Mombasa Water Fund

A Business Case for Nature-Based Solutions to Protect the Water Source Areas of Mwache Dam and Mzima Springs

Summary of Findings
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The Nature Conservancy

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The vision for the Mombasa Water Fund is improved water security through a restored and well-conserved Mwache catchment and Mzima Springs recharge area.

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Introduction

Cities and regions around the world face increasing threats to their water security due to growing water demands as a result of climate change and degradation of their water source areas. This has become a critical issue for Mombasa, Kenya, where the city currently covers less than a third of its total water demand through the formal water supply network. While the problem is now being addressed through massive investments in water supply infrastructure, without looking after the water source areas behind these, such investments could have limited benefits in the long run.

This document summarises the findings of the Mombasa Water Fund (MWF) Business Case.[1] The Business Case puts forward strategic measures to restore, rehabilitate and protect the ecological and built infrastructure that supplies water to

Nature-based solutions are essential for achieving water security. They are also critical for addressing the dual challenge of biodiversity loss and climate change. Such measures can be more cost-effective and versatile than traditional grey infrastructure solutions and have a range of co-benefits. By securing the quantity, timing and quality of freshwater flows and limiting sediment and pollution inputs from water source areas, they complement and protect investments in built infrastructure.

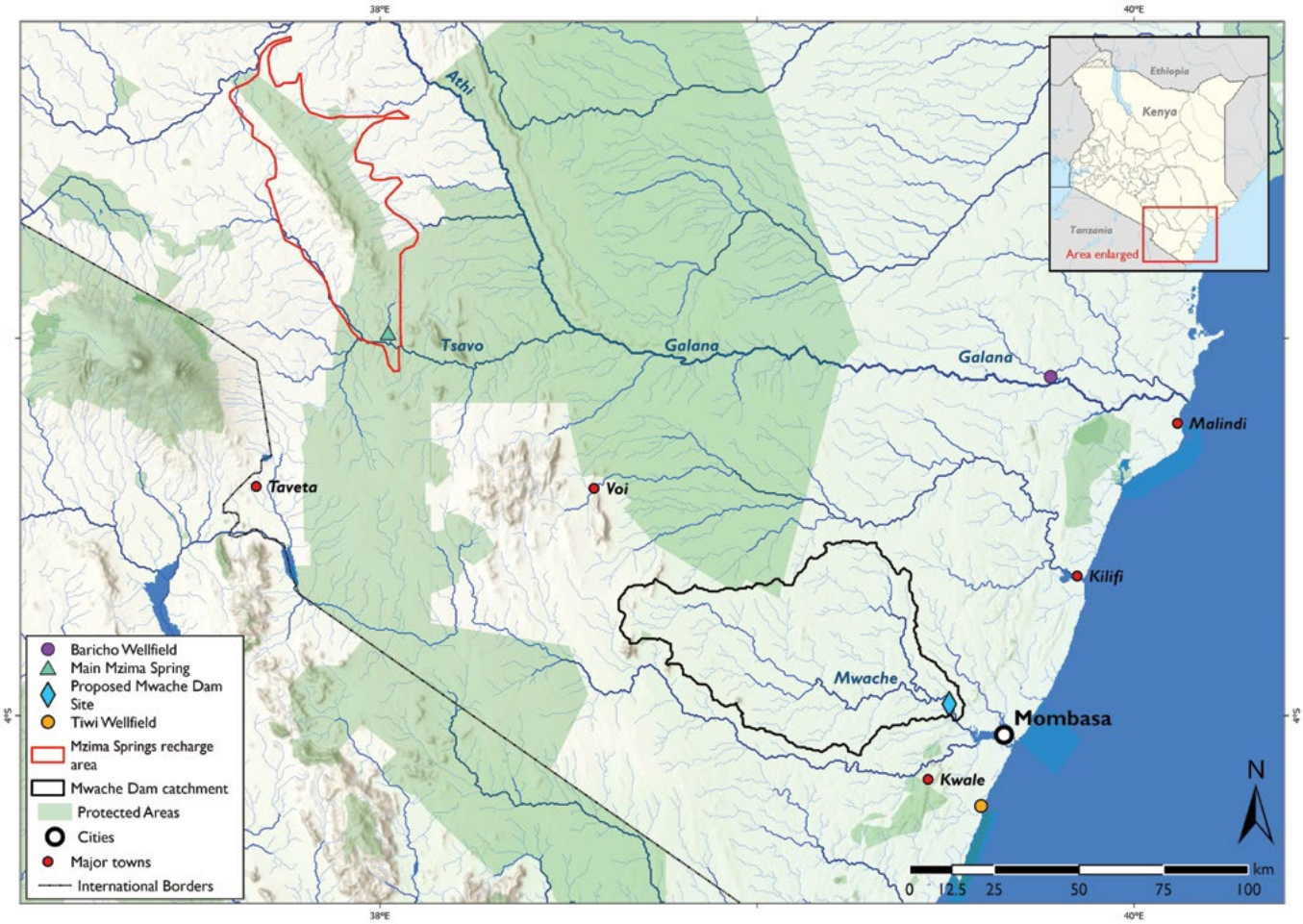

FIGURE 1. THE MWACHE DAM CATCHMENT AND RECHARGE AREA OF THE MZIMA SPRINGS AS KEY COMPONENTS OF THE MOMBASA WATER SUPPLY SYSTEM, WHICH CURRENTLY COMPRISES THE SPRINGS AND WELLFIELDS SHOWN. NOTE THAT THE BOUNDARY OF THE RECHARGE AREA IS APPROXIMATE.

1 Agence Française de Développement. 2022. *Mombasa Water Fund Business Case*. Prepared by Anchor Environmental Consultants, The Nature Conservancy and FutureWater for Agence Française de Développement, Mombasa Kenya.

over 2 million people in southeastern coastal Kenya (Figure 1). The analysis demonstrates that investing in nature-based solutions in two key water sources areas of the Mombasa water supply system will reduce sediment and nutrient loads entering rivers and prevent losses to water yield. This will not only save on dredging and water treatment costs but will also ensure the longevity of grey infrastructure assets that are being built to improve water supply in the region.

The role of the Mombasa Water Fund

A water fund is a multi-stakeholder entity with discrete funding, governance and management mechanisms that promotes and implements land restoration, conservation and improved management practices to prevent water problems at the source, while also providing a number of co-benefits to both upstream and downstream communities.

The Mombasa Water Fund aims to provide a multi-stakeholder response to addressing environmental degradation in the Mwache Dam catchment and Mzima Springs recharge area.

The Mombasa Water Fund builds on the experience of over 40 other water funds that have been established in 13 countries by The Nature Conservancy. This includes the Upper Tana-Nairobi Water Fund, launched in 2015, which has already contributed to the improved conservation and management of 40,000 ha of public forest and 78,400 ha of farmland working with over 44,000 farmers. They are growing over 3.4m trees and have brought 35,000 youth into conservation. This has led to increased water yields and improved quality for local and Nairobi community and hydropower generation.

The Mombasa Water Fund seeks to help ensure the long-term sustainability of major water supply infrastructure investments, improve the quantity and quality of future water supply to urban consumers, improve the livelihoods of communities living in water source areas, conserve biodiversity and contribute to mitigating climate change through carbon sequestration.

The water supply situation

The city of Mombasa receives just 17.5% of its total water demand.

Mombasa is Kenya's second largest city, its main port, and an important tourism destination. Although its population has swelled to 1.2 million people, it still relies entirely on groundwater sources and springs for its water supply, most of which are located long distances away in Kwale, Kilifi and Taita-Taveta counties. It shares these water sources with several other smaller towns, such as Voi, Kinango, Malindi, Kilifi, and Kwale, and receives less than a third of the water supplied by the system. Part of this is lost within Mombasa's water reticulation system, and the remaining amount supplied from the public water supply system amounts to just 17.5% of city's total water demand. This has forced residents and business to rely on private boreholes, wells and water vendors. Major new infrastructure has been planned to help remedy this situation, with a planned commissioning date in early 2022. This includes new offtake infrastructure and pipelines to increase the supply from Mzima Springs, and the Mwache Dam and treatment works to augment the supply of water to Mombasa and Kwale County. The Mzima Springs infrastructure, which will take about two years to complete, will almost double the water reaching Mombasa. The dam, which is expected to take six to eight years to complete, will exceed the current supply capacity of the entire bulk water system, enabling the whole system to meet projected water demands in 2035. However, the future sustainability of both these water sources is threatened by land use practices.

The future sustainability of planned infrastructure upgrades is threatened by land use practices in the Mwache catchment and the Mzima Springs recharge area.

The Mwache Dam catchment covers 3,560 km^2, located mostly in Kwale County. Rainfall in this area increases towards the coast, and crop cultivation is widespread in the lower reaches, with livestock and wildlife being more dominant further inland. Land use practices, sand mining and fuelwood harvesting in the catchment area present a serious threat to the lifespan and potential water yield of the dam. These activities increase soil erosion and sedimentation, which at current rates could reduce the lifespan of the dam to as little as 20 years. Although two large check dams have been planned to trap sediments upstream of the Mwache Dam, the costs of managing these dams could be prohibitive: under current circumstances, they are expected to accumulate as much as 1.32 million cubic meters of sediment per year. Increased

protection of the vegetation and soils of the catchment area will be essential to protecting the Mwache Dam investment and avoiding elevated water treatment costs.

The Mzima Springs are fed by water from the Chyulu Hills volcanic aquifer. The aquifer's recharge area is around 2,000 km^2, most of which is in Makueni County. The cloud forests of Chyulu Hills play a vital role in capturing rainfall and condensation (from mist) that infiltrates the underground aquifer. Pastoralism is the dominant livelihood activity on the western side of the Chyulu Hills, making way for crop production in some parts. On the eastern side, small-scale subsistence agriculture dominates. This area also includes the main Nairobi-Mombasa highway and its associated towns and businesses. Water supply from the Mzima Springs is threatened by deforestation. Continued loss in forest cover is expected to lead to a significant decline in rainwater infiltration rates and a reduction in the amount of water that is discharged from the aquifer at the springs. Therefore, measures to halt and reverse the loss of forest cover are also essential to protect the significant infrastructure investments being undertaken and to safeguard future water security for the region.

Nature-based solutions for water security

In the Mwache Dam catchment, the focus of nature-based solutions would be on reducing soil erosion, given that this is the primary threat to sustainability. This would help mitigate the threat of sedimentation to water quality and the future water storage capacity of the dam. A key premise of this approach is that addressing soil erosion at source will be cheaper than removing sediment once it reaches the check dams or main reservoir. This would also reduce water treatment costs by reducing loads of suspended solids and other pollutants. The Business Case proposes the following combination of environmental management measures:

i. Active rehabilitation, which includes planting appropriate trees and grass in badly degraded riparian and roadside areas and restoring tree cover in deforested areas.

ii. Soil erosion control (SEC) interventions on farmland, including cover crops, reduced and no tillage approaches, agroforestry, and terracing, with different combinations of interventions proposed depending on slope.

iii. Sustainable natural resource management, which includes sustainable rangeland management, sustainable use of fuelwood, and the managed recovery of degraded areas.

iv. Conservation of important natural areas, which includes protection of all riparian zones and the establishment of community wildlife conservation areas (i.e., potential expansion of conservancy areas) in larger blocks of remaining natural vegetation that are not currently protected.

The proposed solutions have the potential to improve livelihoods through increased agricultural productivity and expanded opportunities for the generation of income through nature-based tourism. They will also contribute to carbon sequestration and biodiversity conservation.

The proposed portfolio of interventions in the Mwache Dam catchment will cover just over 43,000 ha, with a total cost (expressed in present value terms) of $31.3 million.

In the Mzima Springs recharge area, nature-based solutions would focus on reducing deforestation and rangeland degradation in the Chyulu Hills, thereby aiming to restore and secure the groundwater recharge capacity of the area and avoid future declines in the amount of water that can be extracted from the springs. The improved conservation of this area will come with co-benefits such as flood attenuation, biodiversity conservation and nature-based tourism. There is already an existing Reduced Emissions from Degradation and Deforestation (REDD+) scheme in this landscape — the Chyulu Hills REDD+ Project, which was

established in 2013 and is managed by the Chyulu Hills Conservation Trust. REDD+ is a payments for ecosystem services (PES) scheme that focuses on carbon retention. Among other factors, the success of such schemes is dependent on households receiving rewards of greater value than the opportunity costs involved in complying with the conditions of the scheme. While the existing scheme has already started to generate carbon revenues, the inclusion of payments for hydrological services will bolster the REDD+ project, increasing its effectiveness and reach. This would help the trust to provide a steadier flow of payments and support to communities in return for conservation action. Based on GNIplus (2021),[2] additional funding of $6.3 million per year is needed to meet the REDD+ objectives of halting and partially reversing deforestation in the Chyulu Hills, amounting to $72 million (in present value terms) over a 30-year period.

Return on investment

The results from the cost-benefit analysis provide the economic rationale for the establishment of a water fund.

Contributions to the Chyulu Hills PES Scheme through the MWF to ensure protection of the cloud forests could generate benefits in the order of $92 million over the 30-year time frame. This represents a return of some $1.30 in benefits for every dollar spent. However, the benefits could be far greater than this, as the Chyulu Hills also support significant biodiversity and wilderness areas, which are valued both by Kenyan citizens and the global society, and which contribute to Kenya's biodiversity conservation commitments. There are a great number of people, including many who may never visit the area, who would be willing to pay for conservation of this landscape. These non-use values could greatly exceed the tourism value of this area.

Investments in the Mwache Dam catchment are expected to have even better returns. Here, a $31 million investment in restoration interventions is expected to return at least $65 million in economic benefits over the 30-year time frame. In other words, every dollar invested by the water fund is expected to generate at least $2.10 of included benefits to stakeholders. Again, in addition to the water security and tangible co-benefits included in the calculations, this would come with some biodiversity benefits, in that improved conservation in the upper part of the catchment would increase wildlife habitat and the connectivity of conservation areas in the region.

Taken together, the overall investment costs would amount to $104 million, with returns of $157 million, resulting in a net present value of $53 million and an ROI of 1.5. Figure 2 shows how the benefits, costs and

2 GNIplus. 2021. "Design and Implementation of a Water Payment for Ecosystem Services Scheme in the Chyulu Hills: Baseline Review," London, UK.

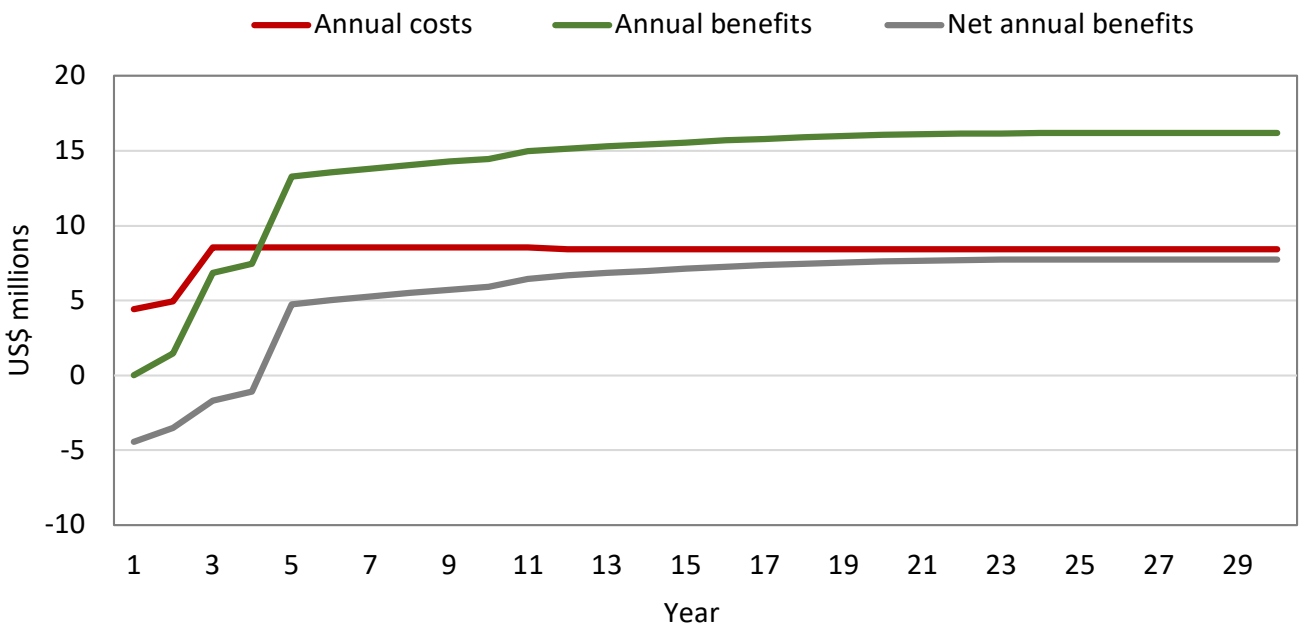

FIGURE 2. TOTAL ANNUAL BENEFITS AND COSTS OVER TIME FOR THE EXTENDED ANALYSIS OF THE MWACHE DAM CATCHMENT AND MZIMA SPRINGS RECHARGE AREA (2021 US$ MILLIONS, 30 YEARS).

net annual benefits are anticipated to be realised over time for the combined interventions in the Mwache Dam catchment and the Mzima Springs recharge area.

The following key results demonstrate the importance of catchment restoration and conservation and the feasibility of establishing the MWF. Compared with a business-as-usual scenario, investments in catchment ecological infrastructure would yield the following returns:

- The amount of sediments entering the rivers of the Mwache Dam catchment would be reduced by approximately 16% (109,000 tonnes), with an annual cost savings in terms of dredging sediment check dams of $1.23 million per year.
- A 1% loss in average annual water yield from the Mwache Dam catchment could be prevented, which translates into avoided costs of $380,000 per year for the first five years, $420,000 per year for the next five years, and $750,000 per year after that.
- Losses of at least 25% in water yield from the Mzima Springs could be prevented, translating into avoided costs of at least $3.26 million per year.
- The amount of phosphorous and TSS entering the rivers of the Mwache Dam catchment could be reduced by 70% and 50%, respectively, with annual avoided water treatment costs of around $860,000 per year.
- Agricultural interventions implemented on cultivated land could increase agricultural productivity through improved crop yields, generating increases in annual returns of $1.07 million per year to farming households.
- Carbon stored in the study area would be 9.1 million tonnes higher over the 30-year study horizon, avoiding estimated annual climate change damages of $640,000 to Kenya and $438 million globally, with a current carbon market value of $2.5 million per year.
- Increased tourism-related spending across the study area could amount to $5.9 million annually by 2050.
- Nature-based solutions will have several positive effects, including improved pollination of crops in nearby fields by insect pollinators that are supported by natural habitats; increased cultural values

derived from improved community forest management in Kwale County; more abundant nutritious (and income-earning) fruit from trees planted in agroforestry systems; greater human and livestock health benefits associated with the cooling services provided by agroforestry systems; and the potential health benefits as a result of reduced coliform loadings into waterways through the rehabilitation of riparian buffers.

Policy and stakeholder landscape

The envisaged MWF has the potential to help realise goals and visions for conservation and water resource management enshrined in several official policies, acts, strategies and plans. The water fund approach can capitalise on these existing frameworks to engage governments, the private sector and communities in planning, funding and executing watershed conservation and management.

As an important step towards establishing the Mombasa Water Fund, a range of key stakeholders have been identified and consulted. These include various government actors from national to county levels who can support the water fund by sharing their policy and regulatory perspectives or by providing funding and serving as implementation partners for the proposed MWF activities. The Water Resources Authority and Water Services Regulatory Board, as key water sector actors, will be important for winning high-level support for the fund. The World Bank, funders of the new water supply infrastructure, will be interested in the MWF's contribution to the protection of their investments. Donors with interests in human development or biodiversity conservation could also be key sources of funding. Additionally, major private sector water users in the region, particularly those in the manufacturing and tourism sectors, should be interested in supporting the fund as a means of helping to secure their own future water supplies to sustain their business activities. Non-governmental organizations (NGOs) could also play an important role in mobilizing and facilitating land users to implement the proposed interventions.

Implementing the Mombasa Water Fund

Implementation of the restoration and conservation activities can be undertaken using myriad incentive and assistance-based approaches. The Business Case proposes a range of complementary and mutually supportive types of assistance to be funded in order to bring about the land and resource management interventions required in different parts of the two priority water source areas. These include the following:

- **Providing direct assistance to farmers** in Mwache catchment, from the Kwale County government and with the assistance of an NGO, to implement and maintain soil conservation measures.
- **Establishing and financing environmental restoration teams** that include trained core personnel and locally employed labor to undertake vegetation restoration and rehabilitation measures, particularly in the Mwache Dam catchment.
- **Setting up payments for ecosystem services (or PES-like schemes)** in the Mzima Springs recharge area (Chyulu Hills water PES scheme) and Mwache Dam catchment (within the western pastoral/conservancy landscape) to incentivise the restoration and maintenance of woody resources and rangeland ecosystem health.
- **Encouraging and assisting with the establishment of new conservancies** and other community or landowner associations that might be incentivised by and able to benefit from PES-type funding or other opportunities in both water source areas.

The MWF will have the ability to receive, generate, manage and spend funds through endowment and revolving facilities, as well as to guide aligned public investment for financing the above interventions. Funding would be provided by domestic and international donors and water charges, and ultimately also from interest earned by the endowment fund. Public and private investment may also take the form of nonmonetary actions that are aligned with the MWF, such as staff assignments to undertake MWF activities in the designated water source areas or legal assistance.

It is estimated that the average total annual budget that the MWF will need to carry out its mission effectively and efficiently will be approximately $8.8 million. Interventions in the Mwache catchment would require an initial expenditure of $6.4 million followed by annual payments of $2.2 million, while those in the Mzima Springs recharge area would require a smaller initial investment of $2.1 million but higher ongoing payments of $6.3 million per year. Given the size of the overall investment required, it is likely that the MWF would need to aim to raise an initial sum of about $20 million. This could generate a net average annual income of about $1 million and, through demonstrating the success of initial endeavors, obtain further commitments over time. Future funds could also be pledged, though this would depend on the measure of success.

The main goal of the MWF is to protect investments in water security. As such, the primary beneficiary is the state, specifically those responsible for raw water supply infrastructure. Therefore, there is strong motivation for a contribution from the sale of raw water, some or all of which could be passed on to county government water service providers. A modest KSh2/kl catchment conservation levy could generate annual revenues of $1.3 million for expenditure on MWF activities in Mwache Dam catchment, and $700,000 for the Mzima Springs recharge area. This would greatly encourage co-funding by other national and international stakeholders. It is also envisaged that some funders — for example, those motivated by carbon, biodiversity or other gains — might need to see ringfenced funding "pots" for specific projects.

Additional funding from the public sector, domestic and international donor agencies, and the private sector, as well as a small increase in the water tariff, will be critical to achieving the MWF mission of restoring and protecting the Mwache Dam catchment and the Mzima Springs recharge area.

Conclusion

Land use practices in the Mwache Dam catchment area present a serious threat to the lifespan and potential water yield of the under-construction Mwache Dam, and water supply from the Mzima Springs is threatened by deforestation in its recharge area in and around the Chyulu Hills. A long-term commitment to investment in critical ecological infrastructure is needed to restore and protect the catchment areas of these important water source areas.

A long-term commitment to investment in critical ecological infrastructure is needed.

Healthy catchments regulate the timing, quantity and quality of stream flows, saving on grey infrastructure costs. Indeed, the degradation of ecological infrastructure leads to the need for more traditional grey infrastructure, or the need to fix or maintain existing grey infrastructure more regularly. This is particularly pertinent in the Mwache catchment given the construction of the Mwache Dam, the lifespan of which will be significantly curtailed if changes are not made soon to the way in which the catchment is managed.

This Business Case demonstrates an economic basis for establishing a water fund. A $31 million investment in restoration interventions in the Mwache Dam catchment is expected to return at least $65 million in economic benefits over the studied 30-year time frame. This provides a compelling case for developers, such as the World Bank, to consider a long-term commitment to investing in ecological infrastructure to ensure the longevity of their grey infrastructure assets. Indeed, the initial expenditure for effective intervention in the Mwache Dam catchment represents just 3% of the dam development cost. Therefore, the development of a water fund is timely. Completion of the dam is expected to take six to eight years, providing enough time to restore already degraded areas and potentially halt any further degradation. Investment in the recommended activities now would mean that the restoration and conservation projects could be fully tested and operational by the time the dam is operational.

Initial expenditure for effective intervention in the Mwache Dam catchment represents just 3% of the dam development cost.

In the Mzima Springs recharge area, a $73 million investment in a Chyulu Hills Water PES scheme is expected to return about $92 million in economic benefits over the 30-year time frame, with an ROI of 1.3. Potential donors may be further motivated by maintaining the important biodiversity value of the area, the value of which (apart from tourism) is not fully included in this analysis.

Taken together, an investment of $104 million in water fund interventions in the Mwache Dam catchment and the Mzima Springs recharge area is likely to return $157 million in economic benefits over 30 years, resulting in a net present value of $53 million and a positive ROI of 1.5. Given the scarcity of data in some cases and the difficulty in modeling the hydrology of the Mzima Springs, the calculation of benefits was conservative. Sensitivity analysis shows that costs could be increased and benefits reduced further while still maintaining economic viability. Although the Chyulu Hills Water PES Project will likely require further development to secure investment, restoration and conservation interventions in both areas ideally should be funded through the MWF to ensure improved water security for all users of the Mombasa water supply system. In addition to securing water supply, catchment restoration and conservation can bring wider benefits in terms of climate change resilience, job creation and community empowerment, and the restoration and protection of critical biodiversity.

Catchment restoration and conservation can bring wider benefits in terms of climate change resilience, job creation and community empowerment, and the restoration and protection of critical biodiversity.