achieve pollution reduction *and* support beneficial outcomes for biodiversity conservation. In seven of these cities, water treatment cost savings alone could offset a significant portion of conservation costs (more than 25 percent) (Figure 12). In four of these cities (Cape Town, Lubumbashi, Nairobi and Yaoundé), our estimates suggest that avoided water treatment costs alone could offset much or all of the costs of catchment conservation. While our analysis points to specific cities which may offer key enabling conditions for source catchment protection, more importantly this body of work indicates broad potential across the region. These results indicate that source catchment water funds are a valuable strategy to support improved urban water security and conservation outcomes in Africa.

Our sample of the largest cities in Sub-Saharan Africa represents only a fraction of the region's overall potential and need for source catchment conservation. The value and applicability of water funds is likely far greater than that captured here. While this road map presents a guide for implementation – indeed, the Conservancy is already developing or exploring water funds in two of the highest priority cities, Nairobi and Cape Town – these results suggest great potential across other African cities given further analysis. In addition to improved water quality and conservation outcomes, there is a broader range of possible co-benefits including improved livelihoods, governance, water quantity, and climate mitigation and adaptation.[6] Prioritizing for these additional co-benefits could open the door to even further catchment protection opportunities across the region and new sources of funding.

Figure 12. Potential returns for water security and conservation



Potential investment priorities for urban water security and biodiversity conservation resulting from catchment protection activities. Tier 1 represents those places with the highest potential for both treatment cost savings and conservation benefits for natural areas. The full value of catchment protection extends significantly beyond the benefits presented here.

Conclusion and next steps

Cities across Sub-Saharan Africa face an increasing risk of water insecurity driven by rapidly growing urban populations, economic growth and an increasingly unpredictable climate. Changes in land use and its resulting impact on water quality and supply affect both people and nature alike. Solutions are needed urgently.

This assessment demonstrates that catchment protection can play an important role in improving the quality and quantity of water for cities across Sub-Saharan Africa. These benefits extend beyond the cities themselves to help sustain rural livelihoods and huge areas of critical biodiversity. In spite of these benefits, measurable progress in catchment conservation has been slow to date. Water funds provide a solution to catalyze collective action and investment to achieve conservation of surface water sources and biodiversity at scale.

The Nature Conservancy will build on the results of *Sub-Saharan Africa's Urban Water Blueprint* by working with leaders and stakeholders in priority cities to advance the science, business case and implementation of source water protection activities. We aim to advance rapid replication of the water fund model to other cities and watersheds in Africa that are in urgent need of improved water security and biodiversity protection. To that end, the Conservancy is also launching a program to equip leaders across SSA to capitalize on expertise and methodologies developed and refined in diverse geographies.

We are seeking to create a coalition of partners from the private sector, government and civil society that are interested in harnessing the enormous potential of this proven approach. Success depends on a coordinated and targeted effort.

Planned strategic activities include:

- Identifying potential "champions" in cities with strong enabling conditions, who are interested in taking the lead in developing a water fund, or related source water protection mechanisms, with support from the Conservancy's water fund team;
- Facilitating exchanges between stakeholders in Africa and South America to develop first-hand knowledge of the potential benefits and challenges associated with water funds;
- Hosting workshops as part of the development of a source water protection network across Sub-Saharan Africa;
- Developing a toolbox of Internet-based resources that interested municipalities, NGOs and the private sector can use to explore and launch their own water funds;
- Incorporating additional cities, and local data such as source water quality and treatment costs, into future versions of this analysis.

As illustrated throughout this report, the value of source water protection is expansive in terms of scope and utility. Beyond water security and biodiversity, catchment conservation can have far-ranging impacts on economic development, human well-being, climate mitigation and the preservation of cultural heritage. It is this collective value that has fueled the remarkable spread of water funds globally, and attracted hundreds of millions of dollars in new investments.

In a growing number of cities, water funds have created new alliances between governments, corporations and communities in the common cause of protecting the water resources that we all depend on. Water funds present leaders in Africa, both public and private, with a proven approach to meeting their growing water needs and an opportunity to reshape the landscape of the entire region.

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The Nature Conservancy

For more information, contact:
Fred Kihara
Africa Water Funds Advisor
fkihara@tnc.org
The Nature Conservancy
Africa Regional Office
31 El Molo Drive, off Maji Mazuri Road, Lavington
P.O. Box 19738-00100 GPO
Nairobi, Kenya

nature.org/africa