Prosperous Land, Prosperous People: Scaling finance for Nature-based Solutions in Kenya

November 2022

The Food and Land Use Coalition

Contents

Acknowledgements

This report is one in a series produced by Climate Focus and the Food and Land Use Coalition (FOLU). Since September 2021, Climate Focus and FOLU have been collaborating on a research project looking at financing strategies for land-based Nature-based Solutions (NbS) at a country and global level (see following page). The ultimate objective of the project is to enable public and private financiers to prioritize and deploy activities and investments that will unlock the potential of NbS for climate mitigation, adaptation, resilience, biodiversity and beyond. The 2022 report series includes the publication of country-based assessments in Kenya and Colombia, as well as global analyses focused on the voluntary carbon market. This publication about Nature-based Solutions in Kenya is funded by Norway's International Climate and Forest Initiative (NICFI).

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The Food and Land Use Coalition (FOLU) is a global community of country platforms, partner organizations and Ambassadors working to advance sustainability, equity and resilience in food and land use systems. Created in 2017, FOLU supports diversity, embraces disruptive thinking and forges consensus through an evidence-based approach. The coalition empowers farmers, policymakers, businesses, investors and civil society to unlock collective action at scale.

About this project

There is no pathway to limiting global warming to 1.5°C without the protection and restoration of nature, yet there is a significant financing gap with less than 2% of climate finance currently flowing to Nature-based Solutions (NbS).[1] Investors – both public and private - often lack the information to enable them to invest in land-based mitigation, including which concrete programme and jurisdictional-level investment opportunities exist and how to structure investments in nature and sustainable landscapes (including through access to carbon markets). All actors lack the information needed to assess the economic opportunities provided by a sustainable, nature-and climate-positive economy. No study currently exists that sets out a comprehensive country-focused assessment of optimal financing strategies for unlocking the potential of NbS.

Through the series of reports, Climate Focus and FOLU will address the following five questions:

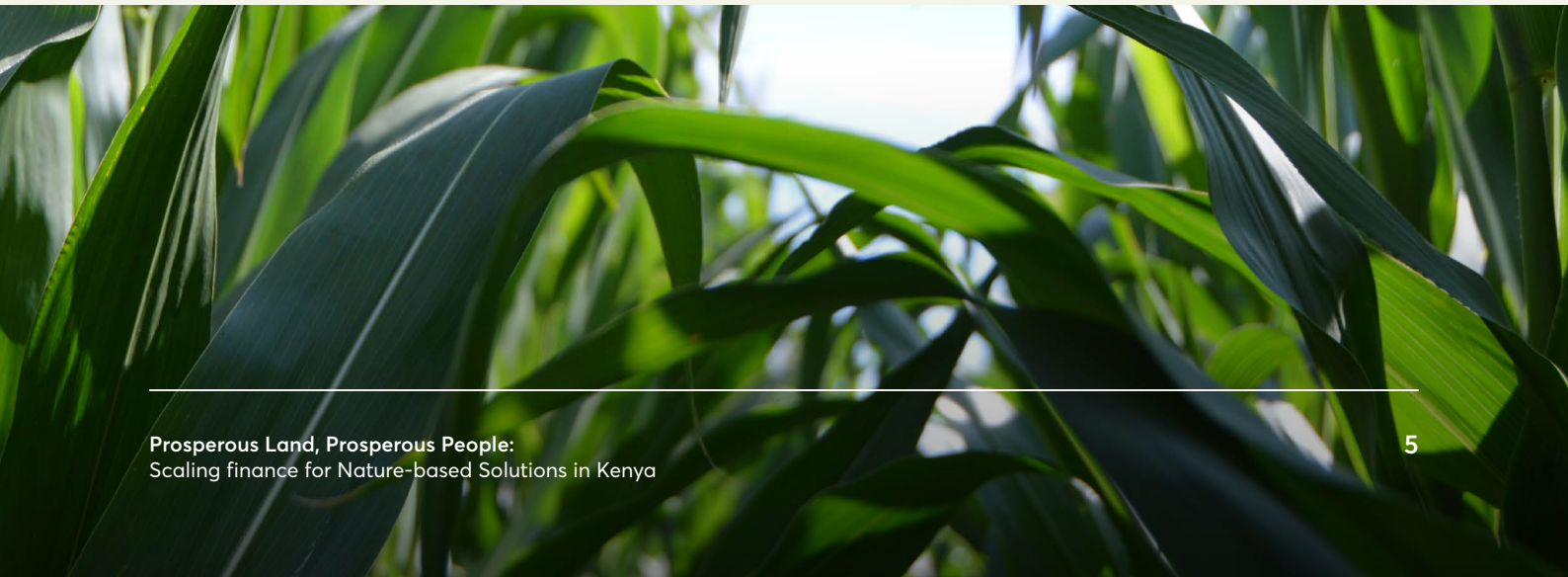
1. What is the mitigation potential of NbS at country level? The report looks at a specific set of NbS which deliver climate mitigation through the protection, management and restoration of natural ecosystems and by shifting how food is produced and consumed within the country. The country-level mitigation potential draws from the work of Roe et al (2021).[2]

2. How much does it cost to implement and manage these NbS in specific countries?

3. What is the finance gap between the finance currently flowing into these solutions and the finance that is needed to unlock the full mitigation potential of these solutions?

4. Which funders and financial mechanisms (i.e., carbon markets, private investment, public financing) will be most effective in unlocking the potential of different types of NbS in different country contexts? What in particular is the role of the voluntary carbon market in financing NbS?

5. What are the features of an enabling environment needed to bridge the finance gap?

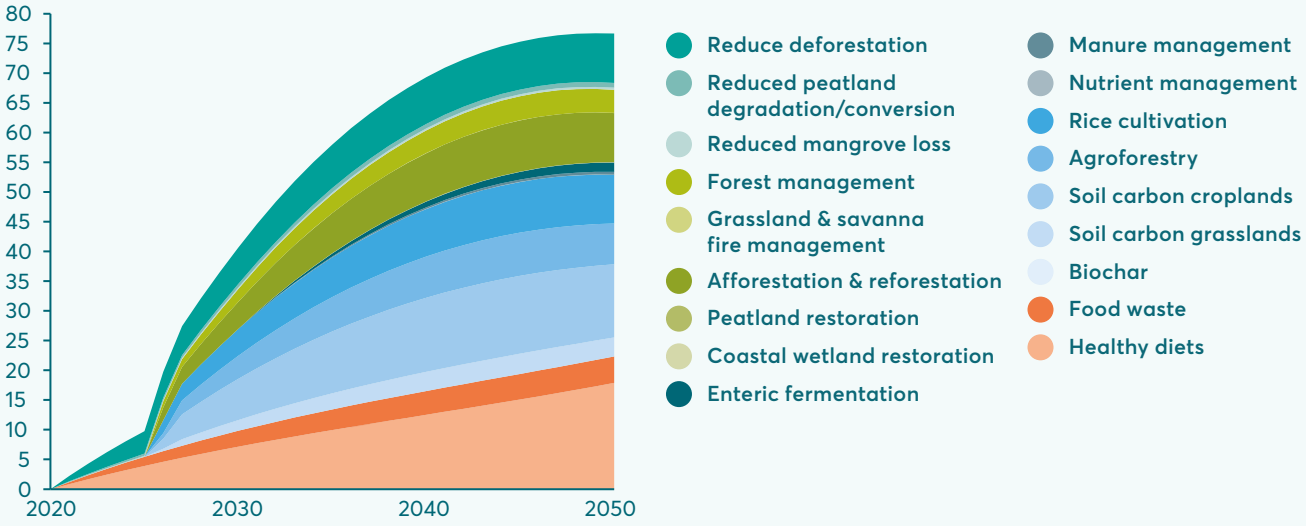


Executive summary

Nature-based Solutions (NbS) are a critical part of the transformation agenda for food and land use systems to deliver better prosperity for people and planet.[3] NbS are actions in land-based and marine ecosystems to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.[4] There has been increasing attention to the role that land-based NbS play in climate change mitigation. Recent evidence suggests that the implementation of 20 different land-based solutions can provide around 30% of global mitigation needed to deliver the 1.5°C temperature target, whilst also securing the climate regulation function of the existing land sink.[5,6] This report focuses specifically on these NbS measures – all of which restore, protect and manage natural ecosystems and shift how food is produced and consumed.[ii]

Kenya faces a tremendous opportunity to implement NbS as part of its transformation of food and land use systems. Implementation of a suite of land-based NbS in Kenya by 2050 has the potential to deliver significant benefits for climate, biodiversity protection, local livelihoods, food and nutrition security. These measures could provide climate mitigation of approximately 80 million tCO_2e per year by 2050, which is equivalent to the annual emissions of Kenya in 2019.[7] Agricultural measures, such as enhancing soil organic carbon sequestration in grasslands and in croplands as well as agroforestry have the highest mitigation potential, but other demand-side interventions are also needed in Kenya.

Figure 1: Estimated cost-effective mitigation potential per NbS measure from 2020 to 2050 ($MtCO_2e$ per year).[iii]



[ii] This report specifically focuses on the 20 land-based measures defined in Roe et al. (2021), 19 of which are relevant to Kenya.

[iii] Cost-effective mitigation potential is mitigation which can be achieved for less than USD 100 per tonne CO_2e (Roe et al., 2021). The total mitigation per year by 2050 was calculated by applying the mitigation potential scale-up between 2020 and 2050 detailed in Roe at al. (2019) to the average cost-effective mitigation potential for Kenya identified in Roe et al. (2021).

Building a more resilient and prosperous, as well as food- and nutrition-secure economy in Kenya is more important than ever. Recent trends reinforce this need, as evidenced by the COVID-19 pandemic, the cost of living crisis and global supply chain disruptions as a result of international conflict and climate-related disasters, which are already costing Kenya between 2-3% of GDP.[8] Studies suggest that NbS can help to build a more climate resilient and food secure Kenya. By increasing the biological diversity on farmland, the agricultural solutions can help drive productivity in both crop and livestock-based systems, alongside producing more nutritionally diverse food. Solutions that plant and protect trees can increase water infiltration, promote soil health and reduce local temperatures, increasing resilience to droughts, erratic rainfall and high temperatures. More quantitative studies are needed, however, to ensure these benefits are experienced across all solutions and in all biomes. Ensuring these benefits can be unlocked requires implementing NbS with guardrails to mitigate against potential risks such as harm to local communities and unintended impacts on local biodiversity.

The Government of Kenya is increasingly recognizing the importance of NbS. Kenya was one of the first African nations to implement a National Climate Change Action Plan (NCCAP), which places significant importance on afforestation and reforestation – aiming to restore 300,000 ha of forest per year by 2030.[9] President Ruto and his Government, have developed a 10-year agricultural strategy, of which a key component will be investment into climate-resilient practices and solutions. He has also made a push to boost international investment and collaboration to adapt to the climate crisis.[10] However, the nascent Government is yet to make longer term commitments around the use of improved forestry and agricultural practices to build resilience to extreme weather events.

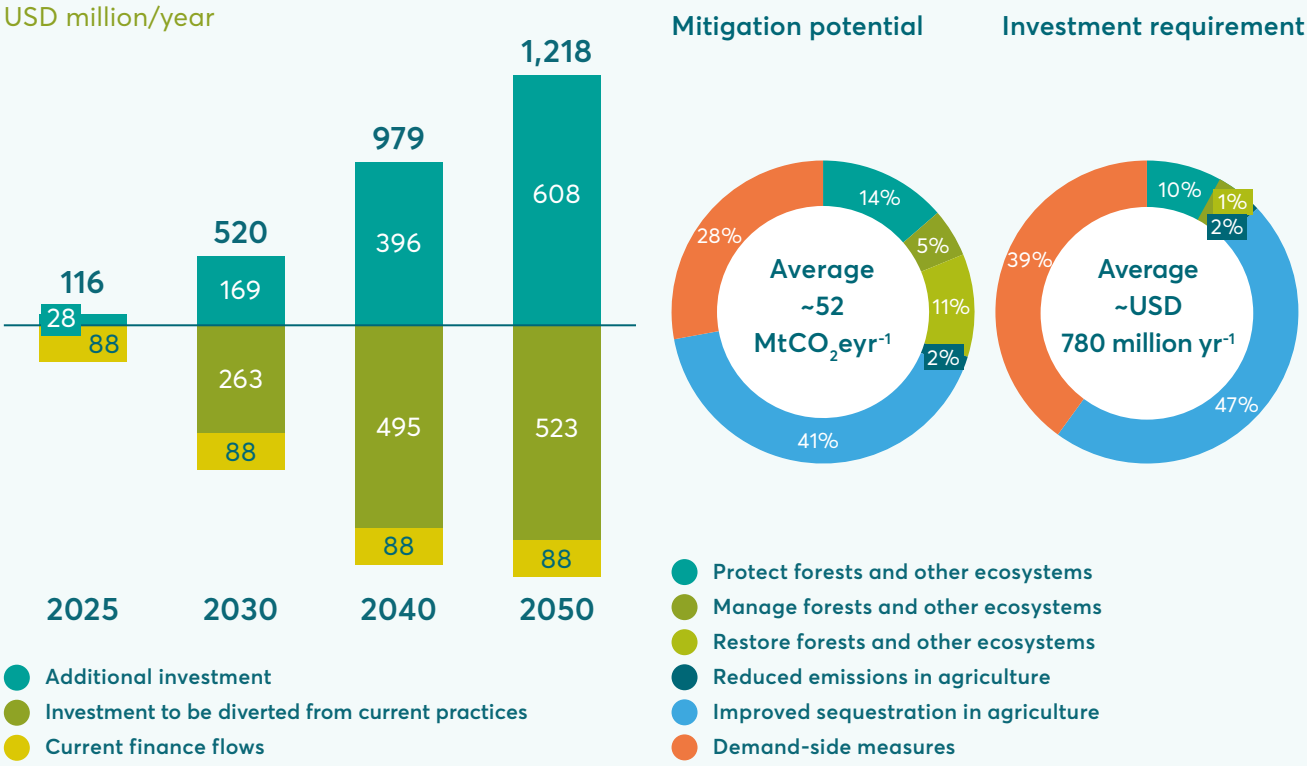
Despite their importance, NbS receive limited funding in Kenya, as well as globally. Less than USD 90 million per year is currently spent on land-based NbS in Kenya – or 0.1% of the Kenyan GDP in 2019. There are several reasons why NbS are underfunded in Kenya despite their increasing policy recognition. For example, public and private sector investors often lack the information to enable them to invest in land-based mitigation, including which concrete programme and jurisdictional-level investment opportunities exist and how to structure investments in nature and sustainable landscapes. Moreover, the rules and dynamics of private carbon markets are complicated and not always easy to navigate. Ultimately, all actors lack the information needed to assess the economic opportunities provided by a sustainable, nature- and climate-positive economy.

There is increasing evidence that NbS are cost-effective solutions that can be deployed today. Solutions which sequester and reduce emissions from agriculture are relatively more costly per tCO_2e than other NbS in Kenya (USD 34 per tCO_2e on average), with the forest and other ecosystem solutions costing far less (USD 5 per tCO_2e on average). Despite higher costs per tCO_2e, agricultural measures tend to be more profitable as they generate higher and faster returns. Some agricultural solutions, such as improved rice cultivation, can generate economic returns immediately, whereas others require more patient capital to yield returns, such as agroforestry which requires time for fruit trees or coffee bushes to mature.

This study estimates that Kenya would require USD 1.2 billion of investment per year by 2050 to unlock the potential of NbS in Kenya (see Figure 2).[iv] This represents an approximately 13-fold increase in total annual finance for NbS by 2050 compared to 2019 finance flows. Agricultural solutions make up half of the total cost between now and 2050, at an average of USD 200 million per annum, but the majority of this investment does not require "new" investment. Over 90% of the finance needed for these solutions could possibly be delivered by re-directing investment that is already going into Kenya's agricultural sector. This is because most of the agricultural solutions require a change in practice (or set of practices) from an existing agricultural model.

[iv] The total investment was calculated using the USD per tonne of carbon dioxide equivalent (USD/tCO_2e) associated with each NbS measure in Kenya as well as the cost-effective mitigation potential summarized in Figure 1 (see methodology document for more information).

Figure 2: *Left:* **investment needed per decade split by existing finance that needs to be augmented or redirected (below the line), and additional finance to be sourced (above the line) in USD million per year.** *Right:* **average percentage split of mitigation potential and investment required by NbS category between 2025-2050.**



Delivering USD 1.2 billion investment by 2050 requires a number of financial instruments – from grant and direct supply chain-finance to equity and debt-instruments. This study has developed a potential investment pathway for how different financing strategies can be deployed over the next three decades to reach Kenya's total investment requirement. The results suggest that while equity, concessional and market-rate debt are projected to make up less than 1% of investments in 2025, they could account for nearly 50% of instruments by 2050. This scaling results from the assumption that NbS business models and revenue streams become more established over time. These could include more innovative business models which create value from standing forests and forest regrowth, such as ecotourism, production of wild forest products or payment for ecosystem services.[11]

Results from the analysis also show that a range of investors have a role to play in financing NbS in Kenya:

- The Government of Kenya, with the support of international development partners, is an important financier (up to USD 240 million per year by 2050, or 1% of GDP), as well as enabler of investment, by crowding in other investors. By investing in a supportive enabling environment, through measures such as policy reform, securing land tenure and engaging with corporates around net zero, the Government could crowd in USD 1 billion of private sector investment (a ratio of roughly 1:4).

- Development finance institutions and philanthropy could provide 10% of the total investment in 2025 and 2050, whilst increasing their investment 10-fold. In the short-term, grant-based investments and concessional financing are projected to be most important whilst the provision of concessional debt becomes increasingly important from 2030 onward. Like the Government of Kenya, these investors could play a key role in creating the pipeline of initiatives necessary to attract interest from private investors.

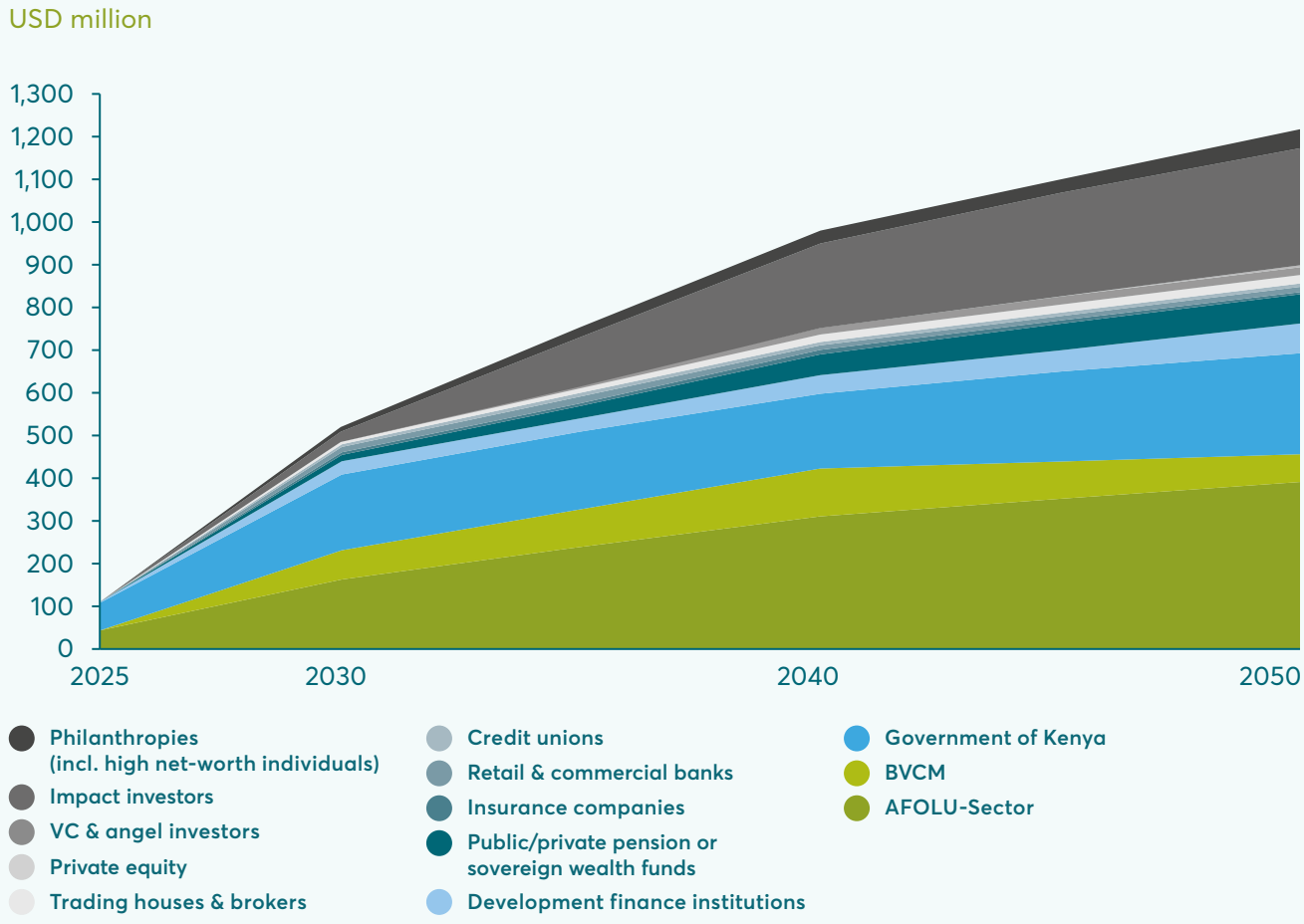
- Domestic and international corporates could make up more than 40% of the investment needed over the course of the transition.

    - Global and domestic Agriculture, Forestry and other Land use (AFOLU)[v] sector companies who have operations and supply chains in Kenya, could invest USD 400 million per year by 2050 but this could increase to over USD 420 million if the sector pays the full cost of aligning their land value-chains with a net zero future. This represents 1.2% and 1.3% respectively of the value add of the AFOLU sector in Kenya today.

    - Over USD 110 million could be financed by 2040 through corporates investing in "Beyond Value-Chain Mitigation" (BVCM), including through the voluntary carbon market (VCM). The VCM is a useful mechanism to improve the commercial case of NbS investments; however, if demand for carbon credits is tied to the volume of unabated emissions then demand for carbon credits would eventually decline as companies transition to net zero.

- Institutional investors including pension and sovereign wealth funds, insurance companies, retail and commercial banks, credit unions, trading houses and brokers, private equity funds, venture capital funds and angel investors, and impact investors could finance nearly 35% of the total investment needed by 2050, compared to a minor contribution today. This reflects the maturation of the business models and revenue streams, as well as increasing ticket sizes, meaning that they are more attractive to investors who require higher returns.

Figure 3: A feasible investment pathway for investing in NbS in Kenya over the next three decades, by investor.



Agricultural solutions, such as enhanced soil organic carbon in grasslands and agroforestry are critical investments in Kenya as they make up 43% of the mitigation potential and 50% of the investment requirement to 2050. There is a significant scaling up of these measures post 2025 with the major investors in these solutions being the Government of Kenya and AFOLU sector corporates. The Government invests more in the early stages of the transition helping to overcome higher establishment costs and the AFOLU sector invests in helping to improve agricultural practices within their value chain.

Although this scenario highlights a potential investment pathway, there are still major barriers to investment that would need to be addressed in order to make this pathway a reality. For instance, the large number of smallholder farmers and pastoral communities in Kenya still face challenges of access to markets and capacity to implement NbS. International investors often perceive the food, nature and land sector in emerging markets like Kenya as high risk, because political, regulatory and currency risks can be elevated and compounded by weaker local capital markets in comparison to markets in high income countries.[12] Overcoming these barriers – from access to market, risk assessment methodologies and beyond – will be key to enabling increased private sector investments into NbS.

Through creating an enabling environment to overcome key barriers to investment, the Government of Kenya can increase the flow of finance towards NbS. Actions include those that require policymakers to develop or reform policy, regulation or incentives, and those that require public spending and investment into activities which will promote NbS investment. Policymakers can incentivize more sustainable behaviours though policy reform and can facilitate sustainable private investment by boosting policies around net zero commitments, compliance and land tenure rights. Policymakers can also play a key role in capacity building and aggregation of initiatives and investments in order to increase the ticket size and thus the supply of investable business models. Investment into technology such as spatial planning and low carbon agri-tech would ease the implementation of these solutions.

Kenya faces an unprecedented opportunity to build a thriving and resilient nature-positive economy through investment into NbS. Critically, this report demonstrates how the Government can lower the investment burden of the public sector in the long term, by crowding in private sector finance for NbS. It is a report for consultation which describes a potential, yet ultimately feasible, investment pathway. As such, the ambition is to inform the Government of Kenya's long-term investment and policy strategy for NbS and to inspire the mobilization of wider investors to deploy a range of financial instruments towards NbS in Kenya and globally.

[v] These companies are referred to as Food, Land use and Agriculture (FLAG) companies in the SBTi guidance for this sector.

Introduction

In 2019, the Food and Land Use Coalition (FOLU) produced a Global Consultation Report, Growing Better: Ten Critical Transitions to Transform Food and Land Use. The report set out why a global transformation of food and land use systems is needed in the next decade, and it provided a vision for a better future along with a proposed reform agenda to achieve it. This action agenda – anchored around ten critical transitions – is necessary to deliver climate mitigation, safeguard biological diversity, ensure healthier diets for all, improve food and nutritional security and create more inclusive and resilient rural economies. FOLU also published People, Health and Nature: A Sub-Saharan African Transformation Agenda in 2019, which highlighted the need and opportunity across the continent to transform food and land use systems.

Nature-based Solutions (NbS) are a critical part of the reform agenda proposed by FOLU globally and across sub-Saharan Africa. NbS are actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.[13] NbS include critical interventions in both marine and land-based ecosystems. In particular, there has been increasing attention on the role that land-based NbS play in mitigating climate change. Recent evidence from Roe et al. (2021) suggests that the implementation of twenty different land-based solutions can provide around 30% of global mitigation needed to deliver the 1.5˚C temperature target, whilst also securing the climate regulation function of the existing land sink.[13] This report focuses on these specific NbS solutions – all of which restore, protect and manage natural ecosystems and shift how food is produced and consumed.[vi]

Nature and agriculture are central to Kenya's economy today. The agriculture sector alone makes up over a quarter of the country's GDP, employs over 40% of the total population[15] and 70% of the rural population.[16] Tourism represents around 11% of Kenya's GDP and 12% of employment and is a growing market, dominated by activities related to its unique flora and fauna.[17] Agricultural land makes up around 50% of total land area, whilst natural forests make up just 6%. Of the agricultural land, 10% receives high rainfall and produces 70% of the agricultural output[18] (mainly tea, coffee, horticulture and key crops such as maize and wheat).[19]

However, Kenya's forests and agricultural land are now severely degraded. Kenya's forests began to be cleared in the early 1970s by the Government, as a means of increasing land area for agriculture and easing population pressure.[9] Since then, deforestation rates have declined due to conservation efforts but still remain concerningly high. This is driven largely by a dependence on wood for fuel and a growing population, which remain the primary cause of deforestation in the country. Further threats to natural forests stem from the increase in trade with countries such as China and India, which whilst providing development opportunities for Kenya, also place high demands on its land.[20] Furthermore, Kenya's agricultural land is now severely degraded and growth in agricultural productivity has slowed in recent years, owing to factors such as unsustainable land practices, rainfall change, pests and disease.[21] This poses risks to food security so, implementing solutions to elevate productivity are a priority.

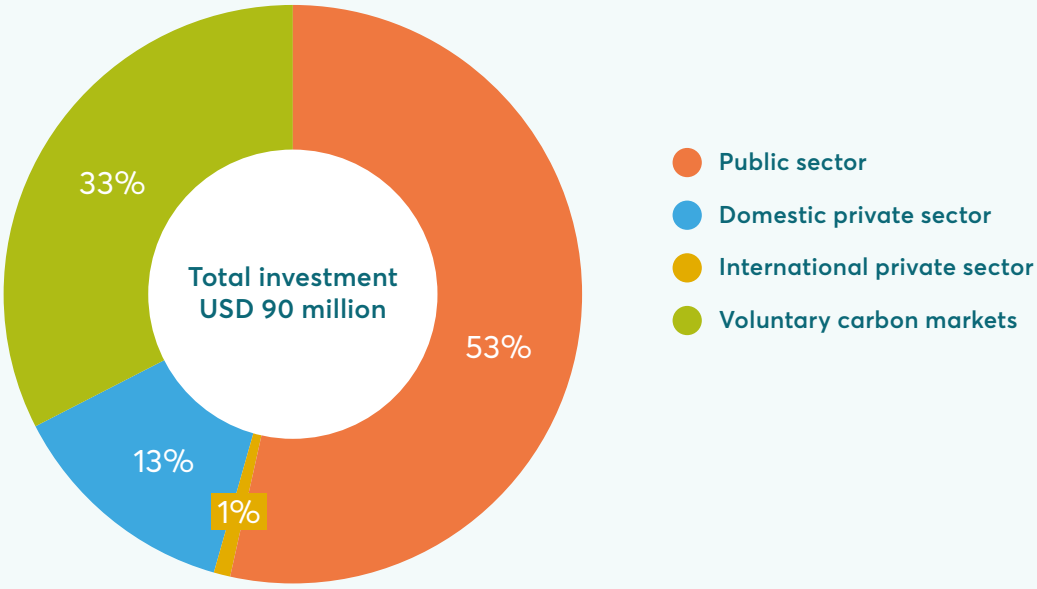
Building a more resilient and prosperous, as well as food- and nutrition-secure economy in Kenya is more important than ever. Recent trends reinforce this need, as evidenced by the COVID-19 pandemic, the cost of living crisis and global supply chain disruptions as a result of international conflict and climate-related disasters. Climate change is already costing Kenya between 2–3% of GDP per year in climate-related disasters, such as droughts and floods; and this figure is likely to increase, putting further pressure on farmers and communities who are already feeling the impacts of more severe droughts, erratic rainfall and increasingly intense heatwaves.[22] Further, the spike in world food prices combined with a recent drought has left 3.5 million people in Kenya in need of humanitarian assistance, intensifying the need to enhance food security and support livelihoods.[23]

[vi] FOLU recognizes that the definition of NbS also includes other measures which help humans to respond to societal challenges, including but not limited to those which deliver climate mitigation in terrestrial, freshwater or marine ecosystems. However, this report specifically focuses on the 20 terrestrial measures defined in Roe et al. 2021, 19 of which are relevant to Kenya. Going forward, any reference to NbS is focused specifically on these 19 measures.

The Government of Kenya has already made significant commitments to support NbS and the president's new strategy supports climate-resilient agricultural solutions. Through its Nationally Determined Contribution (NDC), Kenya has committed to a 32% reduction in greenhouse gas (GHG) emissions by 2030 (compared to projected business as usual emissions). Kenya was also one of the first African countries to develop a National Climate Change Action Plan (NCCAP), which places a large importance on afforestation and reforestation through the commitment to restore 300,000 ha of forest per year by 2030.[24] President Ruto and his Government, have developed a 10-year agricultural strategy which focuses on developing the country through modernizing its agricultural system, of which a key component will be investment into climate-resilient practices and solutions. He has also made a push to boost international investment and collaboration to adapt to the climate crisis.[25] His near-term attention has focused on providing food relief to drought-stricken regions, and has acknowledged the role of climate change in causing this,[26] but is yet to make any longer term commitments as to the use of nature and improved practices to build resilience to extreme weather events.

Despite their importance to Kenya's economy, NbS receive limited funding in Kenya. Less than USD 90 million per year is currently spent on land-based NbS in Kenya, or less than 0.1% of Kenyan GDP in 2019. Over 50% of this finance is from the public sector – both domestic and international – with nearly a third from the voluntary carbon market (VCM) and the remainder coming from the private sector (see Figure 4).[vii] Given that food and land use systems account for over 60% of Kenya's annual greenhouse gas emissions, it is essential that mitigation activities in this sector are funded and implemented.[27] Nevertheless, there are several reasons why NbS finance isn't flowing in Kenya, for example, both public and private sector investors often lack the information to enable them to invest in land-based mitigation, including which concrete programme and jurisdictional-level investment opportunities exist and how to structure investments in nature and sustainable landscapes across Kenya. Moreover, the rules and dynamics of private carbon markets are complicated and not always easy to navigate. Ultimately, all actors lack the information needed to assess the economic opportunities provided by a sustainable, nature- and climate-positive economy.

Figure 4: The breakdown of finance flows into NbS in Kenya by source in 2020



Source: Analysis using data from the Government of Kenya and Climate Focus[28,29]

[vii] Due to data availability issues, particularly for private finance, it is likely that USD 90 million is an underestimate of the current finance flows into NbS; however, it still serves as a useful comparator to understand the scale of increase in finance required.

This report seeks to address the knowledge gap that exists around the investment requirement and possible financing strategies which can be used by both public and private investors to unlock the myriad benefits of NbS in Kenya. As such, the ambition is to inform the Government of Kenya's long-term investment and policy strategy for NbS and to inspire the mobilization of wider investors to deploy a range of financial instruments towards NbS in Kenya and globally.

The report is structured as follows:

- Chapter 1: Summarizes the NbS opportunity in Kenya – including the mitigation potential and analysis of typical costs and revenues associated with NbS business models.
- Chapter 2: Explores financing requirements and strategies for different NbS.
- Chapter 3: Discusses how Kenyan policymakers can help to create a positive enabling environment for investment into NbS in Kenya.
- Chapter 4: Concludes with key recommendations and next steps for scaling NbS investment in Kenya and globally.

What are land-based Nature-based Solutions?

This report refers to 20 specific land-based NbS as defined by Roe et al. 2021.[30]

Implementation of these solutions requires finance to pay for either 1) a change in practice or behaviour (e.g. paying farmers to plant trees on-farm or paying governments to increase incentives for forest protection) or 2) the application of a new or existing technology (e.g. paying for on-farm anaerobic digesters to improve manure management or paying for clean cookstoves to reduce deforestation linked to demand for wood fuel).

There are opportunities for generating positive return on these investments. These business models can broadly be categorized as follows:

1. Cost savings or efficiency gains: e.g. increasing input efficiency can result in less input use, cost savings and increased profitability.[viii]

2. Growth of existing markets: e.g. integrating agroforestry into coffee production systems can generate opportunities for price premiums or increased demand associated with the sustainability attributes of commodities.

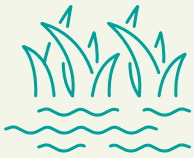
3. New goods or services: e.g. sale of wild forest honey which was previously not harvested.

4. New revenue streams: e.g. generating payment for ecosystem services through frameworks such as Reducing Emissions from Deforestation and Forest Degradation (REDD+).

There are also business opportunities linked to the enabling environment needed for investment into NbS, for example monitoring technology needed to verify reduced deforestation and the validity of associated carbon credits.

The table below defines each of the 20 solutions that are considered within this report and gives examples of relevant business models. It draws on FOLU's previous work in Prosperous Forests, a report which demonstrates that innovative forest business models not only exist across the tropical belt, but also hold significant latent potential. It also uses the Blended Finance Taskforce's Better Finance, Better Food report which showcases a broad range of investable land-based NbS opportunities.[31]

[viii] Impacts on yields under changing conditions have not been assessed as these are too context-specific.

	NbS name and category	Definition:	Overview of types of business models:
Protecting forests and other ecosystems	**Reduce deforestation** 	This solution seeks to avoid emissions that would have otherwise occurred as a result of deforestation (where tree cover falls below 30% of the area). Commodity-driven agriculture in tropical regions – including the production of soy, palm oil, timber, cattle, rubber and cocoa –is a major driver of deforestation.	Finance for forest protection pays for the opportunity cost associated with not converting forests into other land use types, e.g. agricultural land for growing high value commodities such as palm oil. Finance can be generated through payment for ecosystem services models such as the framework for Reducing Emissions from Deforestation and Forest Degradation (REDD+) where communities, land managers and jurisdictions are compensated for actions that reduce or remove forest carbon emissions.[x] Revenue can then be generated through the sale of carbon credits.[32] Other business models include wild forest production (honey, nuts, pharmaceutical products) and ecotourism.
	Reduce mangrove loss 	This solution seeks to avoid emissions that would otherwise have occurred as a result of degradation of mangroves. Major drivers of mangrove degradation include shrimp farming and deforestation for mangrove poles.	As with reduce deforestation, finance is needed to pay for the opportunity cost associated with an alternative use of that land, e.g. shrimp farming. As above, revenue can be generated through carbon credits or other ecosystem service models. One successful example of a regenerative mangrove business model is Selva Shrimp, a company which raises black tiger prawns naturally in the mangrove forests of south-east Asia. They are sold at a premium as they have been produced without chemicals and in a natural environment. Investors and farmers share in the profits, incentivizing shrimp farmers to maintain the mangrove forests through this proxy payment for the mangrove ecosystem services.[33,34,35]
	Reduce peatland degradation and conversion 	This solution involves avoiding greenhouse gas emissions through the protection of intact peatlands.	Similar to the other protection activities, finance is required to cover opportunity costs that come from alternative land uses, such as farming. Finance is also needed for activities that limit degradation, such as community engagement, monitoring of water levels and increased fire management. Revenues can be generated through the sale of carbon credits, eco-tourism or through paludiculture (cultivation on wet peatlands) which can produce valuable materials such as eco-friendly insulation made from endemic peatland crops such as cattails.[36]

NbS name and category		Definition:	Overview of types of business models:
Managing forests and other ecosystems	**Improve forest management** 	Improved forest management involves managing both natural and forest plantations to avoid carbon emissions and to increase carbon sequestration within these forested areas.	Finance is needed for development of new initiatives focused on sustainable management of forest plantations and to help existing initiatives to transition to more sustainable practices such as reduced impact logging, extended harvest rotations and designation of protected areas. Revenue can be generated through the sale of carbon credits, and forest products such as resins, nuts and timber.[37] Producing sustainable timber and then certifying it under the Forest Stewardship Council (FSC) initiative can attract price premiums, further increasing revenues.
	Grassland fire management 	This solution aims to avoid emissions from fires in grasslands. For example, starting early-season fires when there is less organic matter, emits fewer emissions compared to late-season fires.	Finance is needed primarily for training and labour associated with fire management, alongside necessary technologies such as helicopters and remote sensing technologies to monitor and track the extent of the fires.[38,39] The reduced emissions from the landscape can generate revenues through the sale of carbon credits. Farmers also benefit from reduced damage caused by uncontrolled wildfires, and so a reduction in associated cost – fires can destroy pastures, fences, buildings and livestock, all of which need to be repaired or replaced.
Restoring forests and other ecosystems	**Afforestation and reforestation** 	This solution enhances carbon sequestration of degraded land by planting trees to shift it from non-forest to forest cover (i.e. above 30% tree cover). A/R which mimics natural ecosystems and uses species suited to specific environmental conditions can stimulate environmental and economic productivity.	The majority of the financing need is required to purchase and plant seedling trees. Revenue can be generated through carbon credits or through models which maximize productivity, using a broad mix of native seeds but focusing on species from which a commercial revenue can be derived, such as sugar palm or rubber. Such near-natural "forests with a cash flow" have yet to be planted on a large scale but may expand rapidly because of the revenue streams and rich ecosystem services they could deliver.[40]
	Coastal wetland restoration 	This solution increases the carbon sequestration of degraded coastlines by replanting mangroves.	Finance is required to plant mangrove shrubs and to ensure their long-term survival, for example funding the labour and monitoring associated with regulating fishing quotas, restricting certain activities and managing conservation zones.[41] Return on investment can be generated through enhanced fish stocks, medicine and ecotourism.
	Peatland restoration 	Peatland restoration involves avoiding emissions by re-wetting degraded peatlands to restore the natural water flow and saturation level.	Finance is needed to re-wet peatlands through the creation of canals, wells and planting of natives species to restore and maintain water table levels.[42] The Sumatra Merang peatland initiative in Indonesia generates revenue through the sale of carbon credits linked to peatland restoration, alongside delivering sustainable livelihoods for local communities through fishing and smallholder cropping of native species.[43]

NbS name and category		Definition:	Overview of types of business models:
Reducing emissions in agriculture	**Reduce enteric fermentation** 	This solution seeks to reduce methane emissions resulting from livestock digestion. This could be done through changing feed and grazing strategies.	Helping farmers transition to new feed practices can save costs and drive revenues . Feed strategies such as "balanced feeding", which helps overcome mineral deficiencies in the soil, enhances milk production by improving the nutritional quality of the livestock's diet.[44] Investors could generate returns through profit-sharing mechanisms linked to the increased profit from the milk production.
	Manure management 	This involves the use of technologies such as anaerobic digesters to reduce the CH4 and N_2O emissions associated with livestock manure.	Costs for manure management are driven by the price of anaerobic digesters, with this being a major upfront investment. However the digesters can be used to extract methane from manure, producing sustainable biogas that can then be used to produce energy and can be a source of revenue or an on-farm cost saving.[45] Alongside the use of digesters, companies such as Newtrient are converting manure into pelletized fertilizer for use on farm or for sale to market. Pelletized fertilizers are not yet cost-competitive with traditional fertilizers, but this may change in the future, potentially enhancing the revenue stream for investors in this solution.[46]
	Nutrient management 	Nutrient management involves changes in fertilizer application and management practices to reduce CH_4 and N_2O emissions associated with fertilizer application.	Finance is required for educating farmers on new practices or for technology that allows for more precise nitrogen application on farms. If implemented effectively these initiatives will result in significant cost savings, increasing farm profitability. This is especially relevant given the significant global rise in fertilizer prices that have been seen recently.
	Improve rice cultivation 	This solution involves sustainably managing rice production to avoid C_H4 and N_2O emissions, such as improved water and fertilizer management.	Finance is required for training farmers on new management techniques such as lower input rice farming or alternate wetting and drying. Rice education programmes in Thailand have been shown to increase farmers' net-income by 26% on average. Profit-sharing mechanisms could help financiers generate returns on their investment.[47]

NbS name and category		Definition:	Overview of types of business models:
Soil carbon sequestration in agriculture	**Agroforestry** 	This solution involves increasing the carbon sequestration of farmland by integrating trees into production practices.	Upfront financing is needed to establish trees on farms, but this investment can generate a variety of revenue streams. Additional income streams from agroforestry include from fruit, nuts and timber. These commodities may generate price premiums linked to their sustainability attributes – for example one study showed that coffee integrated with agroforests can command a price premium of 36% more than traditional coffee.[48] The income diversification also drives on-farm resilience making famers and investors less vulnerable to external shocks such as increased temperatures.
	Application of biochar from crop residues 	Biochar is created through the pyrolysis of biomass. It can then be added to farmland to increase the inorganic carbon content in the soil. Inorganic carbon is much more stable than its organic counterpart and persists over longer timescales.	Finance is required to help farmers purchase and apply biochar onto their farm. In most cases this is a one-off cost, however some initiatives support small applications each year.[49] In Belize, carbon investment has helped cacao farmers turn their agricultural waste into biochar; they are paid USD 75 for every tonne of biochar they produce and apply to their soils.[50] Farmers also benefit from the increased yield associated with biochar applications,[51] and this solution may soon generate carbon revenues too.[52]
	Enhance soil organic carbon in croplands[ix] 	This solution involves enhancing soil carbon sequestration in croplands by shifting from current practices to no-till management and cover-cropping.	Implementation of no-tillage farming will require farmer training and investment in new technologies which require upfront financing. These investments can be recouped in the long-term as there is a reduction in fertilizer use, in time spent tilling (freeing up labour hours) and in diesel, repair and equipment costs on larger, more mechanized farms.[53] Case studies show that no-till corn and soybean can be more profitable than conventional practices.[54]
	Enhance soil organic carbon in grasslands 	This solution involves enhancing soil carbon sequestration in pastureland by transitioning to more sustainable management and grazing practices.	Finance will be required to help farmers transition their pastureland management strategies to include rotational grazing, improved feed management and pastureland rehabilitation. Rotational grazing typically has higher establishment costs than conventional grazing (due to the need for fencing and water systems), but offer long-term economic benefits, including healthier herds, which results in fewer veterinary expenses; reduced maintenance and fertilizer costs; and greater pasture productivity.[55] Farmers can generate carbon credits associated with improved sequestration and can increase profits from increased livestock sales.

	NbS name and category	Definition:	Overview of types of business models:
Energy	**Bioenergy with carbon capture and storage (BECCS)[a]** 	BECCS involves capturing and storing the carbon that is generated through the combustion of biomass for electricity generation.	BECCS is a nascent technology and therefore current investment is required to establish and operate trial BECCS-based power plants. There is a direct revenue stream from the sale of electricity or products and possibly additionally through carbon payments.[56] For example, a plant currently operating in Illinois captures the emissions released from fermenting corn to ethanol and geologically stores it in the underlying sandstone formation.[57]
Demand side	**Increase use of clean cookstoves** 	This solution involves avoiding emissions through the introduction of more efficient cookstoves which require less fuelwood, leading to less pressure on forests for wood for cooking and heating.	Investment is required to purchase and distribute cookstoves. These stoves are proving to be a cost-saving solution for households as efficient stoves reduce the need to purchase fuel, as well as reducing the health risks associated with indoor air pollution.[58] Additional revenue could come from the sale of the stoves or from carbon credits, global sales of which generated USD 11 million in 2020.[59]
	Reduce food loss and waste 	This solution avoids emissions from the production of food that is wasted (i.e. not consumed) and emissions from decomposition through the implementation of measures such as improved storage and those which change consumer awareness.	Investment in this solution could be targeted across the value chain, from educational campaigns to limit household waste to refrigeration technologies at a farm-level to reduce food loss. Tackling food waste in consumption drives cost savings for households and businesses,[60] whilst addressing food lost in production increases the volume of food sold, improving incomes.[61,62] Other potential business models include obtaining value from the food, such as through the production of bioenergy,[63] and the global cold-storage market is expected to reach over USD 330bn in value by 2030.[64]
	Shift to healthy and sustainable diets 	This solution involves reducing emissions from diverted agricultural production by adopting sustainable healthy diets (not including emissions from land use change).	Investment into this solution could help fund public policy campaigns that encourage dietary shifts, improving meals in public procurement or developing animal protein alternatives. Health related cost savings can be large and revenues can come from sale of meat alternatives – which by some estimates could become a market worth over USD 250bn by 2030 (from USD 3bn in 2020).[65]

[ix] The authors acknowledge the impact of agricultural practices on soil carbon sequestration potential is highly context specific, varying with for example, climate conditions, soil type/ management, crop species and management intensity. It is important to also consider the spatial and temporal limitations of assuming soil carbon sequestration can lead to climate change mitigation because a) there remains questions around the permanence of soil carbon sequestration, b) leakage can occur, for example where agricultural practices increasing soil carbon sequestration in one place may result in lower yields leading to agricultural expansion and carbon losses off-farm or c) where practices increasing soil carbon sequestration may increase at the same time increase other damaging GHG emissions such as CH_4 or N_2O.

[a] NbS not considered in the Kenya case.

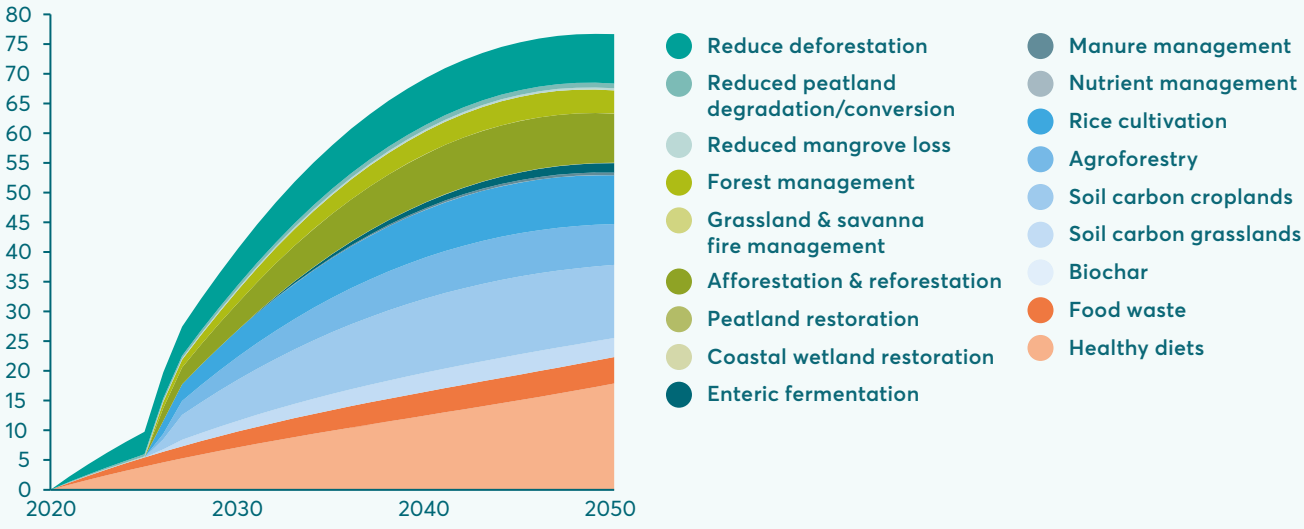
Chapter 1: The Nature-based Solutions opportunity in Kenya

This chapter provides a summary of the mitigation potential of different NbS in Kenya and presents some emerging evidence as to the other benefits they provide in terms of food and nutrition security, health, biodiversity and resilience. It also summarizes the cost and revenue profiles associated with different NbS business models.

NbS can provide an important path to a low-carbon, prosperous, food secure, healthy and resilient future in Kenya. For instance, estimates show that Kenya can cost-effectively mitigate 80 million tonnes of carbon dioxide equivalent ($MtCO_2e$) per year by 2050 through implementing a suite of NbS to 2050.[x] This equates to 41 $MtCO_2e$ by 2030, which exceeds the NDC emissions reductions related to agriculture and forestry ($23MtCO_2e$)[66] and implies that Kenya could look to exceed this target using NbS and further cement itself as a climate leader in Sub-Saharan Africa.

Agricultural solutions, such as enhancing soil organic carbon sequestration in grasslands and in croplands as well as agroforestry have the highest mitigation potential, but other demand-side interventions are also needed in Kenya. Protecting and restoring forests and other ecosystems are important, but agricultural solutions make up the largest share at 40% of Kenya's climate mitigation potential across the 30 years from 2020–2050. Based upon Roe et al. (2019) analysis, there is a significant scaling up of agricultural solutions post 2025.[67] Demand-side solutions such as shifting to sustainable, healthy diets and reducing food loss and waste, which combined make up nearly 30% of the climate potential across the timeline, are also important. Figure 5 shows the growth of annual cost-effective mitigation potential for each of the 19 identified solutions over the next three decades in Kenya (where "cost effective" is defined as costing less than USD 100 per tCO_2e and excluding clean cookstoves and BECCS to avoid double counting). Roe et al. (2021) find that of the 20 land-based solutions, in Kenya there is no cost-effective mitigation potential for BECCS which is also why this solution is not included in Figure 5.

Figure 5: Estimated cost-effective mitigation potential per NbS measure from 2020 to 2050 ($MtCO_2e$ per year).[xi]



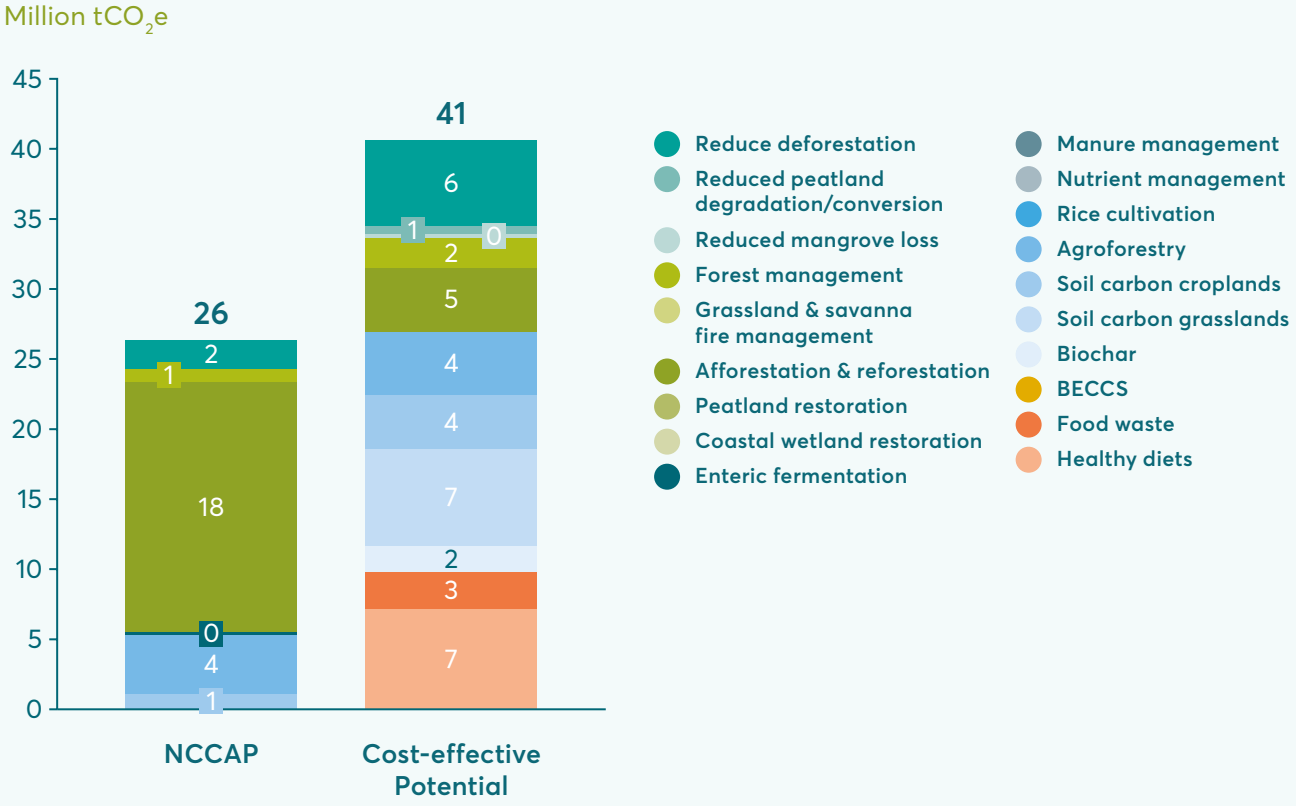
[x] Cost-effective mitigation potential is mitigation which can be achieved for less than USD 100 per tonne CO_2e (Roe et al., 2021). The total mitigation per year by 2050 was calculated by applying the mitigation potential scale-up between 2020 and 2050 detailed in Roe at al. (2019) to the average cost-effective mitigation potential for Kenya identified in Roe at al. (2021).

[xi] Clean cookstoves and BECCs are not included within the total mitigation as they may lead to double counting with reduce deforestation (cookstoves) and afforestation and reforestation or biochar (BECCs).

Beyond climate mitigation, there is increasing evidence – globally and in Kenya – that these same 20 solutions can deliver benefits for food and nutrition security, health, climate resilience and biodiversity. For example, intercropping maize with napier grass and desmodium in Western Kenya has been demonstrated to double maize yields due to increased nutrient efficiency. This style of intercropping known as a "push-pull" system has also been shown to result in an 80% reduction in stemborer moth infestations in maize crops, which can cause significant damage to yields.[68] Further existing evidence related to the benefits NbS can provide for health, biodiversity, resilience and food and nutrition security can be found on page 26. More research needs to be undertaken to quantify and verify the benefits of NbS in different Kenyan biomes as many of the wider benefits have still only been assessed qualitatively or in other local contexts.

Evidence suggests Kenya's National Climate Change Action Plan (NCCAP) could be underestimating the potential climate benefits NbS can provide. Kenya was one of the first African countries to implement such a plan.[69] This plan assumes that by 2030, NbS will be able to mitigate 26 $MtCO_2e$, of which 70% would come from afforestation and reforestation. Figure 6 compares the mitigation potential of the NCCAP to the estimates used in this analysis from Roe et al. (2021). The analysis suggests Kenya could achieve a more ambitious emissions reduction target, reaching 41 $MtCO_2e$ mitigated per year by 2030 based on a wider selection of NbS, such as the inclusion of demand-side solutions. It is also less reliant on mitigation from afforestation and reforestation, which could imply that the 18 $MtCO_2e$ identified in the NCCAP may not be able to be delivered cost-effectively (at less than USD 100 / tCO_2e).

Figure 6: 2030 NbS mitigation potential identified in Kenya's NCCAP, compared to the cost-effective mitigation potential suggested by Roe et al. (2021), split by solution.



NbS can unlock a plethora of core benefits, but if they are poorly implemented they can cause harm, therefore mitigating these risks is vital. For instance, afforestation and reforestation initiatives that involve non-native species can harm local biodiversity, degrade soils and can use too much water, putting pressure on local communities.[70] Further, NbS implemented without active consultation from the community they are embedded within may exacerbate inequality or harm economic opportunities by restricting access to what was once common pool resources.[71] Application of guardrails ensures that NbS are implemented to the highest standard, maximizing core-benefits whilst mitigating risks of unintended consequences. As such, they should be considered throughout the planning, designing, managing and implementing stages of NbS.

1. Provide a net-gain to biodiversity by considering local ecology – NbS should support and/or enhance biodiversity in an ecosystem, using native species that complement the local ecology. Supporting these areas to deliver vital ecosystem services in both the short and long-term.

2. Inclusive and empowering governance and implementation process – NbS should be designed, implemented, managed and monitored with indigenous and local communities. Through a process that respects local circumstances, facilitates local benefits and considers the diversity and pre-existing challenges that exist in an area.

3. Mainstreamed within an appropriate jurisdictional context – NbS interventions should be designed to take account of, work with and align with sectoral, national and other policy frameworks. Helping to create an environment where government and non-government players are aligned, and actors throughout the system are helping to enhance and facilitate a policy environment that is conducive to effective NbS implementation.

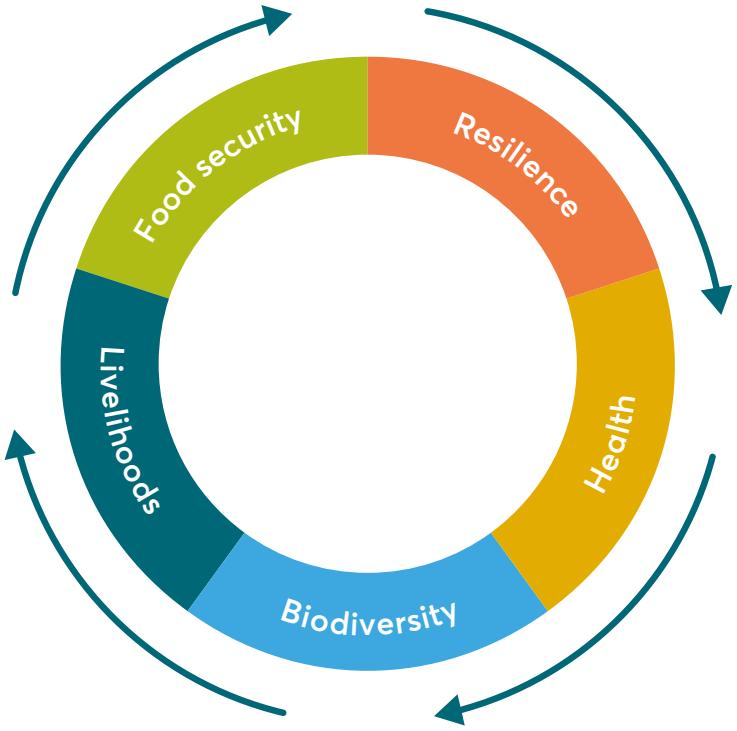
4. Do not substitute action to phase out fossil fuels – NbS should be implemented alongside a suite of other mitigation efforts, understanding that a rapid phase-out of fossil fuels is required and climate change will negatively affect the carbon balance of many ecosystems, potentially reducing their carbon sequestration ability and turning carbon sinks into carbon sources.

These four guidelines do not constitute an exhaustive list but serve to give an indication of the considerations stakeholders need to bear in mind when designing and implementing NbS.[xii] Certain solutions and actors will have to take the guidelines into varying degrees of consideration. For instance, REDD+ reduce deforestation initiatives will have to consider guideline 3 more, due to the significant advantages of jurisdictional approaches.[xiii]

[xii] For further information on NbS guardrails see work by WRI (https://www.wri.org/insights/guidance-voluntary-use-nature-based-solution-carbon-credits-through-2040), IUCN (https://www.iucn.org/resources/issues-brief/ensuring-effective-nature-based-solutions) and Nature-based Solutions Initiative (https://nbsguidelines.info/)

[xiii] For more information on the benefits of jurisdictional REDD+ approaches, see WRI paper on this topic (https://www.wri.org/insights/insider-4-reasons-why-jurisdictional-approach-redd-crediting-superior-project-based)

Examples of NbS benefits in Kenya



Food Security

Food security is the ability to have consistent physical and economic access to nutritious and healthy foods.[72] Research has demonstrated that agricultural practices which integrate NbS have positive impacts on food security, in some cases increasing productivity for both livestock and crop-based products as well as producing more nutritionally diverse food. These solutions can also increase resilience to external shocks, helping to maintain food security during crisis. For instance, increased farmland biodiversity can reduce harm from pests. Avoiding deforestation also supports agricultural productivity and thus food security due to the ecosystem services provided by forests, e.g. by supporting the water cycles, reducing soil erosion and flooding.[73]

Examples of NbS benefits to food security in Kenya and East Africa

Agroforestry-based coffee plots have been shown to produce over 1 million calories per hectare per year more than non-agroforestry-based coffee plots in Ethiopia, due to the increased calories that the fruit trees produce. These mango, banana and papaya trees also help provide farmers with vital sources of micronutrients.[74]

Soil carbon natural reseeding on pastureland involves regrowing natural grasses on degraded land through targeted reseeding. In Kenya, this has been shown to increase cow and goat milk yields by 35% and 66% respectively. This is caused by the increased quality of the feed and forage that livestock are fed.[75]

Intercropping in agricultural land has been shown to double maize yields in parts of Western Kenya due to increased nutrient efficiency.[76]

Livelihoods

Livelihoods are defined as the capability for generating incomes and securing a means of living.[77] Many of the agricultural NbS, when implemented effectively, have been shown to increase farm profitability whilst enhancing economic resilience, helping to drive long-term sustainable incomes. This often occurs due to the lower costs associated with decreased inputs.[78] However, in some instances, farmers and land-managers may have to overcome a period of lower profitability while their businesses adjust to the new conditions, such as in the establishment phase of an agroforestry initiative or while soil fertility recovers when reducing nutrient inputs. Initiatives vary significantly based upon location, and neighbouring initiatives often show widely different results. More research is required to further understand these differences and to identify ways in which all agricultural solutions can be implemented In a way that drives long-term and sustainable livelihoods for all farmers.

Examples of NbS benefits to livelihoods

Sustainable intensification of rice farming in Ghana has been shown to be more profitable by USD 345 per ha per year than traditional rice farming due to lower costs from inputs.[79]

Switching to more sustainable Forest Stewardship Council (FSC) certified forestry production has been shown to drive profitability in tropical countries. This is due to price premiums, increased efficiency and other financial incentives, with the decision to pursue FSC certification having a positive NPV of USD 25.34 per m^3 of production.[80]

A 2021 global study found that site-specific nutrient management that uses targeted application of nitrogen fertilizer on maize, rice and wheat farms, reduced fertilizer use by 10% whilst increasing grain yield by 12% and profitability by 15%. If this study was to be replicated today the increase in profitability would likely be higher given the significant global rise in fertilizer prices.[81]

Resilience

Climate resilience is the ability for a system to effectively anticipate, absorb, accommodate and recover from hazardous events.[82] Evidence suggests NbS can drive resilience, due to their ability to reduce temperatures through the biophysical cooling effect of forest ecosystems, maintain water and soil integrity, and enhance farmland crop diversity.[83] Examples include: agroforestry systems which can reduce temperatures through tree shade and increase water infiltration and soil health through tree roots.[84] The diversity of crops on these farms also helps to limit the damage that may come from one crop failing.[85]

Examples of NbS benefits to resilience

Rotational grazing has been shown to increase household's resilience to shocks more than access to credit, participation in local governance institutions and owning the land in West Pokot, Kenya.[86] This is because, by allowing the pastureland to naturally regenerate, you are increasing the quantity of high-quality feed available to livestock throughout the year, ensuring that the animals are well fed even during times of stress.

In Ethiopia, shading from trees on agroforestry plots has shown to reduce both the soil and farmland air temperatures by 5% and midday temperatures are 6˚C cooler under a canopy of faidherbida trees in comparison to open fields.[87]

In the USA, research has found that farms using rotational grazing practices have 30% higher water infiltration rates than farms using traditional grazing methods.[88]

Health

Certain solutions have clear and quantified direct health benefits. An example of this is the reduction in indoor air pollution for households when they transition to clean cookstoves.[89] More needs to be done to quantify this in the Kenyan context.[90]

Examples of NbS benefits to health

Solutions such as implementing clean cookstoves can help save lives in Kenya as they help to reduce indoor air pollution. Currently over 23,000 Kenyans die from air pollution in the home, with much of this being caused by traditional cooking methods.[91]

In Sub-Saharan Africa, 50% of fruits and vegetables are lost in the post-harvest stages. This plays out in Kenya where the aggregated loss of mangoes between the farm to market is about 45%. Kenyans eat too few fruit and vegetables in comparison to dietary guidelines and the micronutrients present in these products are vital to ensuring healthy communities.[92]

In Malawi, intercropping maize with legumes, alongside the implementation of educational measures, has been associated with increased height and weight in children under the age of 6 in comparison to solemaize cropping, with the legumes providing a valuable protein source for the children and livestock.[93]

Biodiversity

Biodiversity is the variability of all living organisms from all sources.[94] Solutions that protect ecosystems have clear and well understood biodiversity benefits as they are conserving high biodiversity-value intact ecosystems and the species that rely on them.[95] The biodiversity impact of the restoration of ecosystems through solutions such as afforestation and reforestation, and restoring mangroves is highly dependent on whether the projects are implemented with native species and if they consider the local ecology of an area.[96] Agricultural solutions can have significant effect on farmland biodiversity by helping to create, maintain and strengthen ecological niches for a variety of species.[97] However, more research is required in Kenya to fully understand the relationship between agricultural NbS and overall biodiversity. Finally, the controversies around BECCS and biodiversity still need to be clarified, this debate has not been touched upon here though due to the lack of mitigation potential for BECCS in Kenya, according to Roe et al. (2021).

Examples of NbS benefits to biodiversity

83 species of fish and crustacean live within the mangroves on the East coast of Kenya. Protecting and restoring these mangrove ecosystems will help ensure the long-term survival of many of these species.[98]

A study on agroforestry systems near Mount Kenya found that there was a positive correlation between the total number of trees on a farm and the number of farmland mammals, birds, amphibians and reptiles.[99]

Kenya's coastal forests have been labelled as a biodiversity hotspot of global importance. They contain IUCN defined critically endangered species including the Aders' duiker. Reducing deforestation would help maintain the integrity of this important ecosystem.[100]

Methods summary to select NbS costs in Kenya

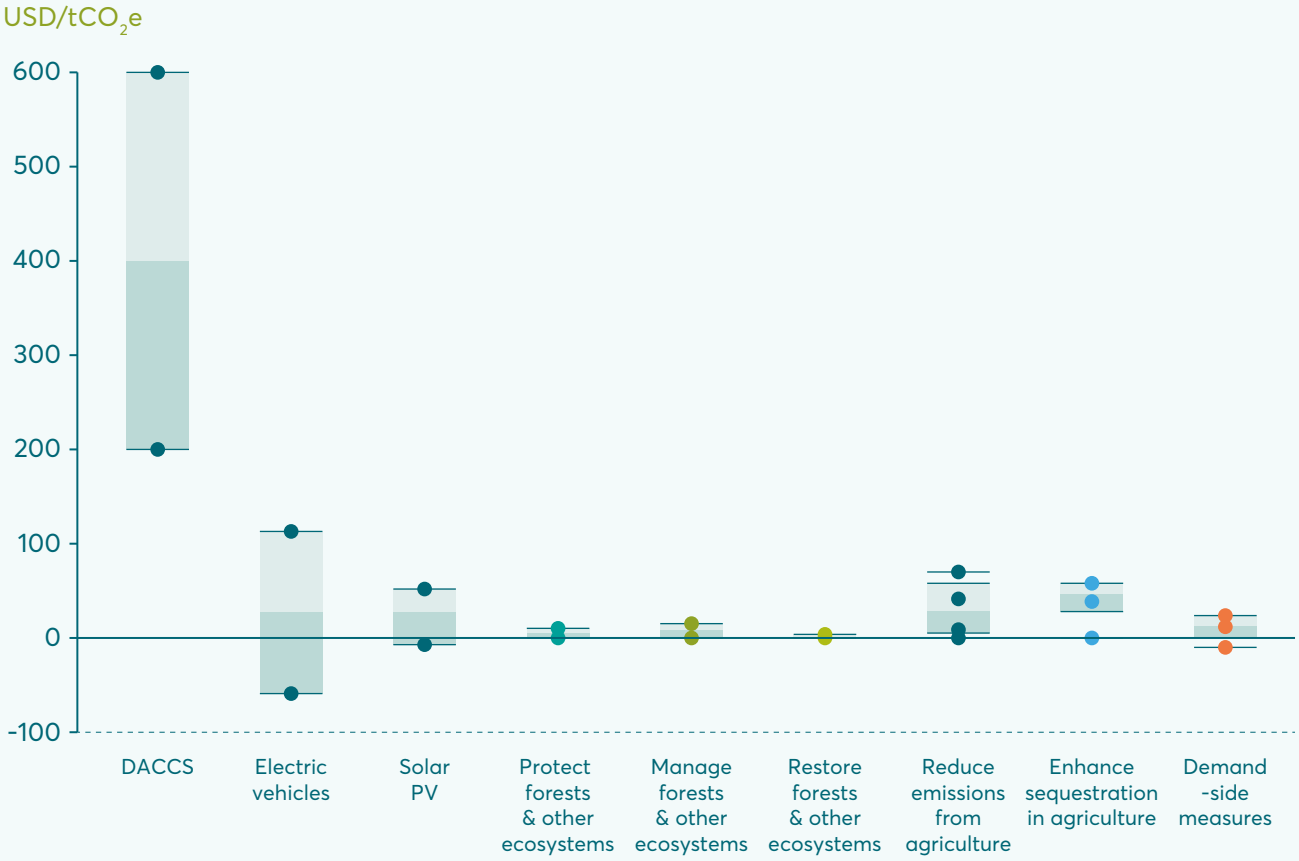
Cost and revenues (in USD per tCO_2e) of NbS initiatives were estimated for the case of Kenya through literature review and collection of cost and revenue data from implemented initiatives, as well as projected costs and revenues from the investment business cases of projects yet to be implemented. A brief summary of this approach:

- Costs have been adjusted to 2020 values and comprise: transaction, establishment, enabling, operational and opportunity costs.
- Revenue data was also collected when it was available. In some cases, proxy data has been used, e.g. to estimate revenue from carbon credits.
- Initiatives and costs are specific to Kenya where possible, but in a number of instances initiatives and data from other countries have been used as a proxy. This is a limitation of the study and an area for future work.
- Costs reflect the forest or farm-level costs incurred when setting up an initiative and omit additional costs related to a certain form of investment, such as Measurement, Reporting and Verification (MRV) costs for carbon finance.
- Opportunity costs have been calculated by considering the profits generated through production of the key commodity driver of habitat destruction in Kenya. For example, the loss in profits from choosing to protect forests rather than using the land for unsustainable timber productions has been used for the opportunity cost for reducing deforestation.
- For the agricultural solutions, costs of NbS practices have been compared to typical business as usual (BAU) agriculture or forestry, in order to understand what the additional cost or cost savings are over and above the costs being paid today.
- Of the 20 NbS only 19 are pertinent in the case of our analysis in Kenya, as BECCS has no cost-effective mitigation potential identified by Roe et al. (2021).

For more detail on this methodology and the costs selected for use in this analysis, please refer to the accompanying methodology document.

NbS are cost-effective solutions that can be deployed in Kenya today. Implementing these solutions will cost less than USD 70 per tonne of CO_2e on average across all solutions, based on the underlying analysis of NbS costs in Kenya. While non-nature related mitigation solutions can attract a lot of attention, NbS can achieve significant emissions reductions and removals, often for a lower cost per tonne of CO_2e. As seen in Figure 7, compared to generic estimates for Direct Air Carbon Capture and Storage (DACCS),[101] electric vehicles[102] and solar photovoltaic (PV) energy,[103] which can cost up to USD 600, USD 110 and USD 50 per tCO_2e respectively, NbS are typically more cost-effective and a highly competitive means of deploying climate mitigation technologies. In this pivotal decade in which we need to halve emissions,[104] actions that can tackle emissions immediately are essential.

Figure 7: Range of annual carbon abatement costs per NbS category compared to global opportunities in other sectors (USD per tCO_2e).[xiv]



Source: Various sources compiled as part of this analysis. Please refer to the annex for all sources.

Reducing emissions from agriculture is relatively more costly per tCO_2e than other NbS, with the forest and other ecosystem solutions costing far less than other solutions. Forest and other ecosystem solutions are comparatively low cost, with reducing mangrove loss costing under USD 7 per tCO_2e. Some solutions, such as improved rice cultivation can deliver cost savings compared to conventional practices.

Despite higher costs per tCO_2e, agricultural solutions in this analysis tend to be more profitable as they generate higher and faster returns. Some agricultural solutions, such as improved rice cultivation, can generate economic returns immediately, whereas others require more patient capital to yield returns, such as agroforestry which requires time for fruit trees or coffee bushes to mature. Some solutions in forest and other ecosystems don't yield traditional returns in markets today, and so may need to look to solutions such as carbon markets to attract investment from a wider range of investors. More innovative business models are also emerging, such as those which create value from standing forests and forest regrowth, such as ecotourism, production of wild forest products or payment for ecosystem services (as described in FOLU's 2019 paper Prosperous Forests).[105] This distinction is important to understand the profitability and overall business model associated with each NbS. This is particularly relevant for traditional institutional investors, i.e. those that require more immediate financial returns and who have thus far struggled to identify their role in this transition.

Afforestation and reforestation and enhancing soil organic carbon in grasslands are two of the most important mitigation activities in Kenya. Their business models are very different and thus require distinct financing strategies. Case studies on the initiative-level economics can be found below.

[xiv] Negative costs refer to cost savings.

Case study 1: An example of an enhanced soil organic carbon grasslands initiative in Kenya[xv]

This initiative, based in the southern rangelands of Kenya near the border of Tanzania, is an effort to reverse the degradation of the area's arid and semi-arid land. The goal is to restore the productivity of this land alongside increasing the carbon sequestration potential of the soil. In Kenya 88% of the land is defined as arid or semi-arid and these areas, that are vital for livestock production systems, have faced significant degradation pressures, from climate change, overgrazing and other factors.[106] This case study is based on a real life initiative that explored the economic potential of reseeding technology to rehabilitate degraded pastureland and to help farmers. Four endemic grass species were used in this instance to reseed the degraded pastureland. This reseeding enables the local grass species to regrow on previously degraded land, helping to increase the soil organic carbon levels of the pastureland. It also reduces soil erosion, and provides high-quality fodder for cattle and goats, helping to drive revenue through increased milk productivity.[107] Additional revenue sources include those from the hay and seeds eventually produced from the planted grasses.

This initiative serves as an archetypal example of an enhancing soil organic carbon effort in Kenya, although it is not the only model that exists (see more information in the accompanying methodology document on how archetypes are used in this analysis). Typical cost profiles of initiatives like this one and revenue sources needed to incentivize pastureland rehabilitation are discussed below. This is based on a real initiative but is supplemented with additional data and assumptions where necessary.

Cost drivers:

- Establishment costs, related to the preparation of land before reseeding are low (<USD 1 per ha). The most important cost drivers are from operations and maintenance (O&M) and opportunity costs.

- O&M costs include the labour, technology and input cost for reseeding the area, alongside the continual operation of the land such as weeding, pastureland management and harvesting of the grasses. These costs do not vary significantly across the lifespan of the initiative and remain below USD 32 per ha throughout.

- Opportunity costs have been calculated based upon profitability associated with traditional dairy farming in Kenya, with this proxy being chosen due to this being a major form of land use on Kenyan pastureland.[108]

Revenue sources:

- For this case study the major revenue source is from the sales of grass seeds and hay produced by the planted grasses, with grass seeds being especially profitable given the demand from fellow farmers and the Government for high quality seeds for pasture rehabilitation. Alongside this, revenue has also been calculated based upon potential cattle sales, with a proxy being used given the lack of data on this in the original case study data and the importance of this source of revenue to smallholder farmers in Kenya.

- Although there is a strong revenue from diverse sources the higher upfront costs may be prohibitive to some investors. This is an example where initial public and/or donor finance could fund the initiative and allow for private investment to take over once returns start to be generated.

[xv] Specific details about the initiative have been deliberately omitted from this case study due to the commercially sensitive nature of some of the data. This has been agreed with partners.

Figure 8: Cashflow over 30 years associated with the enhanced soil organic carbon grasslands initiative (USD per hectare).

Case study 2:
An example of an afforestation and reforestation initiative in Kenya

Afforestation and reforestation make up 70% of the mitigation potential identified in Kenya's NCCAP, being seen as a solution with high potential to help Kenya reach its climate goals alongside fighting land degradation.[109] This case study is based upon modelling conducted by the Government of Kenya that calculated the potential costs and revenue associated with commercially planting bamboo on marginal cropland and un-stocked forest plantations.[110] The calculations were based upon expert discussions, activity restoration budgets and literature reviews. This high-quality location-specific data helped to craft the analysis around what a potential business model may look like in Kenya.

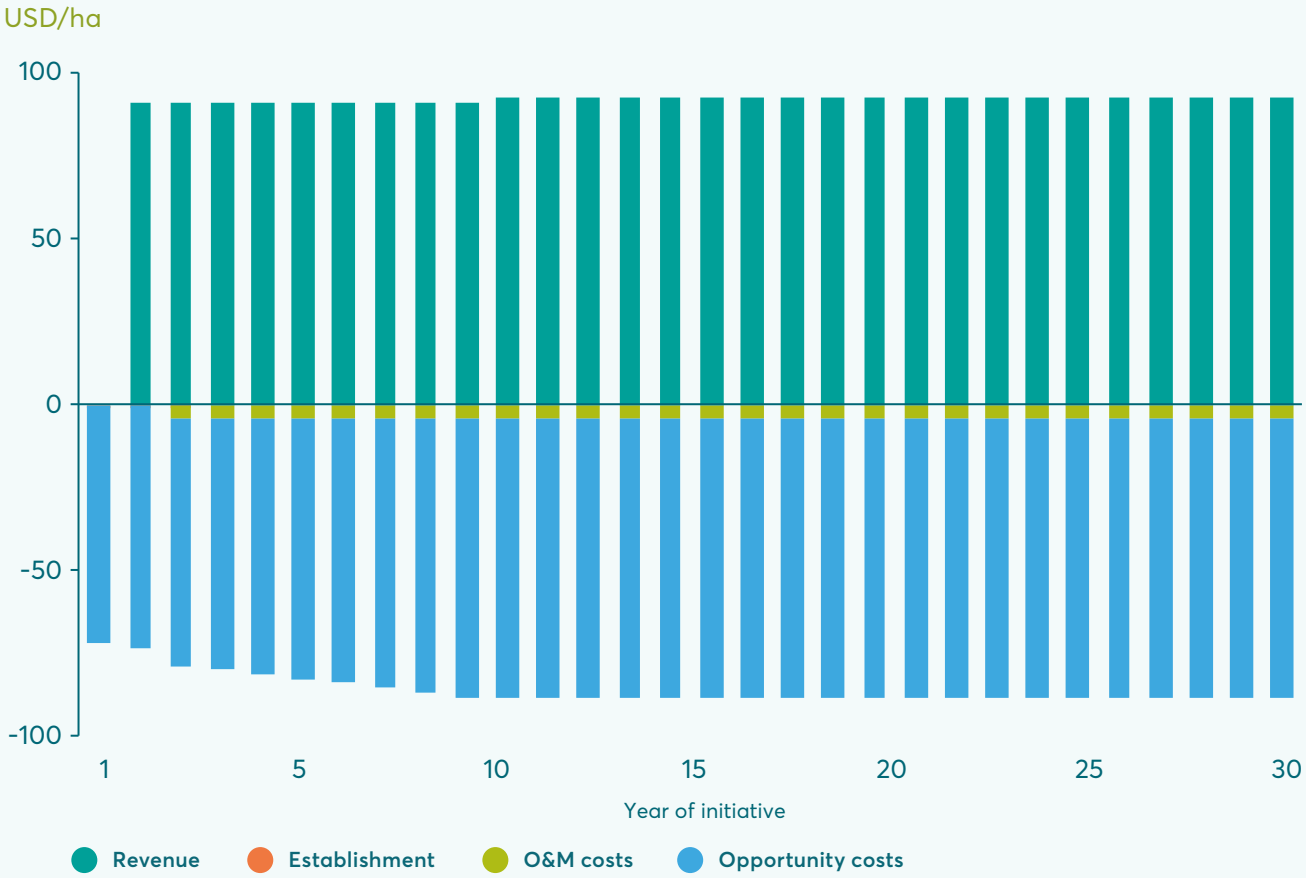
Summary of key costs and revenues:

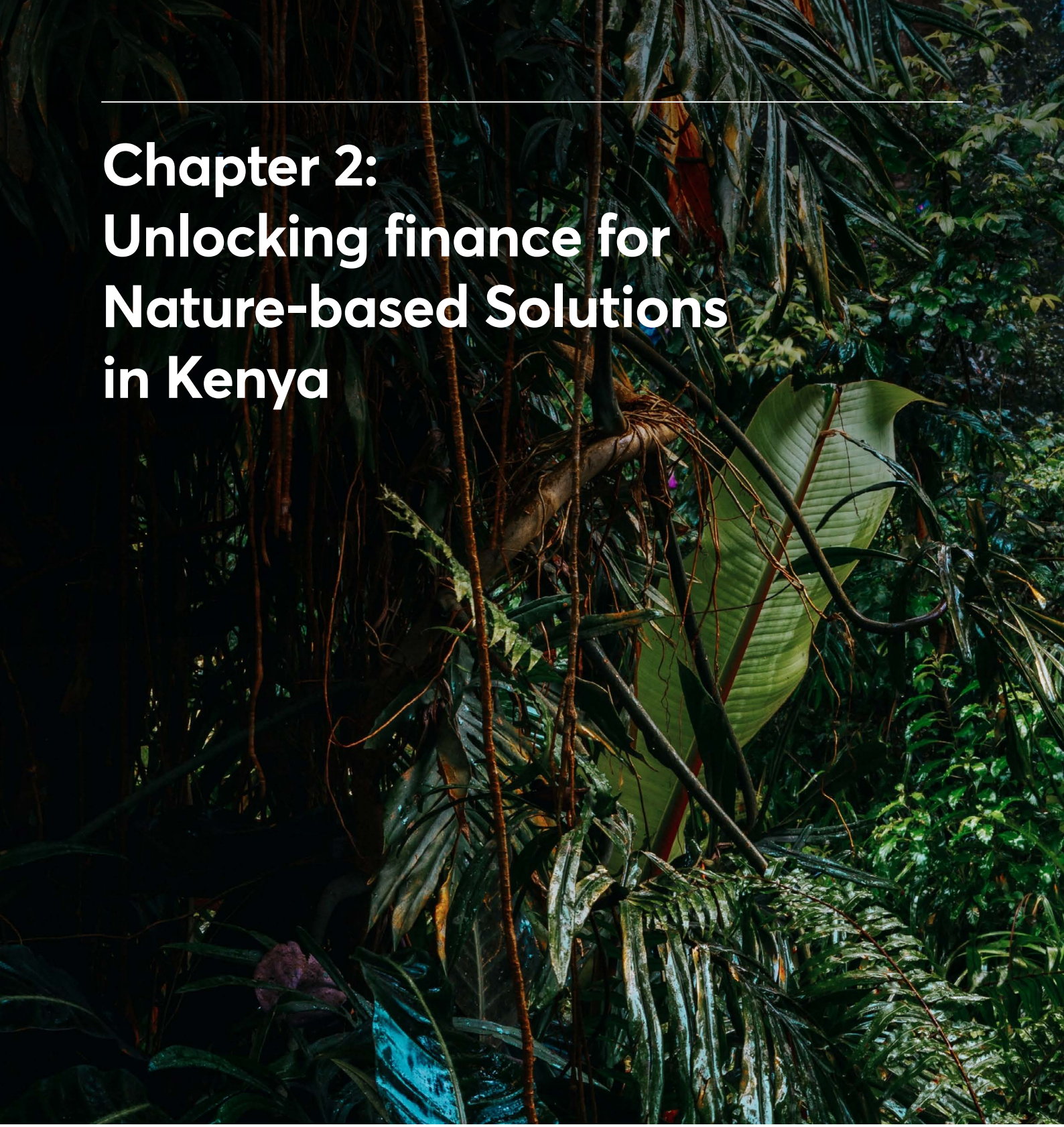
- The most significant cost driver is opportunity costs, which are based on the average profits from Kenyan croplands (calculated using FAO data).[111] The fact that opportunity costs are present from year 1 before revenue may also prove to be prohibitive to certain investors.

- Other major cost categories include establishment and O&M costs. Establishment costs come from the setting up of the initiative, with the primary cost for this being from the transportation of, and then planting of the seedlings. The labour, maintenance and harvesting costs are bucketed under O&M costs. These include costs from the staking out of the bamboo, spot weeding and security costs for the area.

- Sale of bamboo culms produced from the bamboo can be a revenue source in this instance. These culms can be used to produce poles for building materials, food, fodder and bamboo charcoal.[112]

Figure 9: Cashflow over 30 years associated with the afforestation and reforestation initiative (USD per hectare).





Chapter 2: Unlocking finance for Nature-based Solutions in Kenya

This chapter presents an estimate of the total investment required in Kenya by 2050 for each NbS solution. It also presents a pathway for how this total investment can be financed. These results are discussed, outlining implications for the role of different investors and the suitability of different financing strategies to invest in NbS. A summary of the modelling used for this analysis is also provided; more detailed information can be found in the accompanying methodology document.

Methods summary for estimating investment requirements and pathways for Kenya

The main modelling for this report has been produced by FOLU. The model has several components:

a) Estimation of the total investment requirements in Kenya

b) Model of a feasible investment pathway for delivering the total investment requirement

Total investment requirement

This study estimated the total investment required per year across the 20 NbS solutions – or, in Kenya, the 19 solutions that apply, (see Chapter 1) – for four snapshot years: 2025, 2030, 2040 and 2050. The cost and revenue (in USD per tCO_2e) per year of implementing each solution were taken from the database described on page 30 and combined with assumptions around how these costs might change over time as result of decreasing technology costs and increasing costs of land and commodity prices. These costs were then combined with the mitigation potential per year calculated from Roe et al. (2019 and 2021) to yield the total cost of implementing each solution in Kenya to achieve the cost-effective mitigation potential.

Feasible investment pathway

This study built archetypal NbS profiles based on a literature review across all NbS solutions and information from real business models initiatives. A literature review, interviews and a survey were also used to understand the investment approaches of different investor groups to build structured investor and instrument profiles. The model then compares the instrument and NbS profile to determine their alignment in different years of the initiative's lifetime and at the different stages during the transition, before then factoring in which instruments investors can adopt and how well they themselves are aligned with each NbS profile. The breakdown of investment is thus allocated through this exercise, considering both investor and instrument alignment with each NbS. For some investor groups (corporates, philanthropies, development finance institutions (DFIs) and the Government of Kenya), the model also takes into account a maximum limit for potential investment where budgets may be particularly constrained. More detailed methods have also been developed for estimating feasible investment form corporates, which also relies on an upcoming report by Climate Focus, estimating the feasible supply of carbon credits in Kenya. For more detail on methodology, please refer to the accompanying methodology document.

Instrument	Investment risk	Risk/return profile[xvi]	Return expectations
Grant – finance that does not seek a financial return on investment. Supply-chain finance is a subset of this instrument, where AFOLU sector corporates are disbursing grant finance to their supply-chain	Any[xvii]	Any	None
Equity – finance that purchases a stake in the initiative, with high return expectations and a high appetite for risk	Any	High	High
Concessional Debt (CD) – debt finance that has return expectations below the market rate, and so is a comparatively "cheap" form of finance for initiatives. Can be used to de-risk investments	Medium	Medium	Low
Market Rate Debt (MRD) – traditional debt finance at market rates, i.e. non-concessional	Medium	Low	Medium
Beyond Value-Chain Mitigation (BVCM) – finance from corporates from all sectors seeking mitigation outcomes, not a financial return on investment	Any	Any	None

[xvi] Risk/return profile measures the number of standard deviations from the mean revenue in any given year may be.
[xvii] Here and henceforth in this table, "any" refers to a non-restricted boundary, i.e. for any level of investment risk from low to high, the instrument can be adopted.

Investor category	Size of investment (USD amount)	Length of investment	Return expectations	Requirements on maturity of investment	Importance of other 'core' benefits	Instruments				
						Grants	Equity	CD	NCD	BVCM
Government of Kenya	Any	Less than 10 years	Low	None	High	✓		✓	✓	
Domestic and international corporates	Any	Any	Low	None	High	✓	✓	✓	✓	✓
Development finance institutions	Any	Any	Low	Up to, but not including, maturity	High	✓		✓	✓	
Pension and sovereign wealth funds	> USD 5 million	Any	Medium low	Growth and mature stages	High		✓	✓	✓	
Insurance companies	> USD 5 million	>5 years	Medium	Growth and mature stages	Low			✓	✓	
Retail and commercial banks	< USD 30 million	>5 years	Medium	None	Low			✓	✓	
Credit unions	< USD 20million	<10 years	Medium low	Up to, but not including, maturity	Medium			✓	✓	
Trading houses and brokers	> USD 1 million	< 5 years	Medium	Growth and mature stages	Low		✓		✓	
Private equity funds	> USD 5 million	<10 years	High	From pre-seed to mature	Low		✓			
Venture capital and angel investors	<USD 30 million	< 5 years	High	Start-up and pre-seed	Low		✓			
Impact investors	< USD 30 million	< 10 years	Medium low	From pre-seed to mature	High		✓	✓	✓	
Philanthropies (incl. high net-worth individuals)	< USD 10 million	All time horizons	Low	Start-up and pre-seed	High	✓		✓	✓	

2.1 Estimating the total investment required in Kenya for NbS per year by 2050

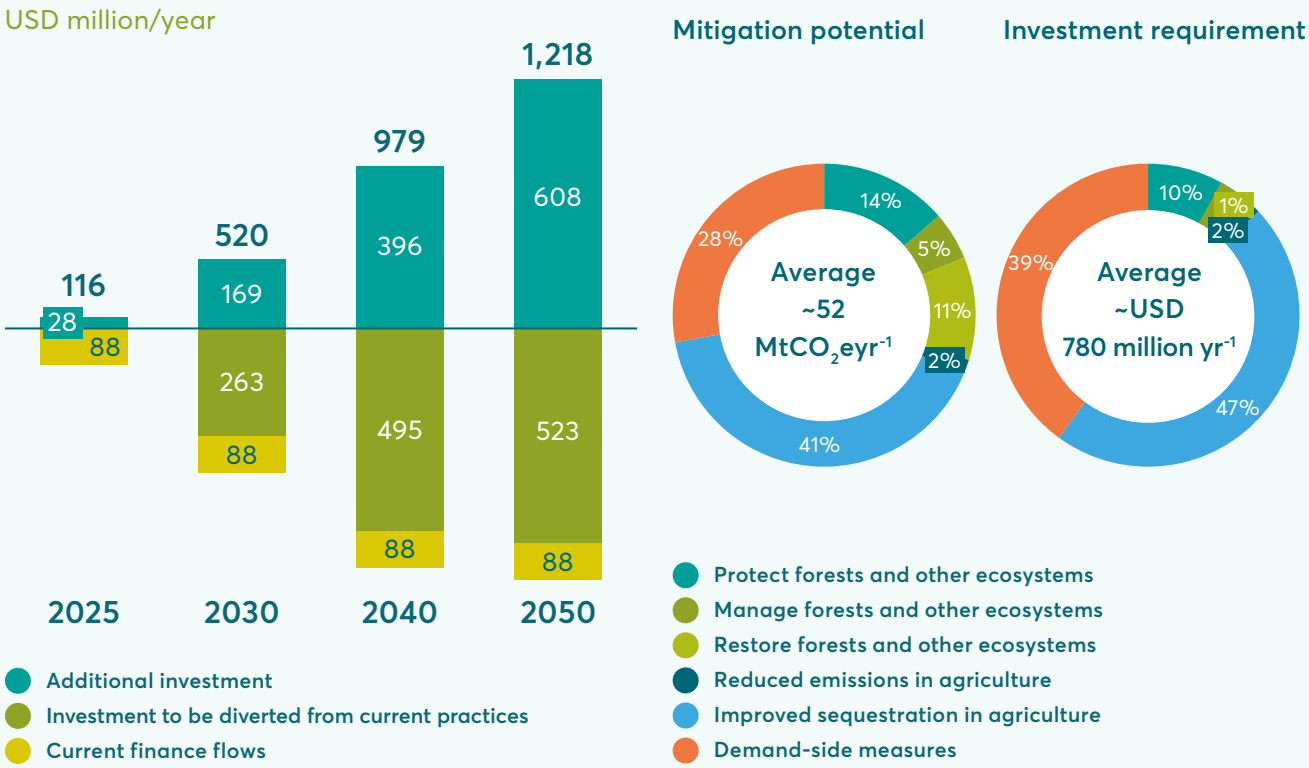
This study estimates that Kenya requires USD 1.2 billion of investment per year by 2050 into NbS (see Figure 10).[xviii] This represents an over 13-fold increase in total annual finance for NbS by 2050 compared to 2019 finance flows, but still less than 1.3% of Kenya's GDP today (and likely making up an even smaller proportion by 2050). Investing this amount could deliver a suite of benefits for people and planet – including 80 million $tCO_2e\ yr^{-1}$ of climate mitigation, biodiversity protection, food and nutritional security, enhanced human health and resilience. As discussed, even by 2030 following the mitigation pathway identified by Roe et al. would lead to an emissions reduction of over 40 million tCO_2eyr^{-1} surpassing Kenya's NDC target of a 32% emissions reduction by 2030, even before taking other sectors into account. [113,114]

Agricultural solutions make up roughly 50% of the total cost between now and 2050, but the majority of this investment may not require "new" investment. Over 90% of the finance needed for these solutions could be delivered by re-directing investment that is already going into Kenya's agricultural sector. Many agricultural solutions require a change in practice (or set of practices) from an existing agricultural model. Moving from BAU agricultural production systems to models which integrate NbS may mean substituting less sustainable with more sustainable practices and redirecting associated support. For instance, in the case of enhancing soil organic carbon sequestration in grasslands, farmers might invest in fencing to implement a rotational grazing regime, improving the quality of available forage for the cattle.[115,116] In this case, some of the costs incurred in the BAU scenario from purchasing supplementary feed or building and maintaining feedlots may be used instead to purchase the fencing necessary to implement improved grazing practices. New or additional sources of finance are therefore only required when the incremental costs of the change in practice exceed the cost of the BAU production system or significantly affect cash flow.

Nearly USD 80 million is needed on average per annum to protect forests and other ecosystems. This compares to an estimated USD 17 million today. These solutions account for just 14% of the mitigation potential of NbS in Kenya but 10% of average annual investment required over the period to 2050. Costs for these solutions are driven by the high opportunity costs incurred from the foregone revenue from not converting the forest land for agriculture or forest commodity production, such as for timber and charcoal for fuel. The solutions that unlock the most mitigation potential for each dollar spent are biochar, grassland fire management, clean cookstoves, coastal wetland restoration and afforestation and reforestation. These five solutions together make up 20% of Kenya's mitigation potential, but just 0.5% of the average annual cost required to achieve Kenya's cost-effective mitigation potential. For a breakdown of investment required per solution, please refer to section 2 of the annex.

[xviii] The total investment was calculated using the USD per tonne of carbon dioxide equivalent (USD/tCO_2e) associated with each NbS measure in Kenya as well as the cost-effective mitigation potential summarized in Figure 5 (see methodology document for more information).

Figure 10: *Left:* **: investment needed per decade split by existing finance that needs to be augmented or redirected (below the line), and additional finance to be sourced (above the line) in USD million per year.** *Right:* **average percentage split of mitigation potential and investment required by NbS category over 2025-2050.**



2.2 A potential pathway for financing the total investment requirement

This study has developed a potential investment pathway to meet the total investment requirement in Kenya. This includes an analysis of different funders, financiers and financial mechanisms that could finance the implementation and ongoing management of different NbS initiatives. The results of this study highlights the importance of a diverse set of investor groups in contributing towards Kenya's total investment requirement.

2.2.1 Summary of key results include:

A range of instruments – from grant and direct supply-chain finance to equity and debt instruments – are needed to finance NbS in Kenya. The pathway results highlight how early grant and supply-chain finance enables growth in the use of all instruments – debt- and equity-based – to 2050. Equity, concessional and market-rate debt (non-concessional debt) make up less than 1% of finance in 2025 but grow to nearly 50% in 2050 whilst equity becomes the most widely used instrument by 2050.

- **Grant and supply-chain finance** are key to unlocking the potential of NbS, particularly when NbS initiatives are in early stages and have not yet been able to demonstrate the viability of their business models to investors. In 2025, grant and supply-chain finance make up 96% of the total finance for NbS. By 2050 this drops to just under 50%, as the share of investment from beyond value-chain mitigation and instruments that seek a market-based financial return on their investment increases.

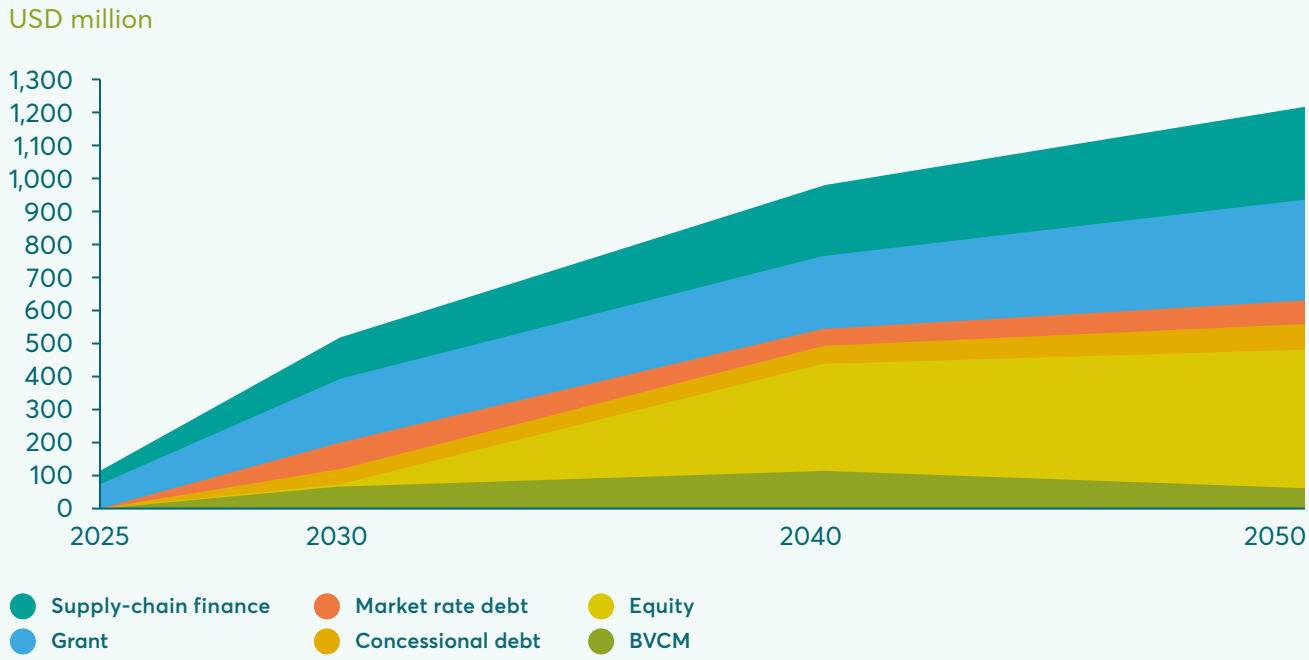
- **Market-rate debt** will be an important source of finance for initiatives which are at more mature stages, meaning they are no longer in early establishment or "proof of concept" stages and have demonstrated profitability over time, enabling them to access debt capital. This analysis identified that NbS most suited to access debt capital include enhanced soil organic carbon sequestration in grasslands and agroforestry, as well as reduce deforestation in the latter stages of the transition when initiatives become commercially viable. Collateral, such as land, is necessary for NbS initiatives to access market-rate debt, but due to limitations of the existing dataset this has not been integrated into the model.

- **Concessional debt** can help finance initiatives in need of upfront investment to grow and therefore help to de-risk initiatives in the early stages of their development. These again include agroforestry and improved soil organic carbon sequestration, as well as improved forest management initiatives.

- **Equity investments** are better suited to initiatives with high potential returns but which also have a higher associated risk. Enhanced soil organic carbon sequestration in croplands and shifting to sustainable, healthy diets are the main recipients of equity investments. This analysis assumes some aggregation of initiatives over time. This allows traditional equity investors, such as private equity funds, to invest in the transition as aggregation can help to overcome the issue of prohibitively small investment sizes.

- **Beyond Value-Chain Mitigation (BVCM) payments** assumed as including, but not only limited to, purchases of carbon credits through the VCM are important enablers of the transition in the early stages, primarily financing agroforestry, enhanced soil organic carbon sequestration in croplands and reduce deforestation initiatives. In 2030, BVCM payments could be of particular importance, making up 13% of the total investment needed in this year. By 2050, BVCM payments make up only 5% of total finance. Recent evidence suggests that the demand for BVCM could be met almost entirely by the carbon markets in Kenya (see Section 2.2.2c).

Figure 11: The use of instruments in the potential investment pathway in Kenya to 2050 to achieve the potential of NbS.



This analysis suggests all stakeholders will have an important role to play in this transition – from the Government of Kenya to corporates contributing to societal net zero and investing in beyond value-chain mitigation (BVCM). In the early years prior to 2030, investment is dominated by public sector actors and corporates engaged in mitigation activities. As the transition matures, the contribution from institutional investors becomes more significant, ultimately making up nearly 35% of the total investment required by 2050.

- **In 2025, over 54% of finance for NbS could come from the Government of Kenya,**[117,xix] almost all of which could take the form of grants to support initiatives in the initial stages of their development. This may also require bilateral partnership in the form of Overseas Development Assistance (ODA), although this study has not evaluated what proportion of the Government of Kenya's contribution would be supported by ODA. By 2050, even though the results imply that the total investment from the Government could grow seven-fold to USD 240 million, this represents less than 20% of total investment as other institutions are expected to contribute significantly more finance. Put another way, the ratio of government to non-government finance (including DFIs) could grow from almost 1:1 in 2025 to 1:4 in 2050.

[xix] In Kenya, semi-autonomous government agencies have been identified as important disbursers of finance, receiving direct finance from the government.

- **Development finance institutions (DFIs) and philanthropies (including high net-worth individuals) could grow their investment ten-fold by 2050.** In 2025, DFIs and philanthropic investment are projected to make up 9% of total investment. By 2050, DFIs and philanthropies could still be financing 9% of the investment needed for the transition, despite the increased involvement of the private sector. While grants are the main instruments used by these two stakeholders throughout, the proportion that concessional and market-rate debt makes up is projected to grow quickly to 26% of total investment in 2030, before again falling to 15% by 2050.

- **Domestic and international corporates could make up over 40% of the investment needed over the course of the transition.** This group involves two distinct buckets, which have been considered separately. Firstly corporates whose operations, supply chains and customers form part of the Agriculture, Forestry and other Land use sector (AFOLU) – for example, companies who work in the coffee and dairy value chains. Reducing emissions and sequestering carbon in their land footprints (scopes 1 – 3) is necessary to limit global warming to 1.5°C . Secondly, corporates from any sector which are committed to net zero and may be incentivized to go beyond their "fair share" of climate mitigation as defined by the Science Based Targets initiative (SBTi) to also invest in BVCM so as to support global efforts to limit global warming to 1.5°C.

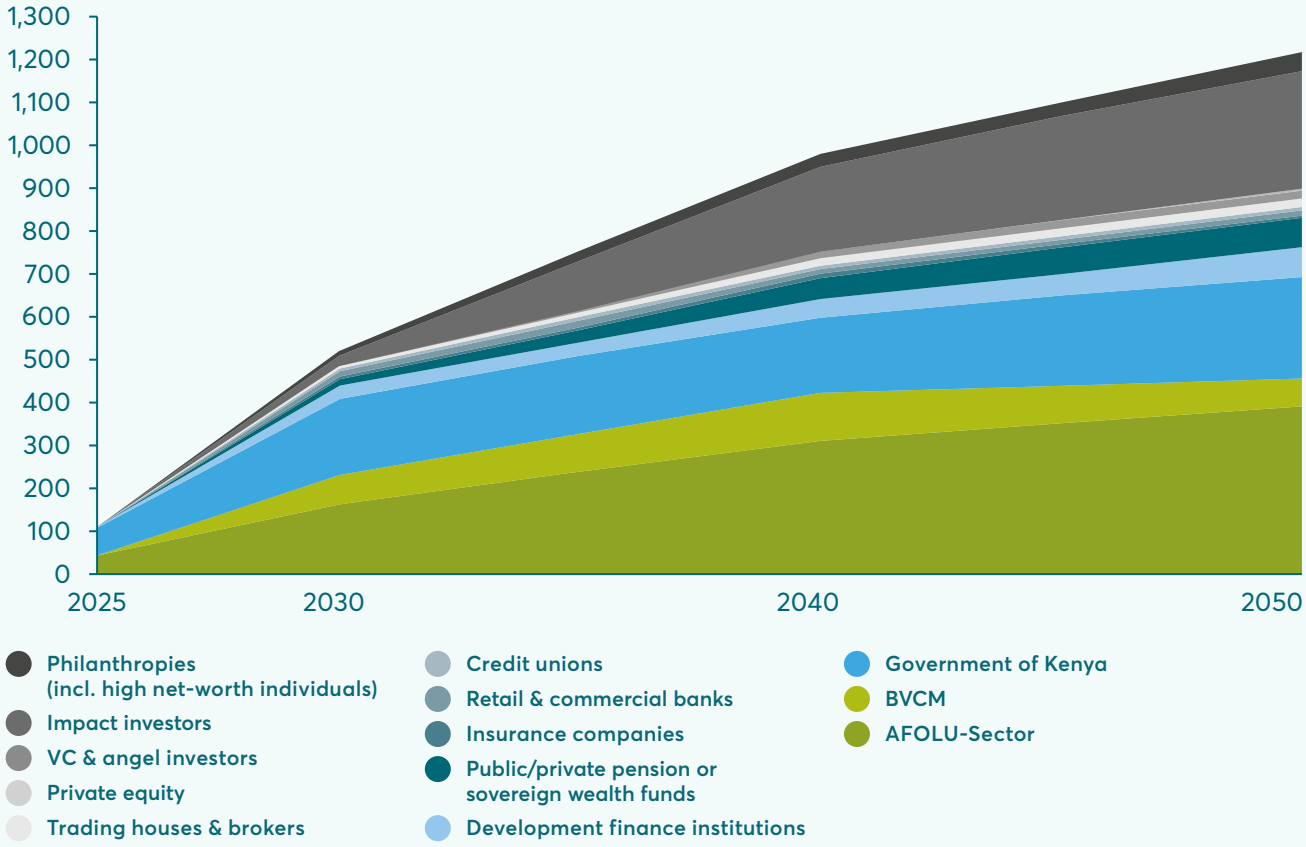
    - **AFOLU sector corporates** could finance a significant proportion of the investment needed over the course of the transition, using the full spectrum of instruments. In 2025, these corporates could finance over 30% of the investment needed, all of which is projected to be supply-chain finance (i.e. does not seek a financial return on investment). By 2050, AFOLU sector corporates could still be responsible for financing just over 30% of the transition, but with some contribution from a broader range of instruments. Supply-chain financing makes up just over 71%, equity 20% and concessional and market-rate debt the remaining 9%.

    - **Corporates engaged in BVCM** could make up 4% of the investment required in 2025 and almost 15% of the investment in 2030. Throughout the transition the majority of finance comes to agroforestry and enhanced soil organic carbon sequestration in grasslands and croplands. These solutions would be best suited towards BVCM investment given the need to shift towards investing in carbon removal to ensure that any residual emissions are neutralized in line with efforts to limit warming to 1.5°C. The absolute and relative contribution of BVCM could also drop off significantly after 2040, from USD 110 million to just USD 65 million, or 5% of total finance in 2050, as society delivers deep decarbonization across all sectors.

- **Institutional investors could provide nearly 30% of the investment needed over the course of the transition.** These investors include pension and sovereign wealth funds, insurance companies, retail and commercial banks, credit unions, trading houses and brokers, private equity funds, venture capital funds and angel investors, and impact investors. Though their role in 2025 is projected to be limited due to the fact that initiatives will require grant funding, by 2050 they could contribute nearly 35% of the total finance required through a mix of debt and equity. Impact investors (23%), and pension funds or sovereign wealth funds (6%) could then be the most significant institutional investors at this point.

Figure 12: A feasible investment pathway for investing in NbS in Kenya over the next three decades, by investor.

USD million



2.2.2 Discussion and implications for key stakeholders

2.2.2a Government of Kenya

This study shows the fundamental role the Government of Kenya needs to play in shifting to sustainable, healthy diets, tackling deforestation, and reducing food loss and waste, as well as getting initiatives to the stage that they can generate returns and attract private sector investment – with large development benefits to wider society. In 2025, almost all of the finance disbursed by the Government of Kenya would rely on grant finance, i.e. investments that do not seek a financial return. This is due largely to the fact that investment is dominated by solutions that are not yet commercially viable, such as shifting diets and reducing deforestation. The burden for this investment need not rest solely on Kenyan taxpayers – instead, there is a clear opportunity here for the Government of Kenya to source payment from high-income countries to support a just transition, through mechanisms such as jurisdictional REDD+ or bilateral and multilateral agreements. Since the cost of reducing deforestation is driven predominantly by the opportunity cost of converting forests to agricultural land, the Government of Kenya should look to mechanisms such as subsidy or land tax reform which would reduce opportunity costs and, therefore, the public sector investment required. These mechanisms are considered in more detail in Chapter 3. Reducing food loss and waste and shifting to sustainable, healthy diets are productive investments for the Government to make (by increasing the supply of edible food and reducing the public health burden) but take some time for commercial opportunities to materialize.

On top of its role as a disburser of finance, the Government of Kenya can support and enable the aggregation of initiatives and shape the dialogue with the AFOLU sector. The Government of Kenya can encourage domestic and international AFOLU sector companies to take responsibility for climate mitigation (emissions reductions and carbon removals) in their Kenyan value chains. To elicit investment from institutional investors, the Government should support business models and organizational structures that seek to aggregate multiple initiatives. Because many institutional investors require ticket sizes surpassing USD 1 million, they are currently unable to invest in anything less than the largest initiatives available. The Government of Kenya could play a role in shaping this process to achieve equitable outcomes for all and ensure it serves its citizens. This role will be explored further in Chapter 3.

2.2.2b Agriculture, Forestry and other Land Use (AFOLU) corporates

If AFOLU sector companies (both domestic and international) paid 100% of the estimated costs associated with reducing emissions and sequestering carbon in their land footprints in Kenya (scopes 1–3) to support global efforts to limit global warming to 1.5°C, they would on average deliver nearly 35% of the total NbS investment requirement in 2050 (USD 420 million). This represents just over 1% of the current value-add of the sector in Kenya. Nearly 50% of the investment will go towards agricultural solutions, over 35% of this investment will go towards shifting to sustainable, healthy diets and the remaining amount will primarily be directed to reduce deforestation and peatland degradation. This calculation is based on the proportion of mitigation potential which sits within the value chains of companies and modelling based on the Science Based Targets initiative (SBTi) Food, Land use and Agriculture[xx] sector guidance which requires AFOLU companies to deliver emissions reductions and removals totalling 72% of their land-based emissions footprint by 2050 (note these corporates will also need to pay for the permanent storage and removal of any residual emissions to achieve net zero). Given that a large proportion of key commodities produced in Kenya are consumed within the country, it is critical that Kenyan AFOLU sector corporates set net-zero targets and invest within their value chains to reach their goals. Despite the fact that Africa is a growing region for the adoption of SBTs, there is still significant potential for improvement. At the end of 2021 less than 1% of high-impact companies committed to SBTs were located in Sub-Saharan Africa, with only 6 high impact companies having set a target across the continent. Scaling up this number will be an important part of unlocking finance for NbS in Kenya.

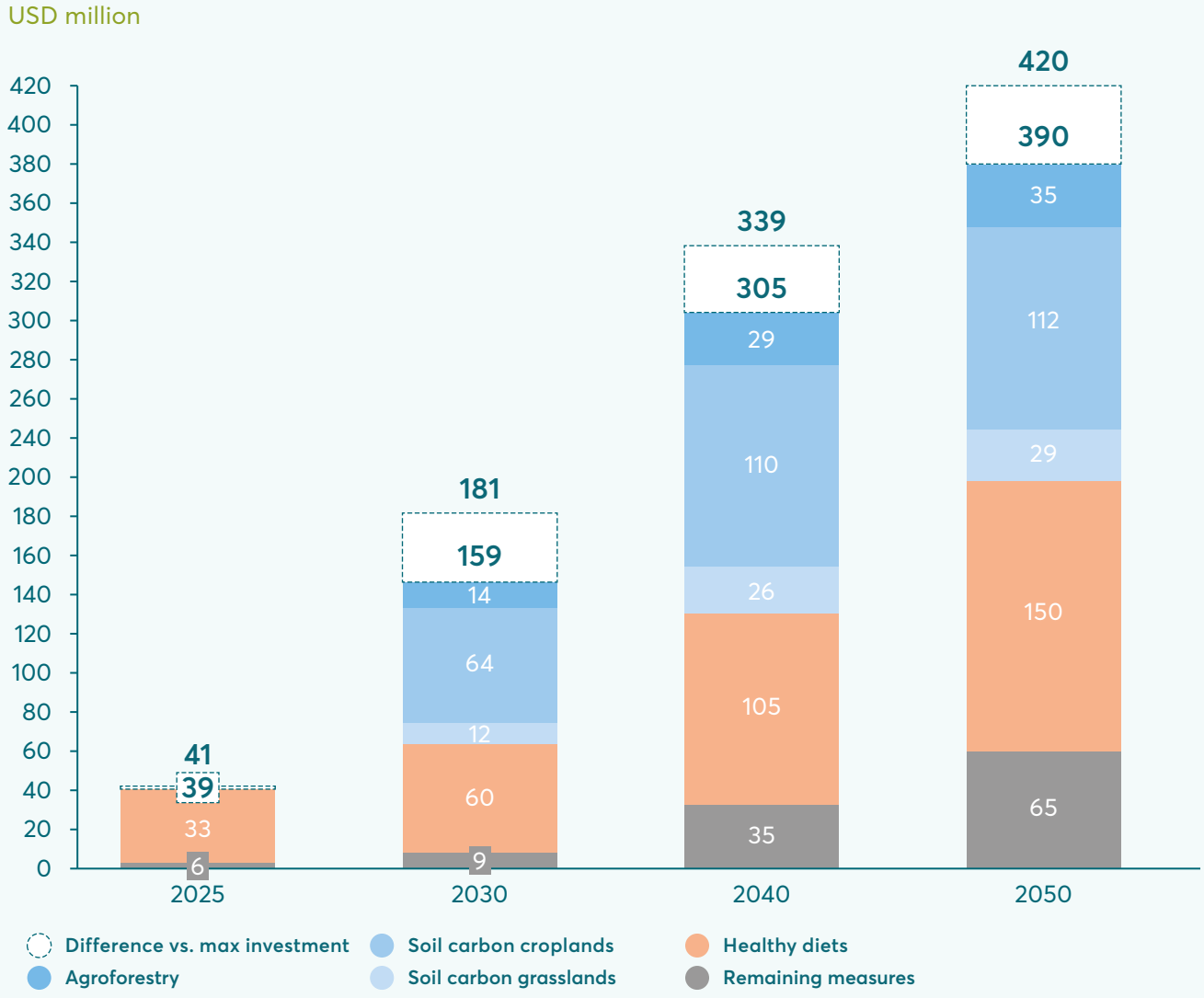
While it is not unreasonable to expect these companies to pay to deliver their own share of climate mitigation responsibility (emissions reductions and carbon sequestration), it is foreseeable that some companies will lag behind in taking responsibility for their climate impact. Other companies – for example domestic small and medium-sized enterprises (SMEs) – might have financial constraints preventing them from covering the full investment. Where AFOLU sector corporates are unable to pay for mitigation in their value chains, they can engage with other investor groups to cover the costs. For example, by deploying catalytic finance, AFOLU sector corporates can engage financial sector actors and encourage them to invest in viable solutions that nevertheless need finance to scale. By engaging these actors, the AFOLU sector can reduce the corporate spend by nearly 10%.

Some corporates are already looking at opportunities to finance mitigation in their value chains through the sale of carbon credits associated with reductions or removals in their value chain to third parties. It is critical to emphasize that if these carbon credits are sold onto a separate third party as an offset, then the corporate seller cannot claim those reductions or removals against its own SBTi target.[xxi] If corporates do intend to finance their value chain mitigation through the sale of carbon credits it is therefore recommended that they are only sold to buyers who will make transparent "contribution" claims to avoid double claiming.

[xx] The SBTi guidance refers to companies in the AFOLU sector as Food, Land use and Agriculture (FLAG) sector companies.

[xxi] Double claiming can only occur where the emission reduction or removal is in one company's scope 1 or 2 and a separate company's scope 3 – for example, where an agribusiness reduces emissions from enteric fermentation and claims that as a scope 1 emissions reduction and a retailer who sources from that farm claims it as a scope 3 emission reduction.

Figure 13: Required versus aligned annual investment in mitigation in AFOLU company value chains.

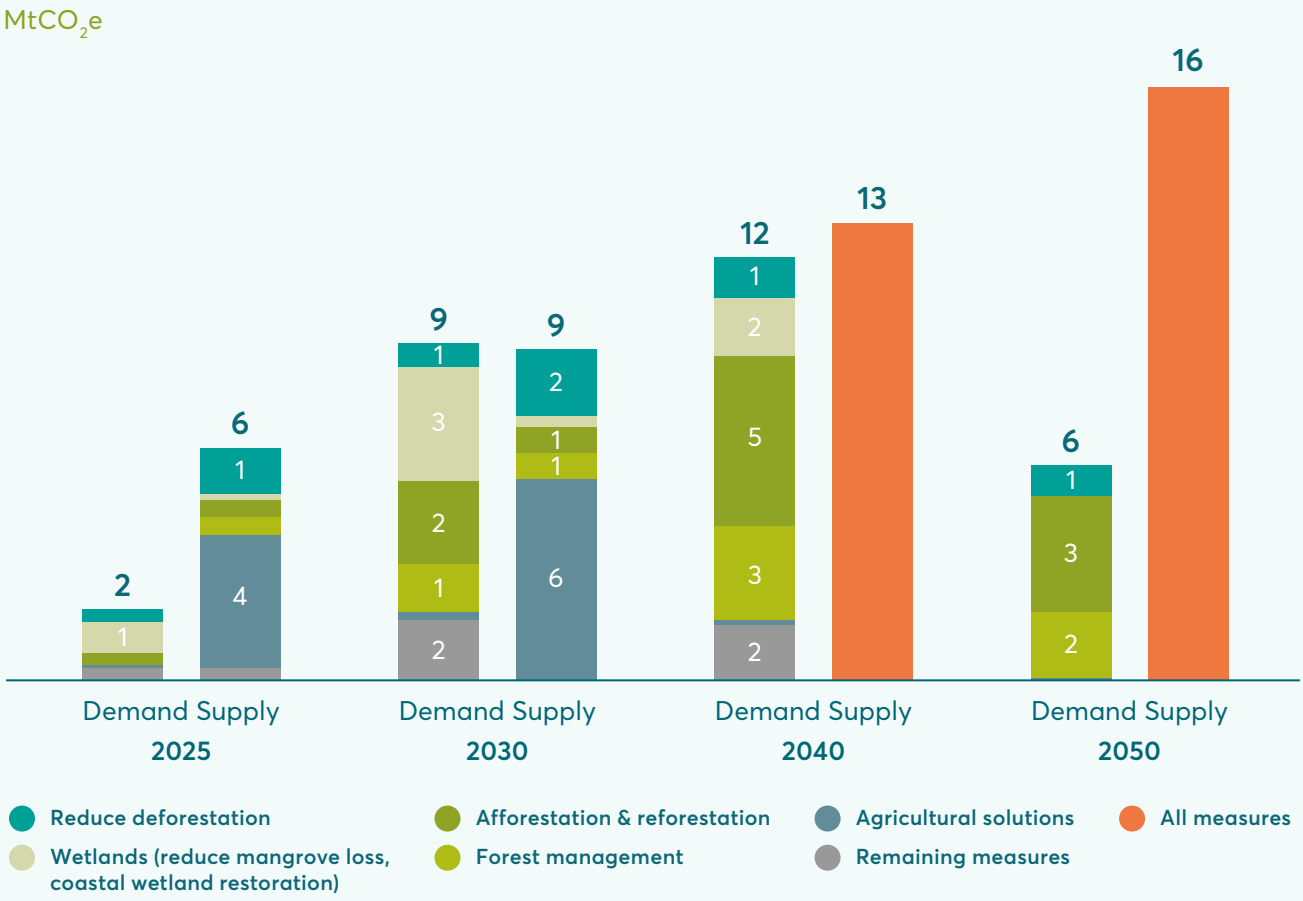


2.2.2c All sector corporates contributing to ""beyond value-chain mitigation"

Kenya could attract over USD 114 million per year in carbon finance from companies investing in beyond value-chain mitigation (BVCM) including, but not limited to, the purchase of carbon credits on the voluntary carbon market (VCM). All corporate sectors (including AFOLU), are recommended by the SBTi to invest in BVCM to support delivery of global net zero targets. The BVCM financing is calculated by modelling the science-based emissions reduction trajectories of all corporates and making assumptions about the proportion of remaining emissions in a given year compensated for by BVCM investments, starting at 20% and increasing over time (see the methodology document for more information). Reduce deforestation, enhance soil carbon croplands and grasslands, and agroforestry are due to receive the highest amount of investment from the BVCM investments over the 30-year period. Some of this BVCM investment could come from carbon finance through the VCM.

Recent evidence suggests that the demand for BVCM could be met almost entirely by the carbon markets in Kenya. A recent study by Climate Focus estimates the mitigation which could be achieved through developing initiatives for the carbon markets.[118] Their estimates are based upon the cost-effective mitigation potential identified by Roe et al (2021), potential carbon price scenarios (low, medium and high) and feasibility barriers related to business, land and political factors.[119] Figure 14 shows a comparison between the supply estimate and the BVCM demand estimated by this analysis. The supply estimate sourced from Climate Focus is only disaggregated until 2035. Total supply outstrips demand for all snapshot years in the high carbon price scenario. and all years except for 2030 in the low carbon price scenario, driven by increased demand for afforestation and reforestation, reduced mangrove loss, coastal wetland restoration and improved forest management. This implies that in some years, finance for BVCM may have to come from beyond the carbon market. This is especially true in the late 2040s and 2050, when the supply, mainly driven by emissions reductions solutions, remains high whilst the demand for these types of credits declines. For wetland solutions (reduce mangrove loss and mangrove restoration) and afforestation and reforestation, the demand estimate is higher than the supply, suggesting that business models for implementing these solutions should also look to BVCM finance outside of carbon markets as an additional source of income.

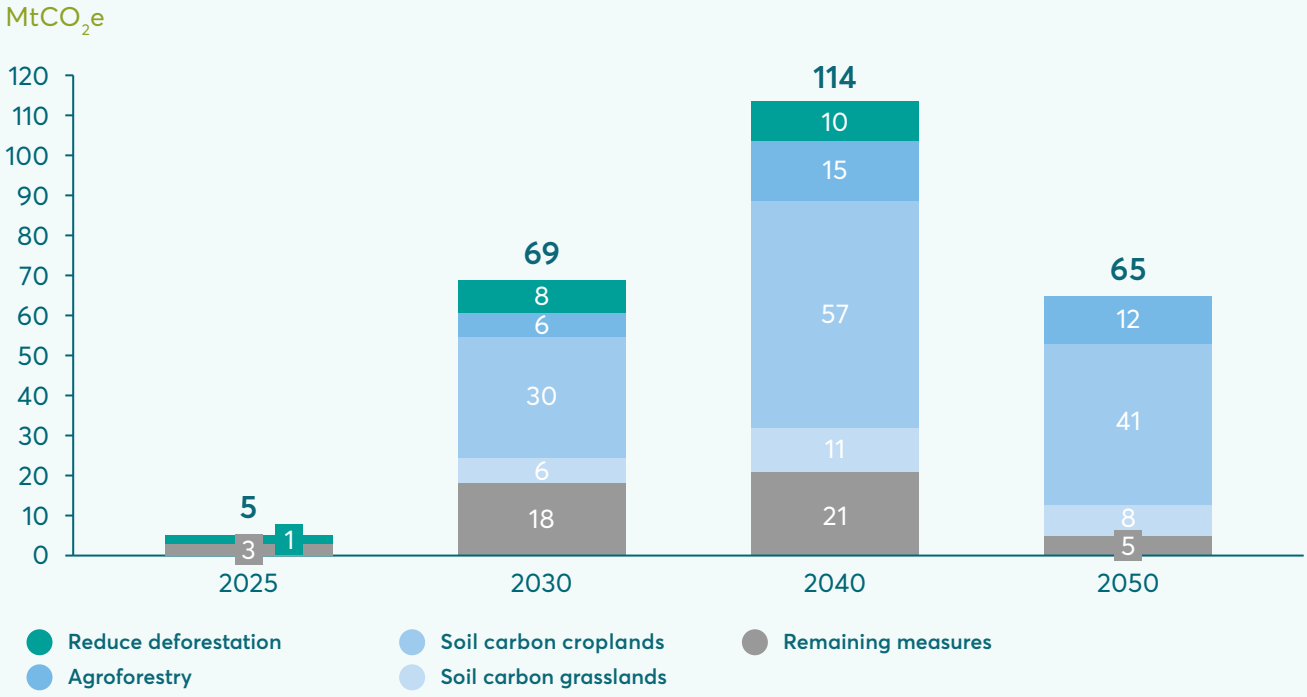
Figure 14: Demand for BVCM compared to mitigation potential which could be supplied through the carbon market in Kenya



Source: Demand from this analysis. Supply estimates from Climate Focus study using a low carbon price scenario.[120]

By setting the right conditions, the Government of Kenya could leverage BVCM payments to make up a greater proportion of investment than the results display. The current scenario hinges upon the proportion of global mitigation potential found in Kenya (0.4%).[121] This could be strongly influenced by the extent to which the Government of Kenya engages with corporates outside the AFOLU sector to create the environment that they need to invest in BVCM in Kenya – both increasing the supply of available initiatives for corporates to invest in and increasing the demand from corporates for these initiatives. This could be through, but is not limited to, the growth of the carbon market in Kenya.

Figure 15: Investment flows by all sectors into climate mitigation in Kenya outside of their value chains to 2050.



2.2.2d Development finance institutions and philanthropies[xxii]

DFIs and philanthropies should seek initiatives that can demonstrate a path to commercial viability at some point in the future, as well as deploy capital to tackle food loss and waste today. In a role similar to the Government of Kenya, as stakeholders capable of disbursing grants, DFIs and philanthropies are key actors in creating the pipeline of initiatives necessary to attract interest from institutional investors. With their long-term perspective and interest in benefits beyond climate mitigation and financial returns, DFIs and philanthropies should invest in initiatives that are high-risk but have an outsized climate and societal impact – such as those that reduce deforestation. To enable the transition away from grant finance, these initiatives should have a clear business proposition where possible, even if it may take some time to become commercially viable. This will allow the solution to move away from a reliance on grant finance and to instead leverage debt and equity finance, where there is a broader spectrum of investors available to engage with.

[xxii] In this instance, DFIs should be understood as those financing initiatives directly and does not preclude their role as financiers of the Government of Kenya. Also, even if they have similar investment profiles, DFIs and philanthropies are significantly different in their investment capacity, in that philanthropies have a significantly limited budget in Kenya compared to DFIs.

2.2.2e Institutional investors

While their contribution to the transition is limited today, institutional investors are projected to finance nearly 30% of the pathway to scaling NbS by 2050. This growth represents an almost 6-fold increase in investment from 2030 to 2050. Two factors drive this evolution in the feasible investment pathway: a) the increase in ticket sizes over the three preceding decades through aggregators and b) the extent to which NbS business models become more mature and more commercially viable and therefore less risky investments later in the transition. The combination of these two factors allows institutional investors to increase their share of finance for initiatives that generate competitive returns and which would otherwise fall below their minimum investment size.

Institutional investors could play an even more significant role in Kenya's pathway to scaling NbS if investors adopt "true value accounting" principles of nature. This approach assesses the true costs and benefits of agricultural production and consumption by considering the adverse impacts to the environment, human health and communities.[122] Currently only impact investors, pension or sovereign wealth funds and credit unions are considered to take benefits to society and the environment into account, and as such they make up the largest proportion of investment from institutional investors – together making up nearly 85% of this group's total investment in 2050, with impact investors alone making up over 67% of investment. If other institutional investors could be convinced to take into account, the true value of nature, either through citizen and shareholder pressure or through domestic and international regulation, then their contribution to the transition would greatly increase.

Chapter 3: Enabling investment into NbS

This chapter highlights some of the barriers which Kenya currently faces to scale investment into NbS and the challenges which farmers experience when trying to access finance. It then provides recommendations as to how Kenyan policymakers, alongside other actors, can act to increase investment in NbS.

Current environment and barriers to investment

Kenya has an increasingly favourable investment climate for NbS and a growing ecosystem of entrepreneurs interested in scaling NbS. Kenya combines a high mitigation potential for NbS, with a thriving ecosystem of entrepreneurs and impact investors eager to deliver greater prosperity across the country. Kenya is already home to world leading NbS initiatives such as Mikoko Pamoja, a mangrove conservation project, and was involved in the decision to set up East Africa's first carbon offset exchange.[123] Several innovative Kenyan-based companies are seeking to disrupt the market for more sustainably produced agricultural commodities. For instance, Twiga Foods is a Kenya-based eCommerce platform connecting producers of fresh fruit and vegetables with local markets and Komaza is a growing smallholder forestry company seeking to reforest degraded land.[124] In addition, Kenya is seeking to make it easier for international investment by, for instance, enacting reforms to support a strong financial sector, investing in telecommunication infrastructure and recent tax and business policy reforms.[125]

Yet, despite its positive investment climate, barriers to investing in NbS still exist. For instance, the large number of smallholder farmers and pastoral communities in Kenya still face challenges of access to markets and capacity to implement NbS. Despite the success of initiatives such as mPesa in addressing financial inclusion, access to finance for smallholder farmers and pastoral communities remains a significant barrier.[126] International investors often perceive the food, nature and land sector in emerging markets like Kenya as high risk, including the perception that political, regulatory and currency risk is particularly high, compounded by weaker local capital markets in comparison to markets in high income countries.[127] Overcoming these barriers – from access to market, risk assessment methodologies and beyond – will be key to enabling increased private sector investments into NbS in Kenya.

Potential barriers to scaling sector finance for NbS in Kenya, based on FOLU (2019)[128]

Private sector investors may face the following barriers to investing in NbS in Kenya:

- **Investment climate:** Kenya has a positive investment climate compared to other African countries, with a reputation for being relatively stable. Despite this, it is still considered risky in comparison to other global economies. This stems from factors such as corruption, which has troubled Kenya previously and may deter certain investors. Alongside this, there are often concerns about the investment situation changing from government to government and a slow judiciary process making it difficult for businesses to resolve disputes in a timely manner.[129] Finally, currency volatility caused by periods of economic instability can increase the cost of capital.

- **Law enforcement:** There have been cases of weak enforcement of policies and illegal activities in forested areas, which can lower the certainty of long-term protection of ecosystems. For instance, illegal poaching and deforestation can occur within protected areas.[130]

- **Regulatory barriers and lack of policy incentives:** In Kenya, perverse subsidies create disincentives for investing in NbS and can result from the holistic benefits of nature being undervalued. For instance, high fertilizer subsidies makes low-nitrogen farming unattractive for farmers.[131] There is also a lack of regulatory sanctions, which levels the playing field between sustainable and unsustainable land management activities.

- **Knowledge and data:** There is a lack of knowledge and data on NbS business models and investment opportunities within the global investment community. This includes a lack of investor awareness around key investment characteristics (investment requirements, return profiles, etc.) which can lead to misperceptions about risk-return profiles and reluctance to invest. A lack of data also makes it difficult to price risk. Spatially explicit data is also needed for land use plans, alongside economic data.

- **Supply and demand restrictions:** There are also market barriers to investing in sustainably produced agricultural and natural forest products which are applicable to most geographies. These include supply instability (particularly for forest products) and uncertain demand for sustainably produced products, which is likely to be exacerbated by the current global cost of living crisis, which may undermine business models relying on price premiums. There is also currently weak traceability and accountability, meaning it is hard for sustainably produced products to create market differentiation. This can be caused by a lack of investment into trusted partnerships. There can also be an uncertain pipeline for NbS investment opportunities. Therefore investors struggle to deploy investments and products with commercial readiness and scale, with too few bankable initiatives available.

From the point of view of farmers and land managers (including pastoral communities), accessing finance to implement NbS can also be a significant hurdle. Some barriers include:

- **Land tenure:** There is a lack of individual incentives to implement NbS, which can often be linked to informal land tenure, a prevalent issue in Kenya. Existing land use incentives and agricultural subsidies can also be problematic. Weak land tenure also means that many farmers and land stewards lack collateral to secure credit. Access to credit by small-scale farmers and land managers is still a challenge in Kenya, with 21% of the population still being unbanked.

- **Knowledge and capacity:** In some cases, farmers lack the capacity to implement NbS and to ensure their efficiency and viability for potential investment. Farmers may lack the necessary skillset to adopt new management techniques such as no-till farming. This can be due to a lack of access to training, equipment and knowledge. In other cases, there may also be reluctance and concern within farming communities around shifting behaviours, due to the potential risks associated with the transition. For example, cocoa producers can be reluctant to shift to climate-smart practices despite the potential for increased yields, given the significant risks and burdens farmers face if productivity declines. There is also a lack of information on how best to maintain and restore complex and deeply interrelated ecosystems and on the impact of regenerative practices on outcomes such as carbon, biodiversity, profitability and productivity.

- **Inequality:** Inequality between stakeholders in agricultural supply chains often means that farmers are not fairly compensated for their products and leads to the proliferation of farmer poverty. This restricts their ability to finance improvements to their farming or land management practices.

- **Limited access to investors:** Smallholder farmers and pastoral communities, especially in remote areas, often lack connection and access to investors outside of microfinance lending. Living in remote and hard to reach regions makes investor due diligence in these areas more challenging, with poor infrastructure exacerbating these challenges. Small ticket sizes means investors are rarely able to consider efforts without aggregated efforts, including jurisdictional-scale investments.

- **Limited access to finance for SMEs:** SMEs struggle to access finance due to their scale, investment risk and time horizon. For example, most SMEs require 3–10 year investments to launch and scale their activities, yet other finance available is seasonal or yearly. Further, SMEs are often too big for microfinance but too small to attract commercial investment. There is also insufficient access to upfront and working capital: certain NbS businesses can require upfront financing to establish. Working capital facilities are largely non-existent for novel products or commodities.

Kenyan policymakers can play a critical role in overcoming a number of the aforementioned barriers to investment in NbS. The following enabling environment recommendations fall into two broad buckets; those that require policymakers to develop or reform policy, regulation or incentives, and those that require public spending and investment into activities which will promote NbS investment.

3.2 Policy, regulation and incentives

Kenya could build on its pre-existing climate leadership by incorporating a broader suite of NbS in its NCCAP. The current plan does not capture the same breadth of solutions as Roe et al., 2021, and in particular, does not consider demand-side solutions.[133] As shifting to healthy and sustainable diets has the largest mitigation potential in Kenya in 2030, it would be possible for Kenya to increase the ambition of its NCCAP by looking to include additional NbS. The NCCAP also places almost 4 times the emphasis on afforestation and reforestation as estimated by Roe et al., 2021, implying that some of these initiatives may be costly. The Government of Kenya should consider looking to more innovative and profitable business models to finance these initiatives which may attract greater private investment. As this report illuminates, NbS investment need not sit solely with public finance and therefore the Government of Kenya should not be concerned about expanding the NCCAP, as long as it has an accompanying financing strategy which seeks to crowd in private capital.

Policymakers can incentivize more sustainable behaviours through policy reform. As designers of subsidy, policy and tax regimes, policymakers have a pivotal role to play in incentivizing behaviours of land owners and relevant actors across Kenya. Sustainable solutions in agriculture will become increasingly important over the next decades and dominate Kenya's mitigation potential, coupled with shifting to sustainable, healthy diets and reducing deforestation. Addressing perverse incentives can be a double-positive for nature by both removing the support to damaging BAU practices and providing support to NbS. It is also important for the Government of Kenya to ensure regulation to boost stability and business activity is enforced. This could include policy around compliance, enforcement procedures, land tenure, transparency and reduction in currency volatility. Trade policies should also consider land use, so that trade deals do not put too much pressure on Kenya's natural capital or farmers' abilities to produce in an equitable and environmentally responsible manner.[10] To ease land tenure issues such as conflicts over property boundaries, Rwanda has turned to a digital land registration programme.[134] Kenya is following suit, which will empower Kenyan farmers to take action on their land and reduce international investment risk.

Countries in Sub-Saharan Africa have been able to successfully facilitate growth in NbS, such as Rwanda, which has been one of only three countries in Central and Western Africa to achieve a major reversal in forest decline and reached its goal of 30% forested land area.[135] It has successfully engaged civil society by organizing forest planting seasons, and the private sector through effective policy frameworks, such as privatizing many of the country's woodlots, with private investors managing the forests through long-term concession agreements. They have also expanded and created new national parks in forested areas, helping to leverage income from Rwanda's diversity of endemic flora and fauna.[136]

By increasing policy and advocacy for climate risk disclosure and net zero commitments, policymakers can reduce the reliance on public investment. The Government of Kenya can benefit from engaging with both Kenyan and international AFOLU sector companies. In the first instance, regulation on climate risk assessment and disclosure such as mandating the Taskforce on Climate-related Financial Disclosures (TCFD)[137] in Kenya would require companies to identify their climate risk hotspots and would encourage action – such as transitioning to more resilient NbS practices. Secondly, if these companies plan to reach net zero emissions across the full value chain by 2050, or are required to do so by law, then they will have to invest into NbS in their supply chains in Kenya. By promoting the uptake of net zero commitments and enhancing due diligence regulation, alongside creating a strong investment environment, the Government of Kenya can increase the responsibility of the AFOLU sector in the transition and decrease its own burden. This analysis assumes that companies set Science Based Targets by 2030 and therefore Kenya should consider legislating such targets imminently.

As this report shows, the voluntary carbon market is another mechanism policymakers could harness that can support investment in favour of NbS. Where business models can augment revenues with carbon credits, rural communities can enhance the financial case for their initiatives and make their returns more competitive, further increasing demand for NbS from private financiers who seek an economic return. Policymakers can shape the extent to which Kenya realizes the opportunity of the VCM which, as explored in Chapter 2, is currently underutilized.

3.3 Public spending and investment

Policymakers should focus on capacity building to scale up and increase the supply of investable NbS business models. Many of the solutions to achieve more sustainable land use in Kenya already exist but require support to scale business models to become commercially viable. Initiatives such as Partnership for Forests (P4F) are already catalysing investment in forests and sustainable land use through uniting communities, private companies and the public sector to bring together solutions, capital and technical assistance.[138] Capacity building in the rural economy will be key to both securing the pipeline of initiatives by ensuring their effectiveness and in garnering the political will and public support necessary to sustain the transition in the long term. Knowledge sharing on the best business models for specific solutions in specific biomes for generating returns for farmers and investors will also be needed to scale private finance. In Kenya, this knowledge should be drawn from Indigenous Peoples and Local Communities (IPLCs) who have a unique understanding of how to create value from their ecosystems.

Developing mechanisms for aggregation opens Kenya up to a broader range of international investors. Smallholder farming is dominant in Kenya, with 98% of farms making up 66% of agricultural land and occupying on average less than 5 hectares of land each.[139] Local and national government could play a key role in fostering initiatives that work with smallholders and small enterprises to aggregate their initiatives into a package of solutions which can be financed through a sole investment. This increases the overall ticket size, reduces the transaction costs of investments and can reduce risk to investors, allowing larger financial institutions such as pension funds or insurance companies to invest. Increasing smallholder and indigenous access to markets for sustainable commodities will be essential to guarantee the transition. Aggregators could come in many forms – for example, this research has highlighted cooperatives, landscape-level carbon projects and supply chain investments that all achieve a level of aggregation. Producers Direct has developed "Centres of Excellence" which provide smallholders with access to loans, training and support market access.[140]

Additional investments into cross-cutting activities such as technology development will improve the ease of implementation of NbS opportunities in Kenya. In particular, improved land governance, spatial planning and monitoring systems will be needed to address cross-border challenges such as creating deforestation-free supply chains for multinational corporations. Technology can support both on-the-ground implementation of NbS and the investment assessment of such opportunities, through increased data availability and quality. For example, the African Green Revolution Alliance (AGRA) and Atlas AI have developed predictive analytics for crop harvests to support farmers, investors and policymakers. Research into the understanding and use of endemic tree, plant and seed species would increase the efficacy of restoration activities and support the development of productive and nutritious food production. Investment into increasing the accessibility and affordability of agri-tech could help farmers transition to more sustainable activities. For instance, precision nitrogen application technologies can help farmers apply fertilizer more accurately and reduce the amount applied. Additionally, platforms such as Hello Tractor, which use Internet of Things (IoT) technology to improve smallholder farmers access to tractors could be expanded into other sectors helping to facilitate the ease of use of novel technologies.[141]

The Government of Kenya can stimulate demand for climate-positive commodities through its public procurement. Public procurement for schools, government offices, hospitals and prisons can stimulate demand for healthier, more sustainable products. This can send a demand signal to value chain actors (from farmers to retailers) for healthier and plant-based alternatives as well as sustainably sourced commodities. First and foremost, food procurement must focus on delivering nutritious food in suitable quantities as to support a healthy lifestyle. A similar approach could be used for procurement of other products which rely on natural materials. This could include clothing, furniture or timber building materials.

Chapter 4 :
Conclusions and next steps

Conclusions of this analysis

There is a strong investment case for NbS in Kenya. The 19 solutions presented here could mitigate 80 $MtCO_2e$ per year by 2050. NbS would provide additional benefits including supporting biodiversity, food security, resilience and improving livelihoods and health outcomes (not quantified here). The majority of solutions can be achieved at low cost (USD 71 per tCO_2e on average), and some yield strong returns (predominantly agricultural solutions). There are also promising new business models which should be adopted in coming years to unlock higher returns for currently unprofitable solutions.

In order to unlock the full benefits of these solutions, USD 1.2 billion will need to be invested per year by 2050, relating to just over 1% of current GDP. This implies a 13-fold increase in annual investment into NbS in Kenya from current finance flows. Of the finance required for agriculture, over 90% could be covered by diverting pre-existing finance in agricultural production systems towards the more sustainable NbS practices.

Investment should not be reliant on public finance alone and should come from a wide range of instruments and investors. Government, DFI and corporate finance is critical, and together they are projected to make up almost all finance in 2025. However, this is not a static picture; by deploying finance from these actors catalytically – through grants and supply-chain finance aimed at initiatives that generate financial returns in the long-run – buy-in from other financial institutions can be leveraged later on in the transition. By 2050, most investments would generate a financial return and the opportunity this presents will interest the spectrum of institutional investors. To make investors aware of and responsible for the transition, policymakers will need to engage with all stakeholders, driving the agenda and highlighting examples of success.

Through developing an enabling environment, Kenyan policymakers can work to decrease the burden on the Government and increase private sector investment. Policymakers should consider policy reform to address perverse incentives for unstainable practices and tackle land tenure issues, alongside increasing regulation and advocacy for climate risk due diligence and corporate net zero targets. In addition, investment into capacity building of land managers and farmers to increase the supply of effective and investable solutions, whilst considering mechanisms to package smallholder initiatives into larger, single investments will unlock a broader range of investors. Focusing on a combination of these actions in the near term will help to crowd in private investment and reduce the need for public finance in the future.

Next steps FOLU and others can take to build on this analysis

This analysis is an essential first step in unlocking the multitude of benefits Kenya could receive through implementing NbS; however, more needs to be done to support the transition. By undertaking additional research, data collection and engagement, more nuance can be built into the financing strategies, for example by considering how the business models may change at a county level.

Additional data collection on costs and environmental and social benefits of NbS could improve the financing strategies and support investment selection. Improving the dataset on NbS costs and revenues to ensure all solutions can be specific to Kenya is vital. Additional data on regional or biome specific changes and to demonstrate different business models would also help to inform specific finance strategies and allow investors to explore realistic initiative-level economics. Expanding the dataset to other benefits such as food security or resilience would further strengthen the analysis. Finally, more accurate projections of how costs and revenues may vary over space and time would increase accuracy as, for example, opportunity costs are context specific and can fluctuate. Building a tool which combines all of this information would enable effective prioritization of NbS in Kenya.

Collaborating with policymakers, investors and initiative developers can help to grow the database, enhance the analysis and start to drive finance flows into NbS.

- Collaborating with policymakers could involve improving data quality, starting to map out the policies necessary to create the right enabling environment and developing engagement plans for the Government to increase investment by the private sector, such as with global corporates.

- Working with private investors would enable the analysis to align with more types of investor and to be able to vary the profiles of the current investors. It will be important to engage with corporates to understand the net zero strategies in place and the mechanisms they can use to invest in NbS in their supply chains.

- Engaging with research organizations and economists who have expertise in NbS would support the broader data collection effort that is vital to continued work in this space.

- NbS initiative developers could provide data from real examples and help increase the understanding of potential business models and financing strategies which can be used for each of these solutions.

- There is an opportunity to engage with the Government of Kenya, researchers and spatial intelligence experts to establish where specific NbS opportunities exist to further guide investment.

- There are many more NbS business models than have been considered by this study, which have begun to be synthesized in the annex. Future work and collaborations should allow for full appreciation of these different business models.

Beyond Kenya, this analysis could expand to other countries and a global analysis. This report sits alongside similar analysis for Kenya providing initial deep dives into financing strategies for NbS. Adding further countries and being able to draw comparisons, will help policymakers understand the NbS opportunities they should prioritize and promote.

Annexes

1. NbS data selection

This annex provides an overview of the sources, assumptions and cost categories used while determining the cost of financing Nature-based Solutions for Kenya. Initiatives were selected based on the quality of the data. If no high-quality data was available in Kenya, initiatives from countries in the same region with better quality data were selected. If this was not available, data was selected from countries on a similar development trajectory. Specific details about the initiative have been deliberately omitted from this case study due to the commercially sensitive nature of some of the data. This has been agreed with partners. Additionally, in certain instance data has been manipulated to maintain consistency throughout all solutions.

Reduce deforestation

	Avoided unsustainable timber extraction and fuel wood collection. Shifting cultivation towards pasture in Tanzania
Source	Merger et al 2012[142]
Description	Three REDD+ pilot initiatives in Tanzania, representing an area of 327,825 h, help to shift away from unsustainable forestry and fuel wood collection. Initiatives aim to provide alternative income via pasture instead.
Cost category	• Establishment, enabling and transaction costs are based upon that costs that originate from the development of the alternate business model. • Opportunity costs are calculated by the averaged loss of profit in firewood, charcoal and unsustainable timber production.
Key assumptions	Profit from unsustainable charcoal and timber production can serve as a proxy for opportunity costs as it is a main driver for deforestation in the region. Tanzania can be used as a proxy for Kenya, given the regional and developmental similarities.

Reduce mangrove loss

	Protecting mangroves in Kenya by providing locals with income from Voluntary Carbon Market
Source	Jakovac et al, 2020[143]
Description	Generating carbon credits and sharing benefits with local communities to protect and restore mangroves that are otherwise threatened by logging, fishing and land clearing.
Cost category	• Establishment costs are calculated based upon the setting up of the initiative. • Operation and management (O&M) costs come from the day-to-day management of the initiative. • Opportunity costs are provided by Jakovac (2020) who assessed the potential profit from unsustainable land use per year across the globe.
Key assumptions	Assuming that this initiative, which sells carbon credits at an inflated price due to its high quality, can be representative of future protection initiatives.

Reduce peatland degradation and conversion

	Reducing peatland fires in Indonesia
Source	Systemiq analysis
Description	Increase fire management and monitoring water levels to prevent further damage to peatlands, including community engagement to stop intentional fires.
Cost category	• O&M costs were established based upon the setting up and management of this initiative. • Revenues from carbon credits. • Opportunity costs were identified by calculating average net income from Indonesian smallholder farmer based upon FAO data.
Key assumptions	Indonesia was used as a proxy for Kenya given the relatively similar development trajectories the countries are on and the fact that there was a lack of high quality data available from Sub-Saharan Africa.

Improve forest management

	Setting up sustainable woodlots (Eucalyptus) in Kenya
Source	Cheboiwo et al 2018,[144] Merger et al., 2012[145]
Description	A cost overview of a new ecologically sound eucalyptus plantation in Kenya that is well managed through sustainable practices (e.g., proper tree density, spot weeding, efficient nutrient use) that reduce harm to the local environment.
Cost category	• Establishment costs from the setting up of the initiative, including the costs associated with having to clear the land. • O&M costs from maintaining the initiative. • Revenue from the sales of the wood and poles. • Opportunity costs come from unsustainable timber production in Tanzania.
Key assumptions	Unsustainable timber production in Tanzania can be used as proxy for Kenya, given the similar development and regional circumstances.

Grassland fire management

	Improving fire management in a savanna grassland
Source	WALFA fire management report[146]
Description	Reducing early season grassland fires by improving fire management and control. Cost covered and revenue generated by sales of carbon credits.
Cost category	• Establishment costs come from the setting up of this initiative. • O&M costs come from the starting of early-season fires that take place to limit the overall impact of fire on the landscape. • Revenue comes from the selling of carbon credits.
Key assumptions	O&M, establishment cost and carbon revenue are used from Australia as a proxy for Kenya, this is due to fact that no relevant data exists outside of this country. No business as usual (BAU) data due to the land being unproductive prior to fire management.

Afforestation and reforestation

	Reforestation of degraded cropland via plantations in Kenya
Source	Cheboiwo et al 2019[147]
Description	Restoration from degraded marginal crop lands and un-stocked plantations to sustainably managed commercial bamboo and tree plantations.
Cost category	• Establishment costs come from setting up the initiative, including land preparations. • O&M costs come the management of these plantations • Revenue from the selling of timber and poles. • Opportunity costs come from the average cropland profit in Kenya based upon FAO data.
Key assumptions	Profits from farming serve as a proxy for opportunity costs of reforestation initiatives.

Mangrove restoration

	Mangrove replanting initiatives in sub-Saharan Africa
Source	Feka and Ajonina 2011[148]
Description	Average costs of mangrove restoration initiatives in nine countries in Western and Central Africa.
Cost category	• Establishment costs come from the average startup costs associated with setting up these initiatives. • O&M costs are based upon the maintenance of these initiatives. • Opportunity costs were calculated from loss of profit due to salt mining, which is a major driver of mangrove deforestation in sub-Saharan Africa
Key assumptions	Western and Central Africa can be used as a proxy for Kenya.

Enteric fermentation

	Feeding strategies and manure management for cost-effective mitigation of greenhouse gas emissions from dairy farms in Wisconsin
Source	Dutreuil et al., 2014[150]
Description	An integrated farm system model was used to simulate the economic and environmental impact of changing feed management strategies to more sustainable practices to reduce enteric fermentation on dairy farms in Wisconsin.
Cost category	• O&M costs are calculated based upon the cost of the changing the feed strategies.
Key assumptions	The USA can be used as a proxy for Kenya, based upon the limited data that exists outside of the USA.

Peatland restoration

	Reducing peatland fires in Indonesia
Source	Systemiq analysis
Description	Replanting and restoring peatlands via canals, wells and planting. Costs include community engagement to reduce intentional fires in peatlands.
Cost category	• Establishment, enabling and transactional costs were all used to calculate the startup costs associated with this initiative. • Revenue was calculated based upon the sales of carbon credits. • Opportunity costs were based upon loss of profit from average smallholder farm in Indonesia, using FAO[145] data.
Key assumptions	Indonesia was used as a proxy for Kenya given the relatively similar development trajectories that the countries are on and the fact that there was a lack of high quality data available from Sub-Saharan Africa.

Manure management

	Implementation of small-scale bio digesters in Kenya
Source	Khatri-Chhetri, 2020[151]
Description	Economic assessment of biogas plants in various locations in Kenya, looking at small-scale digesters with a capacity of manure from 4-5 cows.
Cost category	• Establishment costs were based upon the setting up of these biogas plantations. • O&M costs came from the management of this initiative.
Key assumptions	The use of manure for the biodigester does not result in increased need for fertilizers and the investment (establishment costs) are written off over a 10 year period.

Nutrient management

	Improving nutrient management on single crop rice cultivation in China
Source	Systemiq analysis
Description	Change in cost (compared to BAU) for the application of Urea and urease inhibitors on a single rice-cropping area, as well as controlled release of fertilizer through inhibitors.
Cost category	• Incremental change in cost and revenue compared to BAU cost structures.
Key assumptions	Limited data could be found on the isolated impact of nutrient management. Therefore, a top-down analysis was conducted (see source) to determine the changes in costs and revenues. We are assuming that this can be a strong proxy for a bottom-up approach. China can be used as a proxy for Kenya, given the limited data in Sub-Saharan Africa.

Rice cultivation

	Transitioning towards systems of Rice Intensification practices
Source	Denkyirah, 2015[152]
Description	Comparative analysis between conventional rice farming and System of Rice Intensification (SRI) practices for smallholder farms (0,4 hectares) in Ghana. Alongside intensification, practices include wider planning and intermittent watering. Data is an average of 70 conventional farmers and 70 SRI farmers and 220 farmers
Cost category	• Cost and revenues of BAU rice production with incremental changes in revenue and costs associated with switching towards SRI. • O&M costs from labor, material and other various inputs. • Transaction costs that came with the administrative processes associated with this initiative.
Key assumptions	Ghana can be used as a proxy for Kenya. The costs and revenue over a 5-year period can be averaged out to provide a nuanced image. There are no establishment costs switching from BAU to SRI.

Agroforestry

	Agroforestry with coffee in Laos including carbon accreditation
Source	Lopez-Sampson et al., 2020[153]
Description	Production of organic coffee combined with trees in Laos
Cost category	• Establishment costs from setting up the new agroforestry initiative. • O&M costs from managing the agroforestry coffee initiative. • Opportunity costs from profit produced by non-agroforestry based coffee farming in Nicaragua. • Revenue from selling coffee and non-coffee products in Ethiopia
Key assumptions	Cost and revenue data from Laos, Nicaragua and Ethiopia which all have very high quality and detailed data, can serve as proxies for Kenya. Average farmers income from coffee sales can serve as a proxy for opportunity costs.

Biochar from crop residue

	Application of biochar as a one-off investment
Source	Dickinson et al, 2014[154]
Description	Cost of biochar at a 12 t/ha application rate on cereal farming in Kenya.
Cost category	• Establishment costs are identified through a one-off application of biochar at the start of initiative.
Key assumptions	Biochar application is an on-off action.

Soil organic carbon in grassland

	Restoration of overgrazed land via reseeding in Kenya
Source	Bebe, 2003[155] Manyeki et al, 2015[156]
Description	Natural pasture rehabilitation through reseeding in Kenya. A comparison between various grass types. Main driver for grassland reduction is overgrazing.
Cost category	• O&M costs from the management of this initiative, including labor and pasture reseeding. • Revenue generated from the selling of cattle. • Opportunity costs were calculated based upon the profits from BAU milk sales.
Key assumptions	Costs and benefits from various grass types can be averaged.

Soil organic carbon cropland

	No-till practices on rice fields in Nigeria
Source	Magani & Shave, 2011[157]
Description	Comparison between various rice cultivation practices in the lowlands of Nigeria on small plots of land with comparable conditions. Differences between no-till and BAU were determined on a small plot (0,06h).
Cost category	• O&M costs based upon the management the no-tillage rice cultivation initiative. • Revenue based upon the sale of the rice. • Incremental change in costs and revenue between non-till and till production.
Key assumptions	No-till farming in Nigeria can serve as a proxy for Kenya. Rice cultivation serves as a good proxy for no-till farming.

Increase clean cookstoves

	Production and use of clean cookstoves in Ethiopia
Source	Global Alliance for clean cookstoves, 2015[158]
Description	Regional production costs of clean cookstoves in Ethiopia.
Cost category	• Establishment and Transaction costs from setting up the initiative, • Incremental changes in costs are calculated, with this being negative due to the reduction in costs of charcoal purchase that comes from the increased efficiency of the cleaner cookstoves.
Key assumptions	Ethiopia is a good proxy for clean cookstoves in Kenya. Clean cookstoves are sold at production cost / minimal margins.

Reduce food loss and waste

	Top-down analysis on additional cost and revenue (value) of food loss and waste in Kenya
Source	Systemiq analysis
Description	Using national value of the food system (expressed in GDP) to assess the value of FLW along the supply chain (Lipinski, 2020)[155]. Using targets as set by Roe et al, (2021)[156] of FLW reduction of 50% by 2050 as the potential value that can be captured (assuming linear trajectories with 2021 as base). Cost of solutions determined using ReFed data from the United States.
Cost category	• Incremental costs and revenues were calculated based upon changes associated with reducing food waste
Key assumptions	Linear FLW decrease from 2021 to 2050. Value of food system as percentage of GDP as proxy for value of food loss and waste reduction. Mitigation measures will be implemented with cost <100$ or mitigation potential >2MT per year (86% of ReFed proposed measures). Incremental cost as weighted average of measures per phase of the supply chain.

Shift towards sustainable healthy diets

	Top down approach on additional cost and revenue for shifting to a healthier diet in Kenya
Source	Systemiq analysis
Description	Calculating the transition towards a healthy diet using public health campaigns, diversified protein supplies and reduced meat consumption as proxies.
Cost category	Incremental costs and revenues were calculated based upon changes associated with shifting diets.
Key assumptions	Using data from the United Kingdom as a proxy, corrected for price of food, population, number of inhabitants, number of people in public sector and GDP.

BECCS

	No mitigation potential
Source	<no mitigation potential> as determined by Roe et al. 2021[161]
Description	-
Cost category	-
Key assumptions	There is no $/tCO$_2$ CEMP for BECCS in Kenya between 2020-2050

2. NbS results comparison

NbS	Cost-effective mitigation potential (million tCO_2eg)		Cost (million USD)	
	Average annual	Cumulative	Average annual	Cumulative
Reduce deforestation	6	186	1,331	39,940
Reduce peatland degradation	0	18	2	50
Reduce mangrove loss	1	8	30	910
Forest management	3	80	9	277
Grassland and savanna fire management	0	0	0	0
Afforestation and reforestation	6	170	5	158
Peatland restoration	0	0	0	0
Coastal wetland (mangrove) restoration	0	1	0	2
Enteric fermentation	1	18	8	254
Manure management	0	0	0	0
Nutrient management	0	5	0	10
Rice cultivation	0	0	7	203
Agroforestry	6	168	69	2,061
Soil carbon croplands	2	143	0	0
Soil carbon grasslands	5	257	243	7,305
Biochar	9	67	66	1,986
BECCS	0	0	0	0
Food waste	3	91	37	1,110
Sustainable diets	10	288	258	7,730
Clean cookstoves	2	55	0	0

Average $/tCO$_2$eq	Three most significant investors	Most significant instruments
214.38	AFOLU sector corporates, DFIs, Government of Kenya	Market-rate debt, grant
6.36	AFOLU sector corporates, DFIs, philanthropies	Grant, supply-chain finance
50.56	DFIs, Government of Kenya, BVCM	Grant, market-rate debt
3.47	BVCM, Government of Kenya, DFIs	BVCM, grant
0.00	BVCM, DFIs, Government of Kenya	Grant, BVCM
0.93	BVCM, DFIs, Government of Kenya	BVCM, grant
0.06	DFIs, BVCM, Government of Kenya	Grant, BVCM
7.27	BVCM, DFIs, Government of Kenya	Grant, BVCM
14.09	AFOLU sector corporates, Kenyan Government, philanthropies	Grant, supply-chain finance
2.74	AFOLU sector corporates, Government of Kenya, impact investors	Equity, supply-chain finance
38.15	AFOLU sector corporates, DFIs, philanthropies	Grant, supply-chain finance
38.15	AFOLU sector corporates, Government of Kenya, impact investors	Equity, supply-chain finance
12.29	AFOLU sector corporates, Government of Kenya, impact investors	Equity, concessional debt
0.00	AFOLU sector corporates, Kenyan Government, BVCM	Equity, supply-chain finance
51.06	AFOLU sector corporates, Kenyan Government, impact investors	Concessional debt, market-rate debt
7.73	AFOLU sector corporates, DFIs, philanthropies	Grant, supply-chain finance
N/A	N/A	N/A
12.23	AFOLU sector corporates, DFIs, philanthropies	Grant, supply-chain finance
26.87	AFOLU sector corporates, impact investors, Government of Kenya	Equity, grant
0.01	BVCM, VC & angel investors, DFIs	BVCM, grant

3. Possible NbS business models

Source used by project example Other potential sources

Measure	Cost saving or efficiency gain	Growth of existing market	New goods or services	New revenue streams	Examples
Reduce deforestation					Carbon credits, PES, forest products e.g. wild honey, sale of monitoring data
Reduce mangrove loss					Carbon credits, PES, sale of monitoring data
Reduce peatland degradation and conversion					Carbon credits, PES, sale of monitoring data
Forest management					Carbon credits, sustainably sourced products e.g. palm oil, carbon credits, sale of monitoring data
Grassland and savana fire mgmt					Carbon credits, payment for ecosystem services (PES)
Afforestation and reforestation					Carbon credits, sale of new forest e.g. coffee, 'Dragons blood' and data
Coastal wetland (mangrove) restoration					Carbon credits, PES, sale of monitoring data
Peatland restoration					Carbon credits, PES, sale of monitoring data
Enteric fermentation					Carbon credits, PES, cost savings from higher productivity, sale of new products which reduce methane
Manure management					Carbon credits, revenue from sale of new anaerobic digesters
Rice cultivation					Carbon credits, potential increased yields, premium for sustainably sourced products
Nutrient management					Carbon credits, reduced cost of fertiliser inputs, sale of biofertilisers
Agroforestry					Carbon credits, potential increased yields, premium for sustainably sourced products, sale of additional products
Biochar					Carbon credits, PES, sale of biochar or pyrolyser technology
Soil carbon croplands					Carbon credits, potential increased yields
Soil carbon grasslands					Carbon credits, potential increased yields
BECCS					Carbon credits, electricity generation
Food waste					Cost savings through less wastage, sale of new data and solutions for reducing waste
Healthy diets					Health cost savings, sales of existing and new protein alternatives
Clean cookstoves					Carbon credits, sale of cookstoves, fuel cost savings

4. Investor profiles

National, local and municipal governments

- **Return on investment:** full range, from below 5% to above 10%
- **Ticket size:** no limits, from USD 0 to above USD 30 million
- **Project maturity:** all stages, from start up to mature projects
- **Investment time horizon:** less than 10 years
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** high

Private/listed business (corporations)

- **Return on investment:** full range, from below 5% to above 10%
- **Ticket size:** no limits, from USD 0 to above USD 30 million
- **Project maturity:** all stages, from start up to mature projects
- **Investment time horizon:** over any timeframe
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty, alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** high

Development finance institutions

- **Return on investment:** below 10%
- **Ticket size:** no limits, from USD 0 to above USD 30 million
- **Project maturity:** all stages up to, but not including, maturity
- **Investment time horizon:** over any timeframe
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty, alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** high

Venture capital and angel investors

- **Return on investment:** above 10%
- **Ticket size:** below USD 30 million
- **Project maturity:** start up and pre-seed projects
- **Investment time horizon:** less than 5 years
- **Do non-fictional benefits influence decisions and if so, what are they?** No
- **Investor's overall risk appetite:** high

Philanthropies (including high net-worth individuals)

- **Return on investment:** below 5%
- **Ticket size:** below USD 10 million
- **Project maturity:** start up and pre-seed
- **Investment time horizon:** over any timeframe
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty, alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** high

Impact investors

- **Return on investment:** full range, from below 5% to above 10%
- **Ticket size:** below USD 30 million
- **Project maturity:** from pre-seed through to mature projects
- **Investment time horizon:** less than 10 years
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty, alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** high

Public/private pension or sovereign wealth funds

- **Return on investment:** below 10%
- **Ticket size:** above USD 5 millions
- **Project maturity:** from pre seed through to maturity
- **Investment time horizon:** over any timeframe
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes. Poverty, alleviation, climate adaptation and resilience, biodiversity, health and food security
- **Investor's overall risk appetite:** medium

Credit unions

- **Return on investment:** below 5%
- **Ticket size:** below USD 20 million
- **Project maturity:** all stages up to, but not including, maturity
- **Investment time horizon:** less than 10 years
- **Do non-fictional benefits influence decisions and if so, what are they?** Yes, food security
- **Investor's overall risk appetite:** high

Insurance companies

- **Return on investment:** 5% to 10%
- **Ticket size:** above USD 5 million
- **Project maturity:** growth and mature projects
- **Investment time horizon:** 5 years or more
- **Do non-fictional benefits influence decisions and if so, what are they?** No
- **Investor's overall risk appetite:** medium

Trading house and brokers

- **Return on investment:** from 0% - 10%
- **Ticket size:** over USD 1 million
- **Project maturity:** growth and mature projects
- **Investment time horizon:** less than 5 years
- **Do non-fictional benefits influence decisions and if so, what are they?** No
- **Investor's overall risk appetite:** medium

Retail and commercial banks

- **Return on investment:** 5% - 10%
- **Ticket size:** below USD 30 million
- **Project maturity:** all stages, from start up to mature projects
- **Investment time horizon:** 5 years or more
- **Do non-fictional benefits influence decisions and if so, what are they?** No
- **Investor's overall risk appetite:** medium

Private equity funds

- **Return on investment:** above 10%
- **Ticket size:** above USD 5 million
- **Project maturity:** from pre-seed through to mature projects
- **Investment time horizon:** less than 10 years
- **Do non-fictional benefits influence decisions and if so, what are they?** No
- **Investor's overall risk appetite:** high

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