



Ministry of Environment and Natural Resources

TECHNICAL REPORT ON THE NATIONAL ASSESSMENT OF FOREST AND LANDSCAPE RESTORATION OPPORTUNITIES IN KENYA 2016



WORLD
RESOURCES
INSTITUTE



Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

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FOREWORD

Many people across the globe rely on the natural environment for food, water, energy and building materials. As society grows, so do the demands for ecosystem services. Humankind is therefore compelled to find a delicate balance between the demand for resources and their sustainable supply. When this balance is lost, ecosystems become degraded and less productive, providing fewer of the resources that we depend on for survival. In Kenya, we are familiar with this cycle. While we have a wealth of natural ecosystems and resources, we have also seen how quickly they can be depleted. In addition, climate change is amplifying these effects, making it harder for us to plan for the future. In an effort to address these pressures, the Government of Kenya has enacted a number of laws and policies that aim to restore landscapes so that they can continue to provide valuable services. The constitutional mandate to maintain at least 10% tree cover, the National Climate Change Response Strategy, and Kenya's Vision 2030 development roadmap are all examples of these efforts.

In order to be successful in these initiatives and achieve the targets we have set for ourselves, there is need for collaboration and coordination amongst all stakeholders. This is not the sole responsibility of one agency or ministry, but the responsibility of all of us. Landscapes encompass vast areas, and cut across political and social boundaries. Because of this, the County and National government, universities, NGOs, community groups, and the private sector will all need to be involved if we are to reverse the direction of ecosystem degradation, and live in a more verdant and productive world.

The process described in this report presents a critical milestone by the Government of Kenya in enhancement of such a multi-stakeholder effort as we scale up our restoration work. This assessment brought together experts from land

based sectors, especially forests, agriculture, wildlife and rangelands, to form a Landscape Restoration Technical Working Group. With leadership from the Kenya Forest Service, the Landscape Restoration Technical Working Group carried out an in depth analysis of the forest and landscape restoration opportunities in the country. The report highlights the large area of land that can potentially support restoration interventions in Kenya. While this vast area of land may seem daunting, it should be seen as a tremendous opportunity for Kenya to address its development goals by restoring ecosystem services. Restoring forests and landscapes, and the services they provide, is paramount to improving livelihoods for and ensuring we all live in a food secure world. The aim of this assessment is to identify where the opportunities for forest and landscape restoration are located, an important starting point for us as a country to begin working together to achieve large scale changes in our landscapes. This will require broad stakeholder engagement and cooperation, and has the potential to greatly improve the quality of life for millions of Kenyans.

I am hopeful that all of us will put into good use the findings presented in this report as we embark on this important forest and landscape restoration journey together. I urge each one of us to rise to the challenge and chart a path forward for Kenya as we launch the restoration of 5.1 Million hectares of degraded land by 2030. This will be difficult endeavor, but it is important to note that this will not be only about sacrifices, but about the opportunities that lie ahead.



Prof. Judi Wakhungu
Cabinet Secretary
Ministry of Environment and Natural Resources

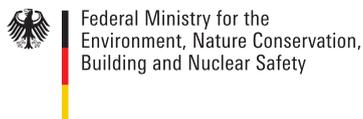
ACKNOWLEDGMENTS

This assessment of forest and landscape restoration opportunities in Kenya was made possible through the contributions and support of the Ministry of Environment and Natural Resources and the Kenya Forest Service. Their leadership role throughout this process was key in ensuring its success. In addition, contributions from the Landscape Restoration Technical Working Group, which spent many hours discussing and determining the appropriate assessment criteria and data needed to generate the ensuing maps and area statistics, was also crucial in producing this report.

The Ministry of Environment and Natural Resources wishes to acknowledge the important roles played by the World Resources Institute, the Clinton Climate Initiative, and the Green Belt Movement, in this assessment.

Further acknowledgment goes to the Government of Germany through the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, and the United Nations Environment Programme through the Global Environment Facility for their financial support that made this assessment possible.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACC	Africa Conservation Centre
AEZ	Agro-Ecological Zone
AFR100	African Forest Landscape Restoration Initiative
BMUB	German Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety
CCI	Clinton Climate Initiative
CO ₂	Carbon Dioxide
DRSRS	Department of Resource Surveys and Remote Sensing
FAO	Food & Agriculture Organisation of the United Nations
GBM	Green Belt Movement
GEF	Global Environment Facility
GoK	Government of Kenya
ICRAF	World Agroforestry Centre
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KARI	Kenya Agricultural Research Institute
KFS	Kenya Forest Service
KWS	Kenya Wildlife Service
LRTWG	Landscape Restoration Technical Working Group
MALF	Ministry of Agriculture, Livestock, and Fisheries
MENR	Ministry of Environment and Natural Resources
Mt	Megaton
PNV	Potential Natural Vegetation
REDD+	Reduce emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks
ROAM	Restoration Opportunities Assessment Methodology
RUE	Rain-Use Efficiency
SRTM	Shuttle Radar Topography Mission
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
WCMC	World Conservation Monitoring Centre of the United Nations
WRI	World Resources Institute
WRMA	Water Resource Management Authority

DEFINITIONS

In the context of this assessment, “national forest and landscape restoration potential maps” was defined as follows:

- **National:** Supporting national-level decision-making. While it is recognized that counties may have priorities other than those defined nationally, these maps were produced with the aim of supporting national level decision-making processes. Counties are encouraged to produce their own maps in order to tailor them to their specific development agendas and circumstances.
- **Landscape:** Social-ecological system that consists of a mosaic of natural and/or human-modified ecosystems. (Buck and Bailey, 2014);
- **Restoration:** Long-term process of regaining ecological functions and enhancing human well-being in degraded landscapes. This process may or may not result in the reestablishment of the original vegetation.
- **Potential maps:** Mapping where landscape restoration opportunities could potentially be implemented. These maps do not show where each landscape restoration option should be implemented, rather, they indicate where restoration potential criteria are met and guide where to conduct further assessment and stakeholder engagement. The decision of which restoration option to implement where lies with the local stakeholders as they will be the ones managing the land, reaping the benefits and bearing the costs of implementing these options.
- **Tree-based:** Adding more trees into landscapes. This may be as a forest or, in other cases, as agro- or silvo-pastoralism and other land uses.
- **Forest:** Kenyan forests are defined as land spanning more than 0.5 hectares with trees of at least 2 meters and a minimum canopy cover of 15%, and include natural and planted plantation forests on state, community and private land. (KFS, 2016).
- **Forest Landscape:** A landscape where trees or forests play a key role in ecosystem health and productivity, providing multiple ecological functions and benefits to human well-being. (Adapted from IUCN and WRI, 2014)

SUMMARY

The purpose of this report is to document the process taken by the Government of Kenya to identify and map potential areas suitable for different landscape restoration options in the country. The report describes the data and analysis carried out by the Landscape Restoration Technical Working Group, with technical support from the World Resources Institute, the Clinton Climate Initiative and the Green Belt Movement. The methods, maps and statistics presented in this report will inform the implementation of the constitutional target of reaching at least 10% tree cover. In addition, the report provides a summary of the area statistics for potential landscape restoration options and proposes three potential scenarios for consideration by the Government of Kenya to inform its restoration commitment to the Bonn Challenge, New York Declaration on Forests and the African Forest Landscape Restoration Initiative (AFR100.) Finally, the report provides the carbon sequestration potential for each of the proposed restoration scenarios.

INTRODUCTION

Much of the planet's lands and landscapes are becoming degraded, causing a myriad of different challenges to people and wildlife alike. Restoring these landscapes is paramount to improving human livelihoods, long-term food security, biodiversity conservation and climate stability. Trees play an important role in landscapes across the world, helping to provide multiple ecosystem services such as stabilizing soils, providing important habitat for wildlife, as well as keeping soils fertile for our agricultural use. By introducing more trees into landscapes, whether as natural forests or as mixed agroforestry systems, and through better land management practices, degradation can be reversed, restoring productivity and resilience (Buckingham et al, 2016). This holds true for the drier regions as well, where rangelands are very important ecosystems for both people and nature. Here, holistic rangeland management, which in some cases may include allowing more trees to regenerate across the landscape, has been shown to revitalize ecosystems and improve livelihoods.

In Kenya, forest restoration is a high priority on the government's agenda, and is reflected in a number of different legislations and policies. The Government of Kenya has put in place several high level initiatives and laws that are strongly linked to restoring lands and their associated ecosystem services. These include:

- The 2010 Constitution calls for reforesting and maintaining a tree cover of at least 10% of the country (GoK, 2010a);
- The National Climate Change Response Strategy calls for growing 7.6 billion trees on 4.1 million hectares of land during the next 20 years (GoK, 2010b);
- Kenya's Vision 2030 has a flagship project underway for rehabilitating and protecting indigenous forests in the five water towers (Mount Kenya, the Aberdare Range, the Mau Forest Complex, Mount Elgon and the Cherangani Hills), with the goal to increase forest cover and volume of water flowing from the catchment areas (GoK, 2007);
- The Trees-for-Jobs Programme intends to plant one billion trees to increase forest cover and at the same time create employment for youth (GoK, 2008).

In addition to these restoration initiatives, Kenya is also deeply involved with REDD+ Readiness Preparation. One of the priority topics in the national REDD+ Readiness process focuses on the enhancement of forest carbon stocks and proposes several strategy options to restore forests, including support to the Government target to increase tree cover on 10% of Kenya's land, and promote forest protection that increases carbon stocks, livelihood benefits and improves biodiversity (UNEP-WCMC, 2015).

It is clear from the initiatives mentioned above that Kenya has a strong commitment to landscape restoration and has been putting in place the building blocks for improving its tree cover and restoring its landscapes and associated ecosystem services. Landscape restoration will be an important tool in helping the country meet its economic, development, and environmental

goals. Scaling up these restoration initiatives requires a proper assessment of the existing opportunities, planning and resources to support implementation on the ground. In September 2014, the Government of Kenya established a multi-stakeholder Technical Working Group led by the Kenya Forest Service (KFS) to carry out this assessment of potential restoration opportunities – a critical first step towards forging a coordinated strategy for scaling up landscape restoration in Kenya. The Landscape Restoration Technical Working Group includes a broad range of stakeholders from multiple sectors¹. Over the subsequent two years, the LRTWG held a series of landscape restoration workshops that focused on analyzing different landscape restoration options for the country. The group identified the most pressing land use challenges currently affecting Kenya, as well as a list of restoration options that could help address these challenges and restore the ecosystem services that are currently lacking. The various landscape restoration options identified include:

- Reforestation and rehabilitation of degraded natural forests
- Agroforestry and woodlots on cropland
- Commercial tree and bamboo plantations
- Tree-based buffers along waterways, wetlands and roads
- Silvo-pastoral and rangeland restoration

These restoration options can potentially help restore ecosystem services associated with trees, such as erosion control, regulation of water flows and soil quality, as well as forest habitat for wildlife.

In addition, the LRTWG was tasked with mapping and quantifying where these different restoration options could potentially be implemented in order to help inform a national restoration target that will contribute to the many national priorities. Through extensive work and stakeholder engagement, the LRTWG produced several maps and associated area statistics that are presented in this report as potential areas for landscape restoration. These maps can help various state and non-state actors identify:

- Opportunities to scale up agroforestry to reduce erosion, increase livelihood diversification, fodder production and soil fertility;
- Existing forests that can be restocked, as well as where new natural forests can be established, to increase carbon sequestration, biodiversity habitat, and prevent landslides and flooding;
- Areas where trees can stabilize river banks and control sedimentation;
- Where to invest in commercial plantations;
- Where trees can be planted along roadways to help reduce water runoff and air pollution; or
- Where rangelands might benefit from improved management practices.

Because of the multi-sector, multi-stakeholder nature of the LRTWG, these priorities cover a wide range of landscapes,

1. Please see Appendix 1

including forest lands, agricultural lands and rangelands. It is important to note that this has been an iterative process focused on national level planning and opportunities. Once priority landscapes are identified, similar mapping exercises will need to be carried out at the landscape level to ensure local-level plans meet the specific needs of the local communities and biodiversity, and use the best available data for these areas. This report also incorporates feedback from the High-level Landscape Restoration Working Group², which was organized jointly by the Secretary of Natural Resources and Secretary of Environment within the Ministry of Environment and Natural Resources.

METHOD

DATA AND LIMITATIONS

This assessment was conducted using the best readily available data sets that covered the entire country. Where national-level data was not available, global data sets were used. While more data may exist, it was not made readily available during the time this assessment was being conducted. Many of the data sets used are national or global in scope, and therefore set limitations on how the assessment and corresponding maps should be used. The results of this assessment are meant to provide an overview of potential restoration opportunities across all of Kenya in order to inform discussions and help start a dialogue on how best to proceed with landscape restoration activities. The maps should not be used to inform local-level planning of restoration interventions, as the data does not account for all of the specific contexts on the ground. Once a potential project area has been identified, a local-level assessment and community consultations need to be carried

2. Please see Appendix 1

out to ensure that planned activities are aligned with local-level objectives. Local-level assessments may choose to use this national-level technical report as an example of how to proceed at the sub-national level.

OVERALL PROCESS

The process of producing the national forest and landscape restoration potential maps and developing restoration commitment scenarios followed five steps (Figure 1) adapted from the mapping module of the Restoration Opportunity Assessment Methodology (ROAM) (IUCN and WRI, 2014).

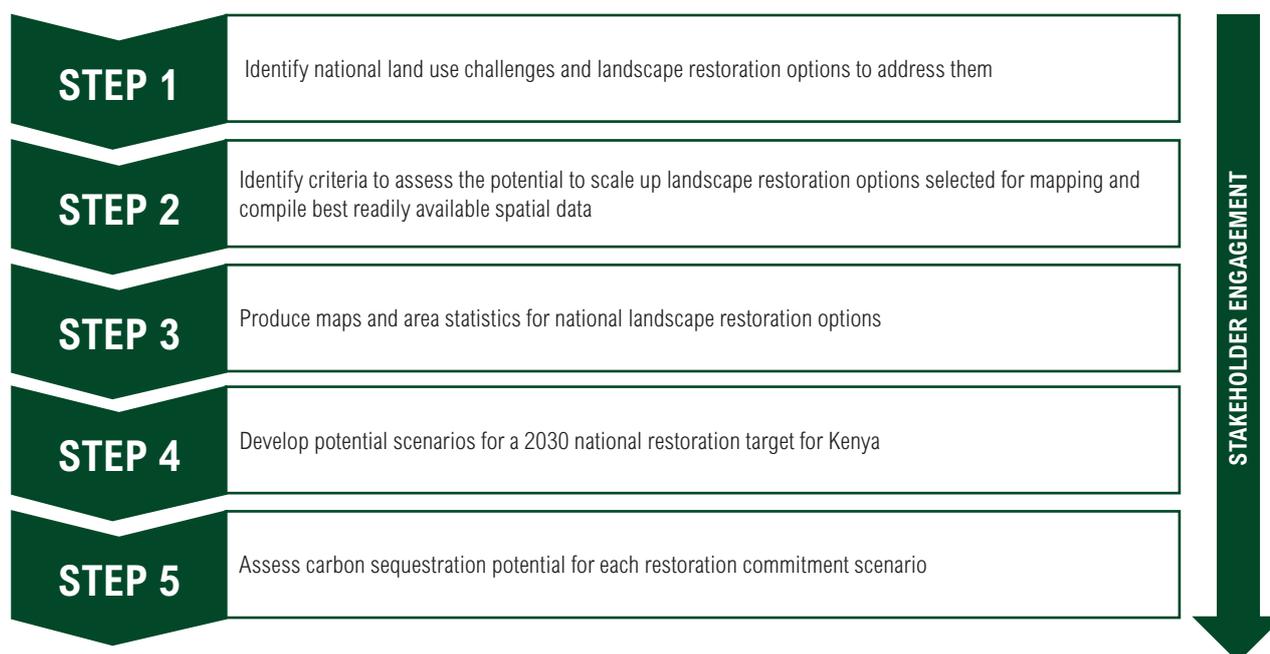
While the steps are presented in a linear fashion they were revisited as need arose based on stakeholder engagement, new knowledge, and new data.

STAKEHOLDER ENGAGEMENT

Throughout the process of mapping national landscape restoration opportunities in Kenya, multi-sector stakeholder engagement and feedback was key in providing guidance on the analysis and results. Landscapes transcend political and jurisdictional boundaries, often times encompassing many different land uses. Because of this, it was important to include representatives from these different sectors to ensure that the concerns and expectations of each group were reflected in the analysis.

In September 2014, a multi-sector consultation workshop was conducted to introduce the concept and benefits of landscape restoration, and to gain an understanding of the land use challenges affecting Kenya. The workshop participants identified the key land use challenges as well as a list of

Figure 1: Steps followed in producing national forest and landscape restoration potential maps



restoration interventions that could potentially mitigate these challenges and these became the focus of the national restoration opportunity mapping efforts. At the conclusion of the workshop, the LRTWG was established in order to carry out the national mapping process.

Throughout the mapping process, the LRTWG engaged with the Secretary of Environment and Secretary of Natural Resources within the Ministry of Environment and Natural Resources, along with representatives from other ministries. This High-level Landscape Restoration Working Group served to review the progress and results of the LRTWG and provided valuable feedback that helped improve the final maps and results.

Upon completion on the data analysis for this assessment, a national stakeholder workshop was convened in March 2016. The objective of this workshop was to ensure that all stakeholders understood the process and results of the maps and that they were in agreement with the assumptions and assessment criteria that were used.

STEP 1: IDENTIFICATION OF NATIONAL LAND USE CHALLENGES AND LANDSCAPE RESTORATION OPTIONS TO ADDRESS THESE CHALLENGES

Identification of national land use challenges

Land use challenges are defined as problems arising from the way land is used and/or managed. Based on how socio-economic factors (e.g., increase in population density, land

tenure, shifting cultivation, lack of land use planning and policy) as well as environmental factors (e.g., changes in climatic patterns, availability of rainfall, wildlife habitat) affect the way land is used and managed, the experts who attended the first consultation workshop identified the following land use challenges as roadblocks to achieving Kenya's national economic, social, and environmental goals³:

- Habitat fragmentation/loss of biodiversity
- Forest degradation
- Loss of soil fertility
- Overgrazing/free grazing
- Deforestation
- Soil erosion
- Siltation and sedimentation of waterbodies
- Water stress (on water bodies and soils)
- Flooding
- Landslides
- Climate change

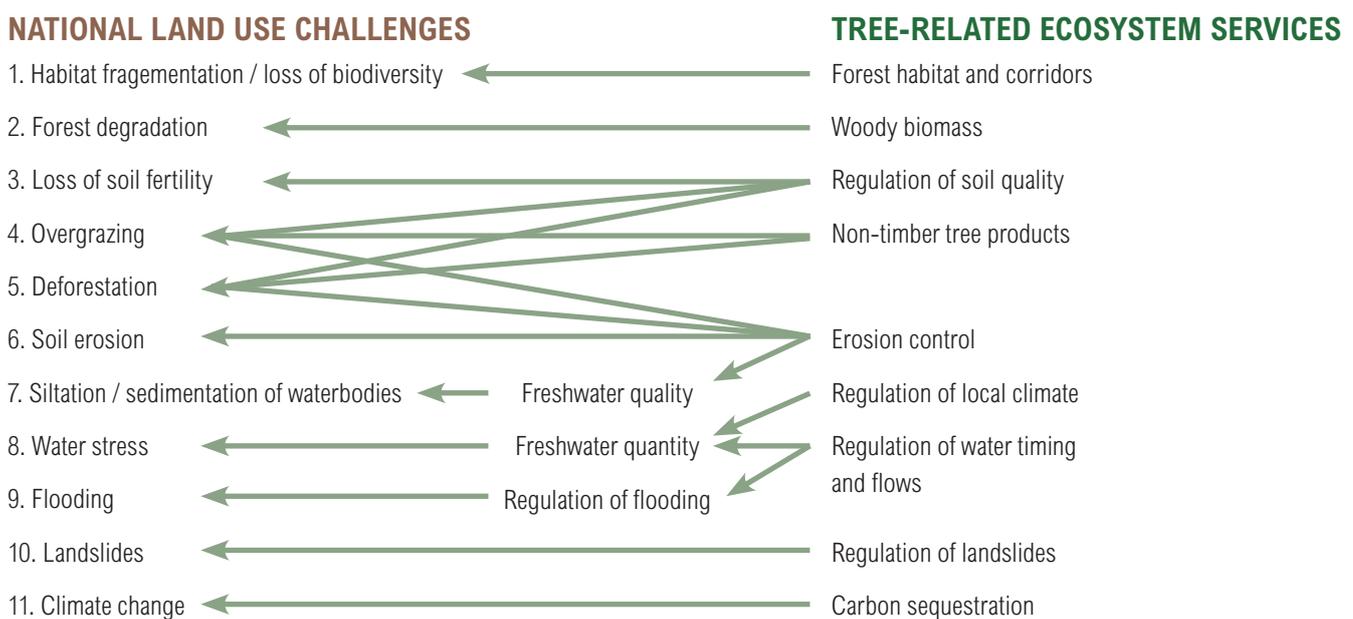
Identification of national landscape restoration options

Trees supply ecosystem services that can directly and indirectly help address the land use challenges identified above (Figure 2). By increasing the number of trees in Kenyan landscapes, these ecosystem services have the potential to be restored.

There are many ways to bring trees back into landscapes depending on the main ecosystem services desired to be

3. Land use challenges specific to counties may differ from these listed here, and should be identified and addressed at the county level following a similar process as the one conducted at the national level.

Figure 2: Trees, ecosystem services, and national land use challenges



restored. The following national landscape restoration opportunities were identified as the most relevant to Kenya:

Option 1: Restoration Opportunities for Afforestation or Reforestation of Natural Forests

Potential opportunity areas where forests could be established on land that had recent forest cover (reforestation) or on land that has been without forest cover for a much longer period (afforestation) (adapted from IPCC, 2000). The term forest refers to a climax ecosystem that can support trees. These forest areas were divided into four distinct types based on KFS forest classifications:

- Montane forest, western rainforest and bamboo
- Coastal forest
- Mangrove forest
- Dryland forest

Option 2: Restoration Opportunities for Rehabilitation of Degraded Natural Forests

Potential opportunity areas for rehabilitating existing natural forests. These differ from option 1 in that these are currently existing forests showing signs of degradation, and option 1 identifies areas that have no current forest cover and need to be reestablished. For the purpose of this national mapping exercise, forest degradation was determined by using distinct tree canopy cover thresholds for the four forest types. The LRTWG recognizes that tree canopy cover alone cannot determine the health of a forest, but in the absence of detailed national data on other factors such as tree species, land productivity, and carbon stocks, tree canopy cover has been used as a proxy.

Option 3: Restoration Opportunities for Agroforestry on Cropland

Potential opportunity areas where on-farm trees or the use of agroforestry could be increased. This can be done through a number of different interventions such as field border plantings, woodlots, agroforests, and inter-planting trees with crops. Two distinct areas were identified for this option:

1. *Agriculture areas with less than 10% tree canopy cover.* Under the Agriculture (Farm Forestry) Rules, 2009 (GoK, 2009), all agriculture lands need to maintain a minimum of 10% tree canopy cover. Areas with less than 10% tree canopy cover are thus not meeting the Agriculture (Farm Forestry) Rules, 2009 and could be targeted as priorities in order to bring them into compliance with the law.
2. *Agriculture areas with more than 10% but less than 30% tree canopy cover.* While 10% is the minimum threshold under the Agriculture (Farm Forestry) Rules, 2009, some areas may be able to increase tree canopy cover above that, particularly on farmlands that have degraded soil quality. 30% tree canopy cover was determined to be the upper threshold for using agroforestry to regenerate degraded land successfully without negatively impacting overall agricultural production. While these areas may

have potential to increase tree canopy cover based on the assessment criteria, feasibility will need to be assessed at individual sites before implementation, as current site productivity may already be high.

Option 4: Restoration Opportunities for Commercial Tree and Bamboo Plantations on Potentially Marginal Cropland and Un-stocked Plantation Forests

Potential areas where commercial tree plantations could be established for the production of wood products for income generation. The LRTWG determined that on potentially marginal cropland that may currently have lower levels of productivity, it may be more beneficial to switch to a tree plantation or agroforest management scheme, including the use of bamboo. In the absence of available data on national cropland productivity, a proxy was used to determine what areas might have marginal agricultural productivity. It is important to recognize though that some of these areas may in fact be producing adequate crop yields and it may not be desirable for alternative land management options. The decision to change land management practices will need to be assessed at the local level. This option also considers areas of officially designated plantation forests that are currently un-stocked or have very low levels of tree canopy cover.

Option 5: Restoration Opportunities for Tree-based Buffer Zones along Water Bodies and Wetlands

Potential areas along water bodies and wetlands where tree buffers can be established, and where currently there are no trees. These areas are very critical due to the importance of trees in helping to reduce erosion and sedimentation into waterways, and because of such, several laws and policies in Kenya require these buffers. It is important to note that while the total area where tree buffers could be established is relatively small, these areas play a key role in managing sediment and water quality and have the potential to provide high levels of ecosystem services and benefits to society and the environment.

Option 6: Restoration Opportunities for Tree-based Buffer Zones along Roads

Potential areas along roads where tree buffers can be established. These buffers are important for controlling local air and noise pollution, as well as run off from road surfaces. While the reserves required under the current law (The Kenya Gazette, 2003) are not specifically intended as tree buffers, the LRTWG agreed that they could accommodate tree plantings to provide ecosystem services until roads are widened or modified in the future.

Option 7: Restoration Opportunities for Rangelands

Potential opportunities for restoration of degraded rangeland and grassland areas. While not one of the original restoration options selected for mapping, throughout the process, the LRTWG and the stakeholders it consulted decided to include rangeland restoration in the analysis because of the large land area it covers (roughly 70% of the country) and because of its importance to livelihoods and

biodiversity. Due to the lack of sufficient data on the current health and productivity or degradation of rangelands, the LRTWG used Rain Use Efficiency (RUE) and tree canopy cover to identify potentially degraded rangelands. RUE measures the long-term changes in net primary productivity, and all rangelands with declines in RUE are assumed to be showing signs of degradation. Areas with the greatest increases in RUE and less than 15% tree canopy cover are assumed to be degraded as this may be a sign of bush encroachment. These areas identify where improved management practices on rangelands could be used to encourage the restoration of silvo-pastoral systems and grasslands to improve grazing quality and wildlife habitat.

It is important to note that by including rangelands in this analysis, the LRTWG is not promoting the establishment of forests or woodlands across Kenya's rangelands, but rather, that some rangeland restoration will use silvo-pastoralism as a strategy, while others will incorporate more holistic management practices to improve grassland productivity. The intended use of the land after restoration would remain for grazing.

These landscape restoration options can potentially address multiple land use challenges as trees and grasslands supply multiple ecosystem services. However, some restoration options may be more appropriate than others in helping address specific land use challenges (Table 1). For example, establishing natural forests and rehabilitating degraded natural

forests are more relevant to addressing habitat fragmentation and loss of biodiversity than commercial tree plantations.

STEP 2: IDENTIFICATION OF CRITERIA TO ASSESS POTENTIAL TO SCALE UP LANDSCAPE RESTORATION OPTIONS SELECTED FOR MAPPING AND COMPILATION OF BEST READILY AVAILABLE NATIONAL SPATIAL DATA

In order to perform the spatial analysis, detailed assessment criteria need to be developed and spatial data need to be collected. The LRTWG went through each restoration option, defining what each restoration option was aiming to identify, and then developing detailed assessment criteria, taking a multi-sector approach. Once assessment criteria were developed, experts on the team helped identify specific national level spatial data that was readily available. This was an iterative process, and once the first draft of the maps were developed, the LRTWG analyzed the maps and made revisions to the assessment criteria to address any issues. The detailed assessment criteria and spatial data for each option can be found below. Note that some spatial data for specific assessment criteria was unavailable and was thus excluded from the current analysis.

Table 1: Landscape restoration options and their potential to partially address identified land use challenges – summary table

NATIONAL LAND USE CHALLENGES RELATED TO TREES	AFFORESTATION OF NATURAL FORESTS	REHABILITATION OF DEGRADED NATURAL FORESTS	AGROFORESTRY ON CROPLAND	COMMERCIAL TREE & BAMBOO PLANTATIONS	TREE-BASED BUFFER ZONES ALONG WATER BODIES AND WETLANDS	TREE-BASED BUFFER ZONES ALONG ROADS	RANGELAND RESTORATION
Habitat fragmentation/ loss of biodiversity	X	X	(X)	(X)	X	X	(X)
Forest degradation	(X)	X	X	(X)	(X)	(X)	X
Loss of soil fertility							X
Overgrazing	(X)	(X)	X		(X)	(X)	X
Deforestation	(X)	(X)	X		(X)	(X)	
Soil Erosion	X	X	X	X	X	X	X
Siltation/sedimentation of water bodies	X	X	X	X	X	X	X
Water stress	X	X	X		X	X	X
Flooding	X	X	X	X	X	X	X
Landslides	X	X	X	(X)	X	X	
Climate change	X	X	X	X	X	X	X

Legend:

X: this restoration option is important to address this land use challenge

(X): this restoration option is secondarily important to address this land use challenge

Option 1: Restoration Opportunities for Afforestation or Reforestation of Natural Forests

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Potential natural vegetation (PNV)	Include vegetation classes that can be classified as forest. (See list of included PNV classes and their Kenya forest grouping below.)	These classes serve as ecological enabling conditions indicating where the natural vegetation is a forest ecosystem. <i>Data source: van Breugel et al 2015</i>
Cropland on steep slopes	Exclude cropland areas with slope less than 35%	“Protection of land with slope exceeding 35 per cent. Any person who cultivates, cuts down or destroys any vegetation, or depastures any livestock on any land of which the slope exceeds 35 per cent shall be guilty of an offence.” (GoK, 1965) Cropland below 35% slope should not be converted to forest. <i>Data sources: SRTM, DEM; KFS 2013, Cropland</i>
Current land cover	Exclude all existing forests	These areas are already forested, but might need restocking or rehabilitation. <i>Data sources: KFS 2013, Forestland; KFS 2013, Forest Legal Status</i>
	Exclude wetlands	It is not desirable to convert wetlands. They provide important ecosystem services and need to be conserved. <i>Data source: KFS 2013, Wetlands</i>
	Exclude natural grasslands and rangelands. In the absence of national data on natural grasslands and rangelands, this analysis excludes rangelands that intersect with the potential natural vegetation classes that form the dryland forest class.	These areas are primarily used for grazing. We make the assumption that not all of the rangelands are natural, and those that intersect with non-dryland potential forests may represent converted natural forests, and thus could be considered for potential afforestation and reforestation efforts. <i>Data sources: KFS 2013, Grasslands; van Breugel et al 2015</i>
	Exclude settlements	Opportunity costs are too high to promote afforestation or reforestation activities in settlements. <i>Data source: KFS 2013, Settlements</i>
Protected Areas	Exclude cropland outside the following protected area classes: <ul style="list-style-type: none"> • National parks • National Reserves • National Sanctuaries • Gazetted Forests • Community and Private Conservancies 	No agriculture should be promoted in these protected areas. <i>Data sources: KWS undated, Wildlife Parks; KFS 2013, Forest Legal Status; IUCN & UNEP-WCMC 2015, WDPA</i>
Altitude	Exclude areas above 3,800 m	Trees cannot grow above the tree line (3,800m). <i>Data source: SRTM undated</i>

The individual potential natural vegetation classes were grouped into four main forest classes. These groupings serve as an estimation of the type of forest that would occur naturally. The Potential Natural Vegetation classes used are those which the LRTWG and other experts identified as having the potential to support forests or woodlands.

1. Montane Forest, Western Rainforest, and Bamboo:

- Afromontane moist transitional forest (Fe)
- Afromontane rain forest (Fa)
- Afromontane undifferentiated forest (Fb)
- Afromontane bamboo (B)
- Afromontane dry transitional forest (Fh)
- Complex of Afromontane undifferentiated forest with wooded grasslands and evergreen or semi-evergreen bushland and thicket at lower margins (Fb/Be/wd)
- Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest (Fi)
- Lake Victoria transitional rain forest (Ff)
- Moist Combretum wooded grassland (Wcm) – (North of Kisumu)⁴
- Single-dominant Hagenia abyssinica forest (Fd)

4. The LRTWG and experts agreed that Moist Combretum wooded grassland (Wcm) would be classified as a montane forest, western rainforest, and bamboo where it occurred north of Kisumu County, and as dryland forest south of Kisumu County.

5. The LRTWG and experts agreed that Moist Combretum wooded grassland (Wcm) would be classified as a montane forest, western rainforest, and bamboo where it occurred north of the Kisumu County, and as dryland forest south of Kisumu County.

2. Coastal Forest:

- Zanzibar-Inhambane lowland rain forest (Fo)
- Zanzibar-Inhambane coastal mosaic (CM)

3. Mangrove:

- Mangrove (M)

4. Dryland Forest:

- Acacia tortilis wooded grassland and woodland (WdK)
- Acacia-Commiphora deciduous wooded grassland + Combretum wooded grassland (compound) (Bdw/Wc)
- Catena of North Zambezi Undifferentiated woodland + edaphic grassland on drainage-impeded or seasonally flooded soils (Wn/g)
- Dry Combretum wooded grassland (Wcd)
- Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (wd)
- Moist Combretum wooded grassland (Wcm) – (South of Kisumu)⁵
- Riverine wooded vegetation (r)
- Somalia-Masai Acacia-Commiphora deciduous bushland and thicket (Bd)
- Transitional zone Somalia-Masai Acacia-Commiphora deciduous bushland and thicket and Dry Combretum wooded grassland (Bd/Wcd)
- Upland Acacia wooded grassland (with sometimes rocky outcrops with evergreen bushland) (We)

Option 2: Restoration Opportunities for Rehabilitation of Degraded Natural Forests

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Degraded natural forests	<p>Categorize all existing forests into four forest types based on which Potential Natural Vegetation class they overlap with.</p> <p>Then using tree canopy cover and agro-ecological zones, classify these forests by level of potential degradation using the criteria listed below.</p>	<p>In the absence of forest degradation data, tree canopy cover and agro-ecological zones were agreed to be acceptable proxies. Each forest type was given different tree canopy cover thresholds to identify forest degradation.</p> <p><i>Data sources: van Breugel et al 2015; KFS 2013, Forest Type; Hansen et al 2013; KARI undated</i></p>
	<p>Non-dryland gazetted forests with no current forest cover (less than 15% tree canopy cover) and all dryland gazetted forests.</p>	<p>These thresholds were determined by the working group based on best knowledge of these forests.</p> <p><i>Data sources: KFS 2013, Forest Legal Status; Hansen et al 2013</i></p>
	<p>Natural forests in the ILEMI triangle were categorized as degraded using the criteria listed below.</p>	<p>In the absence of Potential Natural Vegetation data in the ILEMI triangle, agro ecological zones and tree canopy cover were used instead.</p> <p><i>Data sources: KFS 2013, Forest Type; KARI undated; Hansen et al 2013</i></p>
Natural grasslands and glades	<p>Exclude natural grasslands within forests</p>	<p>Some forests have natural glades and these should not be reforested because they are important for biodiversity.</p> <p><i>Data source: no national data available</i></p>
Non-natural forests	<p>Exclude plantation forests</p>	<p>This option focuses only on natural forests.</p> <p><i>Data source: KFS 2013, Forest Type</i></p>
Current rehabilitation activities	<p>Exclude areas under current rehabilitation programmes</p>	<p>These areas are already being rehabilitated.</p> <p><i>Data source: no national data available</i></p>

1. Montane Forest, Western Rainforest, and Bamboo:

- a) 40-65% Canopy Cover – (Slightly Degraded)
- b) 15-40% Canopy Cover – (Moderately Degraded)
- c) Less than 15% Canopy Cover – (Severely Degraded)

2. Coastal Forests:

- a) 40-65% Canopy Cover – (Slightly degraded)
- b) 15-40% Canopy Cover – (Moderately Degraded)
- c) Less than 15% Canopy Cover – (Severe Degraded)

3. Mangrove Forests:

- a) 15-40% Canopy Cover – (Moderately Degraded)
- b) Less than 15% Canopy Cover – (Severely Degraded)

4. Dryland Forests: It was agreed that dryland forests are unlikely to achieve canopy cover greater than 65%. Because of the variability in forest classes within the dryland forest type, it was agreed that a combination of agro-ecological zone (AEZ) and canopy cover would be used to determine the level of degradation of each forest.

- a) AEZ ≤ 3 and Canopy Cover = 30-40% – (Moderately Degraded)
- b) AEZ = 4 and Canopy Cover = 30-40% – (Moderately Degraded)
- c) AEZ = 5 and Canopy Cover = 15-30% – (Moderately Degraded)
- d) AEZ = 6 and Canopy Cover = 0-15% – (Moderately Degraded)
- e) AEZ ≤ 4 and Canopy Cover ≤ 30% – (Severely Degraded)
- f) AEZ = 5 and Canopy Cover = 0-15% – (Severely Degraded)
- g) AEZ = 7 – (Severely Degraded)

5. Natural Forest in the ILEMI Triangle:

- a) AEZ ≤ 3 and Canopy Cover = 30-40% – (Moderately Degraded)
- b) AEZ = 4 and Canopy Cover = 30-40% – (Moderately Degraded)
- c) AEZ = 5 and Canopy Cover = 15-30% – (Moderately Degraded)
- d) AEZ = 6 and Canopy Cover = 0-15% – (Moderately Degraded)
- e) AEZ ≤ 4 and Canopy Cover ≤ 30% – (Severely Degraded)
- f) AEZ = 5 and Canopy Cover = 0-15% – (Severely Degraded)
- g) AEZ = 7 – (Severely Degraded)

Option 3: Restoration Opportunities for Agroforestry on Cropland

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Current land cover	Include agricultural land only	The goal of the Agriculture (Farm Forestry) Rules, 2009 is to increase tree cover in agricultural land. <i>Data sources: KFS 2013, Cropland</i>
	Exclude large-scale irrigation agriculture	These agricultural practices are not compatible with higher tree cover. <i>Data sources: FAO and DRSRS undated, Rice fields; Wheat and sugar cane, no national data available</i>
Tree canopy cover	Include areas with tree canopy cover < 10% Include areas with tree cover density between 10-30%	The law requires at least 10% tree canopy cover on all agricultural land holdings (GoK, 2009). In addition, agriculture plots that already have 10% tree canopy cover may be able to increase their tree cover even further. The LRTWG estimated that 30% tree canopy cover would be acceptable on some croplands before having a negative impact on production. <i>Data source: Hansen et al 2013</i>
Steep slopes	Exclude cropland areas with slope more than 35%	“Protection of land with slope exceeding 35 per cent. Any person who cultivates, cuts down or destroys any vegetation, or depastures any livestock on any land of which the slope exceeds 35 per cent shall be guilty of an offence.” (GoK, 1965) <i>Data sources: KFS 2013, Cropland; UNEP-WCMC 2015</i>
Protected areas	Exclude the following classes: <ul style="list-style-type: none"> • National parks • National Reserves • National Sanctuaries • Gazetted Forests • Community and Private Conservancies 	No agriculture should be promoted in these protected areas. <i>Data sources: KWS undated, Wildlife Parks; KFS 2013, Forest Legal Status; IUCN & UNEP-WCMC 2015, WDPA</i>

Option 4: Restoration Opportunities for Commercial Tree and Bamboo Plantations on Potentially Marginal Cropland and Un-stocked Plantation Forests

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Commercial Tree and Bamboo Plantations on Potentially Marginal Cropland		
Current land cover	Include potentially marginal cropland Cropland within a 10km buffer along the boundary between agro-ecological zones 4 and 5, as well as zones 2 and 3 for the area surrounding Lake Victoria.	Agriculture areas that fall within this buffer potentially have marginal yields due to ecological stress and low levels of precipitation. Tree plantations may be a viable economic alternative. <i>Data sources: KFS 2013, Cropland; KARI undated</i>
	Exclude natural grasslands and rangelands. In the absence of national data on natural grasslands and rangelands, this analysis excludes rangelands that intersect with the potential natural vegetation classes that form the dryland forest class.	Natural grasslands should not be converted into tree plantations. <i>Data sources: KFS 2013, Grasslands, van Breugel et al 2015</i>
Protected areas	Exclude the following classes: <ul style="list-style-type: none"> • National parks • National Reserves • National Sanctuaries • Gazetted Forests • Community and Private Conservancies 	No agriculture should be promoted in these protected areas. <i>Data sources: KWS undated, Wildlife Parks; KFS 2013, Forest Legal Status; IUCN & UNEP-WCMC 2015, WDPA</i>
Steep slopes	Exclude cropland areas with slope more than 35%	“Protection of land with slope exceeding 35 per cent. Any person who cultivates, cuts down or destroys any vegetation, or depastures any livestock on any land of which the slope exceeds 35 per cent shall be guilty of an offence.” (GoK, 1965) <i>Data sources: KFS 2013, Cropland; UNEP-WCMC 2015</i>
Proximity to roads	Only include areas within a 10km buffer of all road classes	Access to markets is an important factor for commercial plantation success, and proximity to roads ensures that wood products can be transported. <i>Data source: KRB undated</i>
Rainfall	Only include areas with more than 400 mm of precipitation per year	Tree plantations necessitate a minimum of 400 mm of precipitation to have acceptable survival rates. <i>Data source: Hijmans et al 2005</i>
Commercial Tree and Bamboo Plantations in Un-stocked Plantation Forests		
Un-stocked plantations forests	Include plantation forests with less than 15% tree canopy cover	These are un-stocked or understocked plantation forests. <i>Data sources: KFS 2013, Forest Type; Hansen et al 2013</i>

Option 5: Restoration Opportunities for Tree-based Buffer Zones along Water Bodies and Wetlands

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Distance from water bodies and wetlands	30 m buffer zone along lakes, dam reservoirs	<p>There are a number of different policies that refer to the importance of buffer zones: (GoK, 2013), (GoK, 1999), (GoK, 1986), and (GoK, 2002). The buffer distances were developed using these policies and best practices in Kenya.</p> <p><i>Data sources: DRSRS undated, Lakes; MWI undated, Rivers; WRMA 2011, Wetlands; Dams, no national data available</i></p>
	20 m buffer zone along wetlands	
	30 m buffer zone along main rivers	
	15 m buffer zone along secondary rivers	
Current land cover	Exclude existing natural forests, bamboo and mangroves	<p>These areas are already forested.</p> <p><i>Data source: KFS 2013, Forest Type</i></p>

Option 6: Restoration Opportunities for Tree-based Buffer Zones along Roads

ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Road buffers	Class A and B reserves 60 metres, Class C= 40 metres, Class D= 25 metres, Class E= 20 metres.	<p>Class A and B reserves 60 metres, Class C= 40 metres, Class D= 25 metres, Class E= 20 metres. The current law regarding encroachment on classified reserves (The Kenya Gazette, 2003) stipulates the following:</p> <p>Class A and B reserves 60 metres, Class C= 40 metres, Class D= 25 metres, Class E= 20 metres.</p> <p><i>Data source: KRB undated</i></p>
Current land cover	Exclude all existing forests and wetlands	<p>Forested areas already have tree cover. It is not desirable to convert wetlands as they provide important ecosystem services and need to be conserved.</p> <p><i>Data source: KFS 2013, Forestland and Wetlands</i></p>

Option 7: Restoration Opportunities for Rangelands

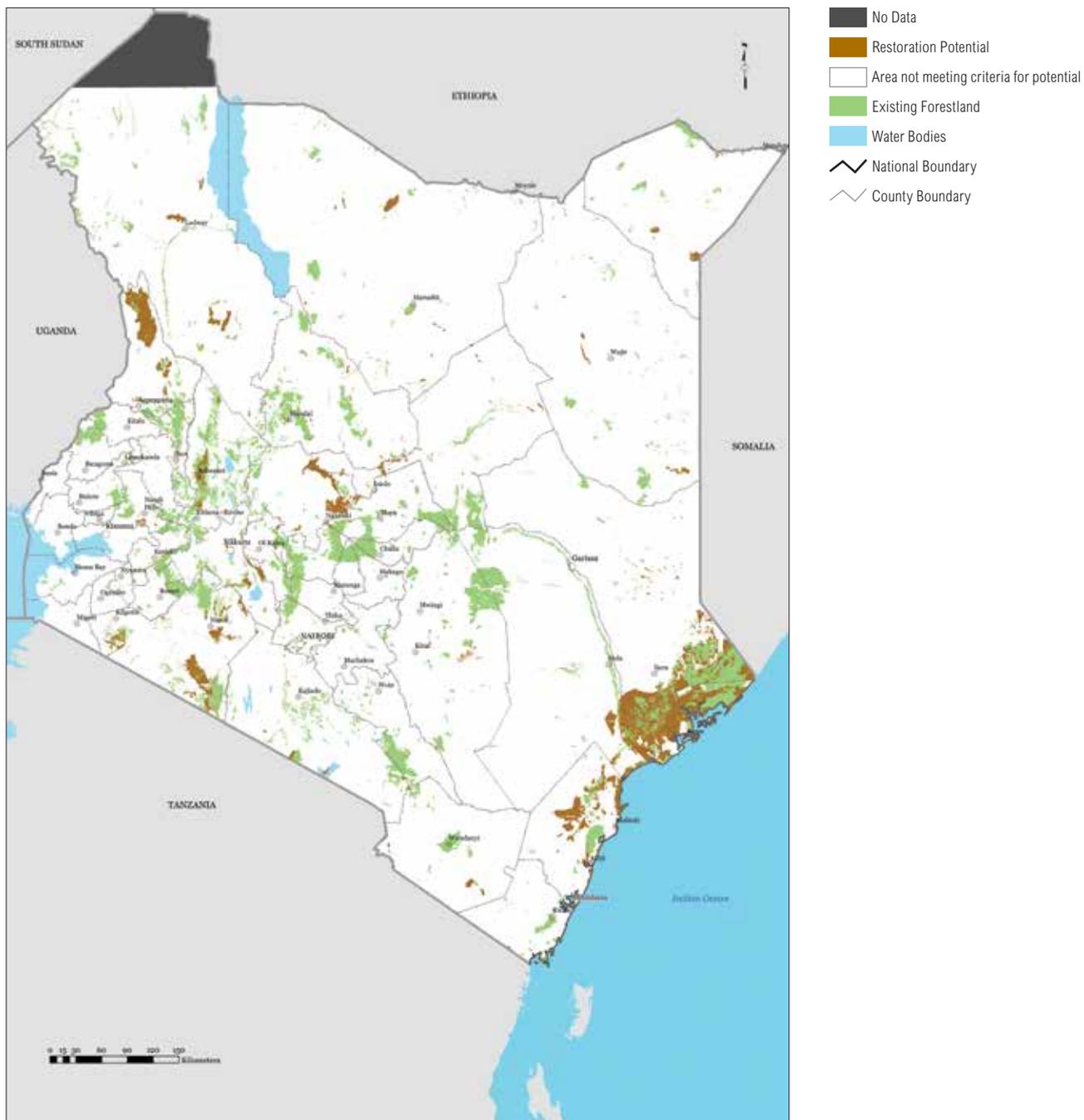
ASSESSMENT CRITERIA	VALUE	JUSTIFICATION AND SOURCE OF SPATIAL DATA
Current land cover	Include only grassland land cover class, as this is the only class that encompasses rangelands.	Silvo-pastoralism, livestock and wildlife grazing occurs on rangelands. <i>Data source: KFS 2013, Grassland</i>
	Exclude all cropland, wetlands, settlements, and otherland.	These land cover classes do not include rangelands. <i>Data source: KFS 2013, Cropland, Wetlands, Settlements, and Otherland</i>
	Exclude all existing forests	Silvo-pastoral and grassland restoration should only occur in rangelands. Forests should not be substituted for rangelands. <i>Data sources: KFS 2013, Forest; KFS 2013, Forest Legal Status</i>
Land degradation	All rangelands with negative RUE are assumed to be showing signs of degradation. Areas with the highest increases in RUE and less than 15% tree canopy cover are assumed to be degraded, as these are non-forest/woodland areas that are showing high increases in net primary productivity which may represent bush or invasive species encroachment.	RUE shows the long-term changes in net primary productivity. Areas with negative RUE values show a long-term decline in net primary productivity with relation to rainfall, whereas positive RUE values represent a long-term increase in net productivity. In the absence of national data on invasive species, woody biomass and grazing pressure, it is difficult to determine if increases or decreases in RUE represent degradation. Local level assessments will be needed. <i>Data sources: FAO 2008; Hansen et al 2003</i>

STEP 3: PRODUCTION OF MAPS AND AREA STATISTICS FOR NATIONAL LANDSCAPE RESTORATION OPTIONS SELECTED FOR MAPPING

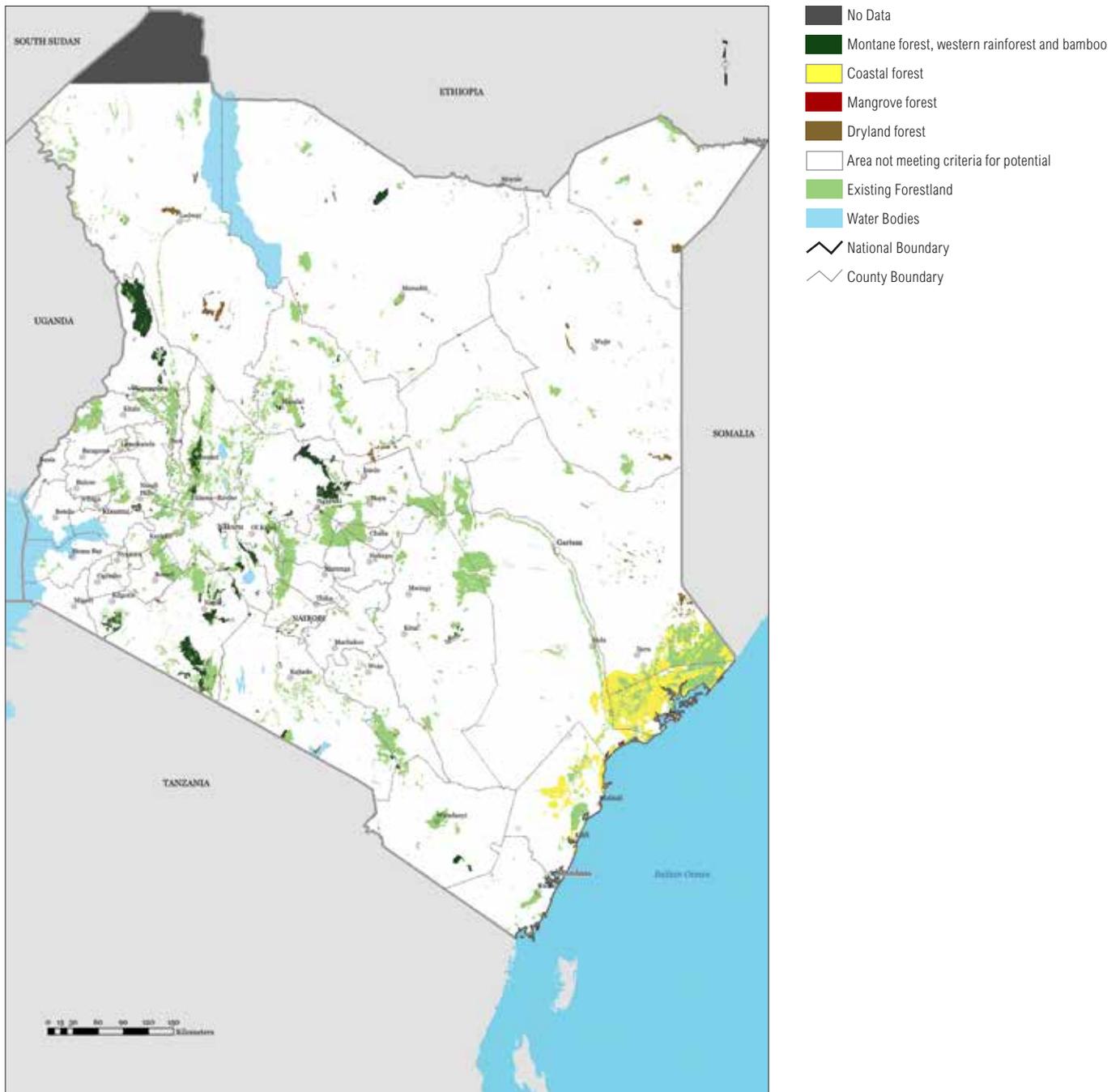
Once assessment criteria was developed for each of the restoration options selected, spatial analysis and mapping were conducted. Multiple drafts of the maps were developed and revised by the LRTWG. Each revision process further refined the assessment criteria and identified additional spatial data that would be useful in developing a thorough analysis. The maps of each restoration option can be found below.

RESULTS

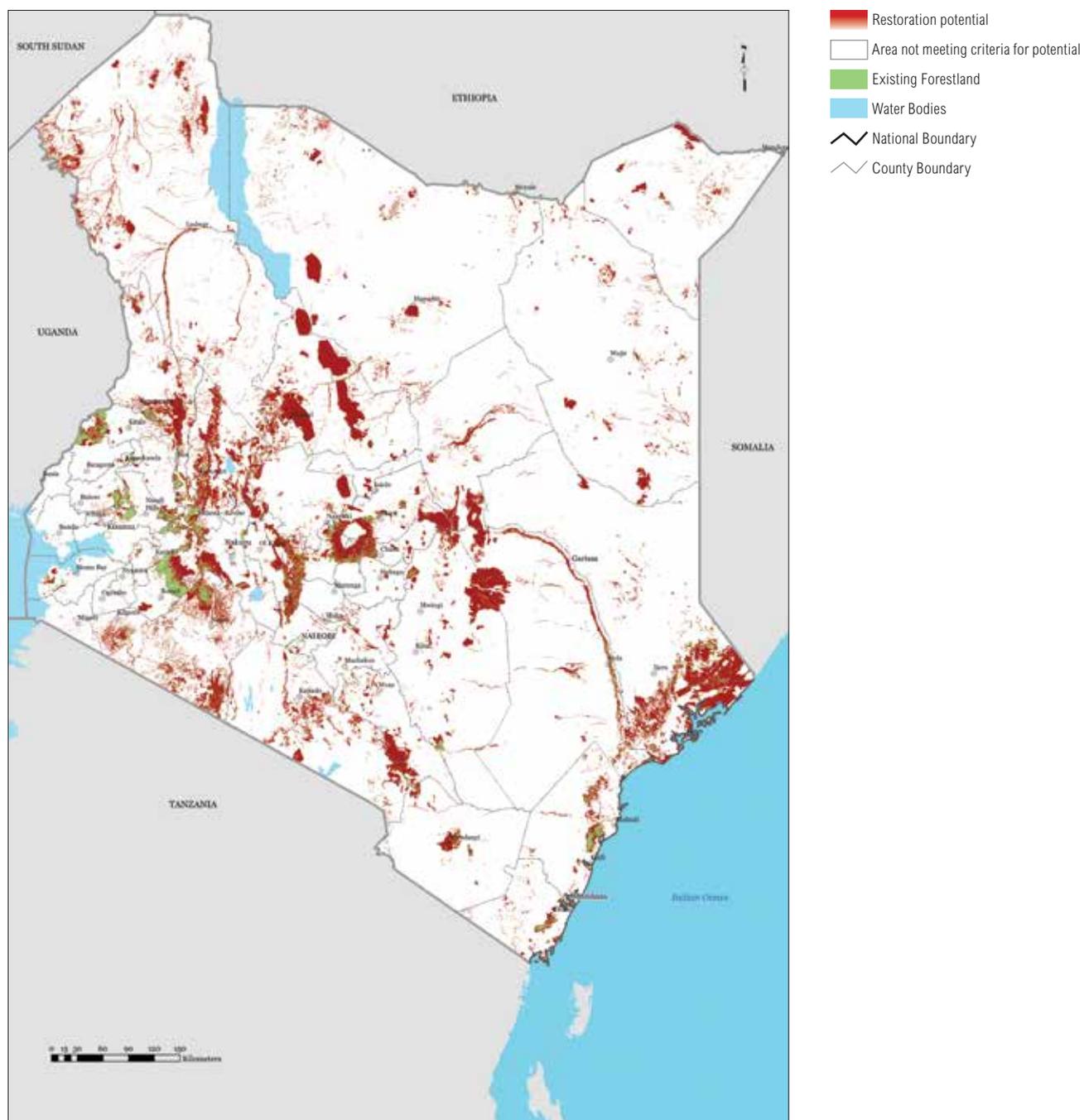
MAP 1A: RESTORATION POTENTIAL FOR AFFORESTATION OR REFORESTATION OF NATURAL FORESTS



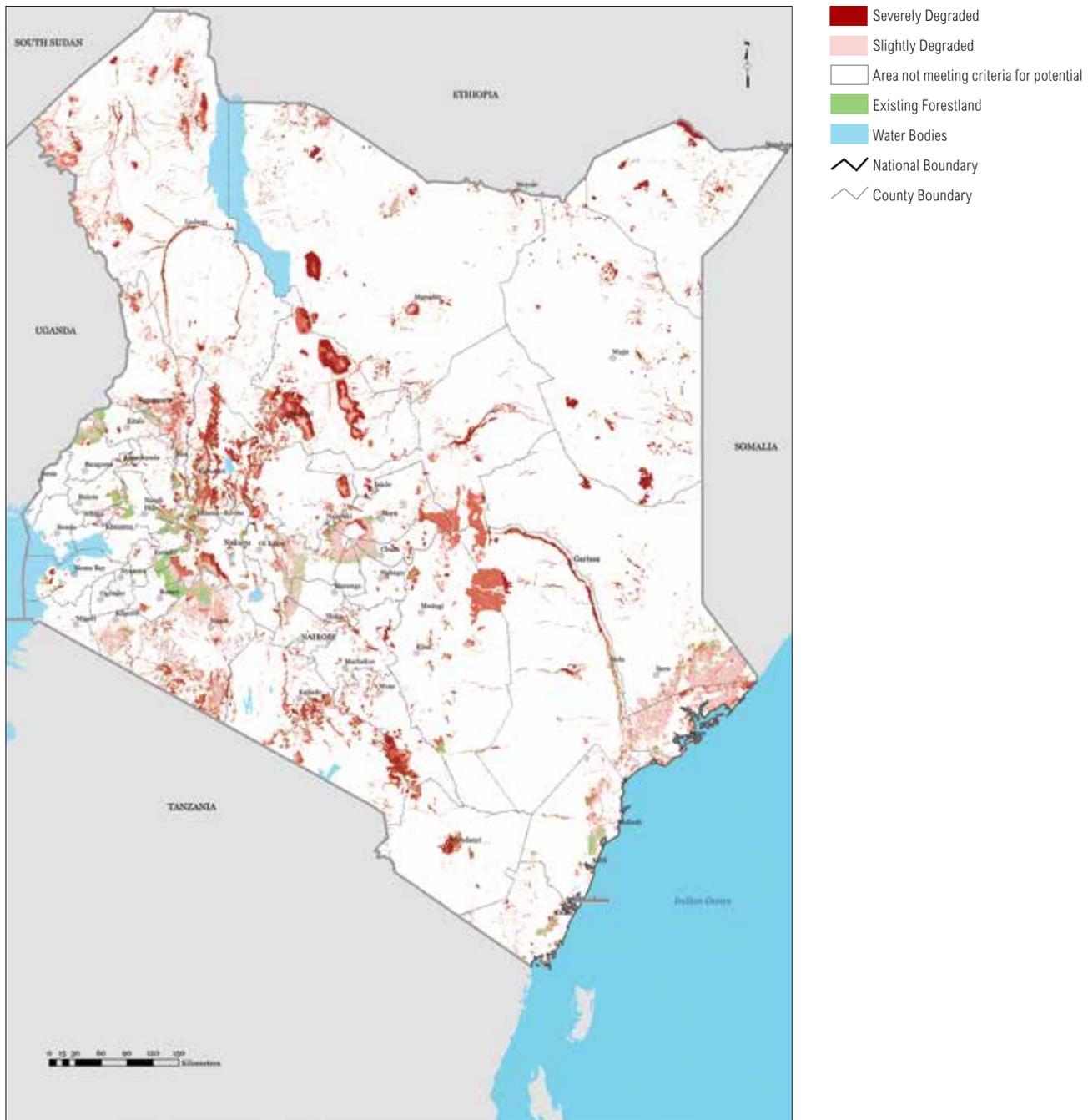
MAP 1B: RESTORATION POTENTIAL FOR AFFORESTATION OR REFORESTATION OF NATURAL FORESTS BY FOREST TYPE



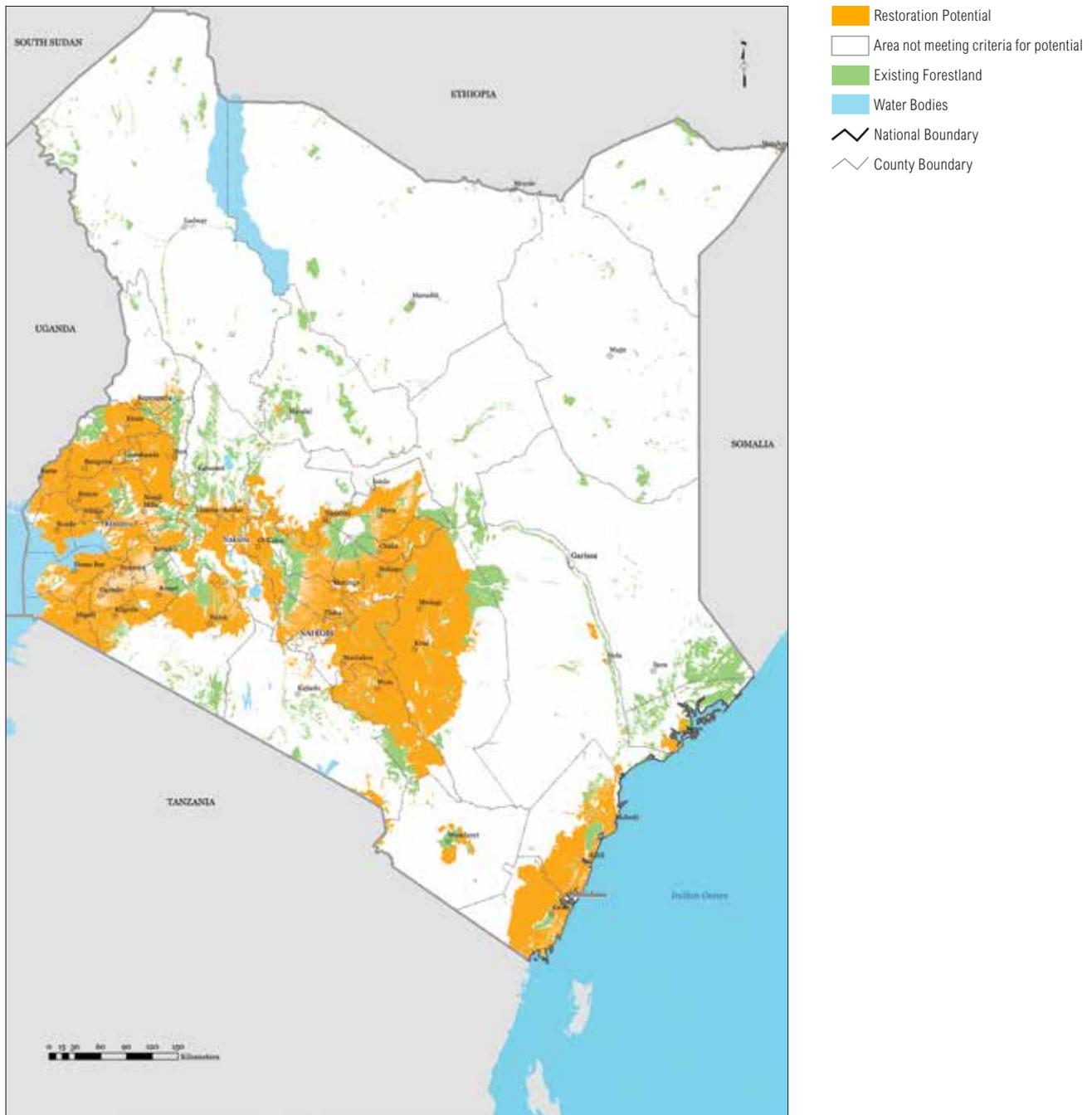
MAP 2A: RESTORATION POTENTIAL FOR REHABILITATION OF DEGRADED NATURAL FORESTS



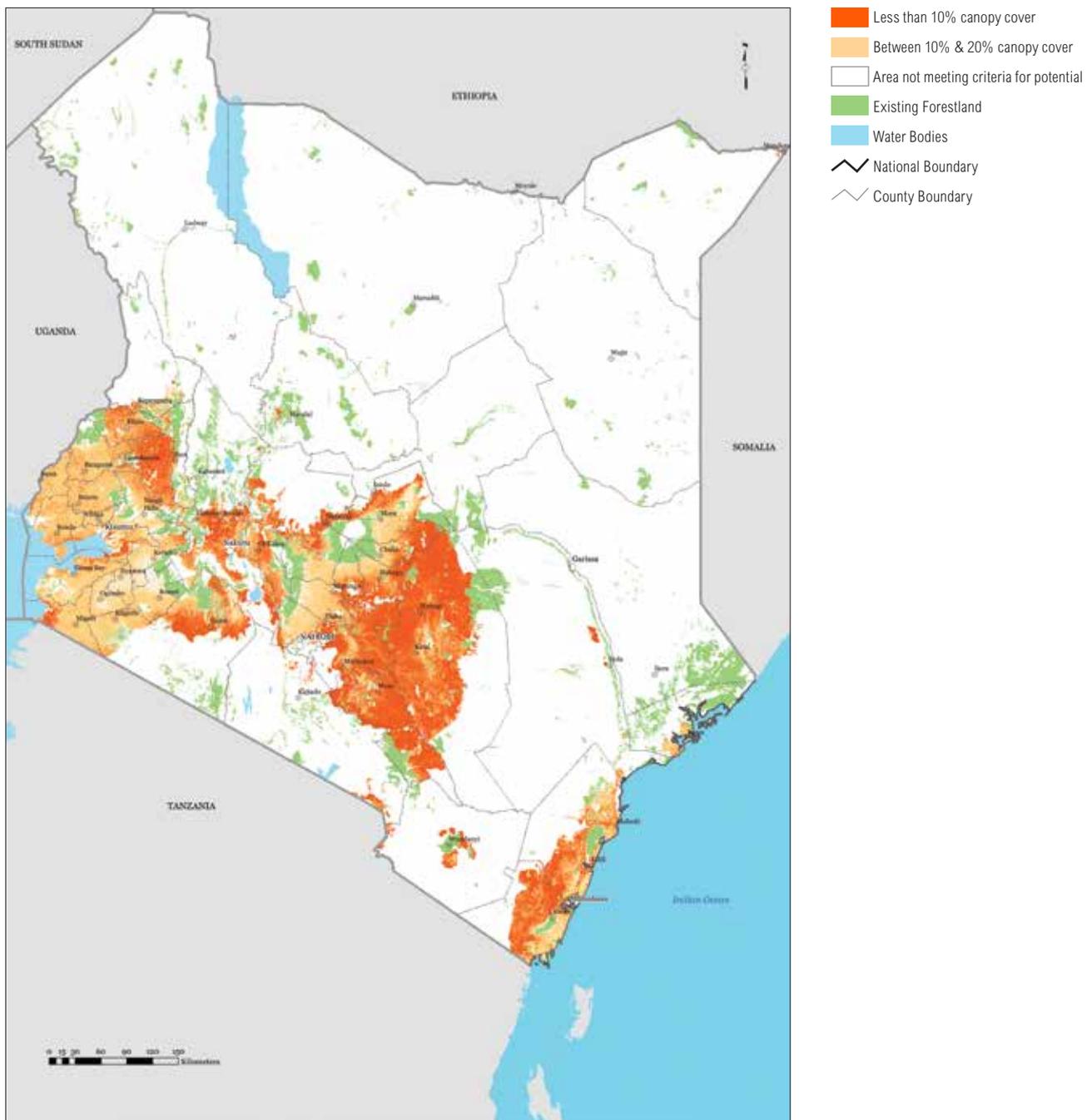
MAP 2B: RESTORATION POTENTIAL FOR REHABILITATION OF DEGRADED NATURAL FORESTS BY DEGRADATION LEVEL



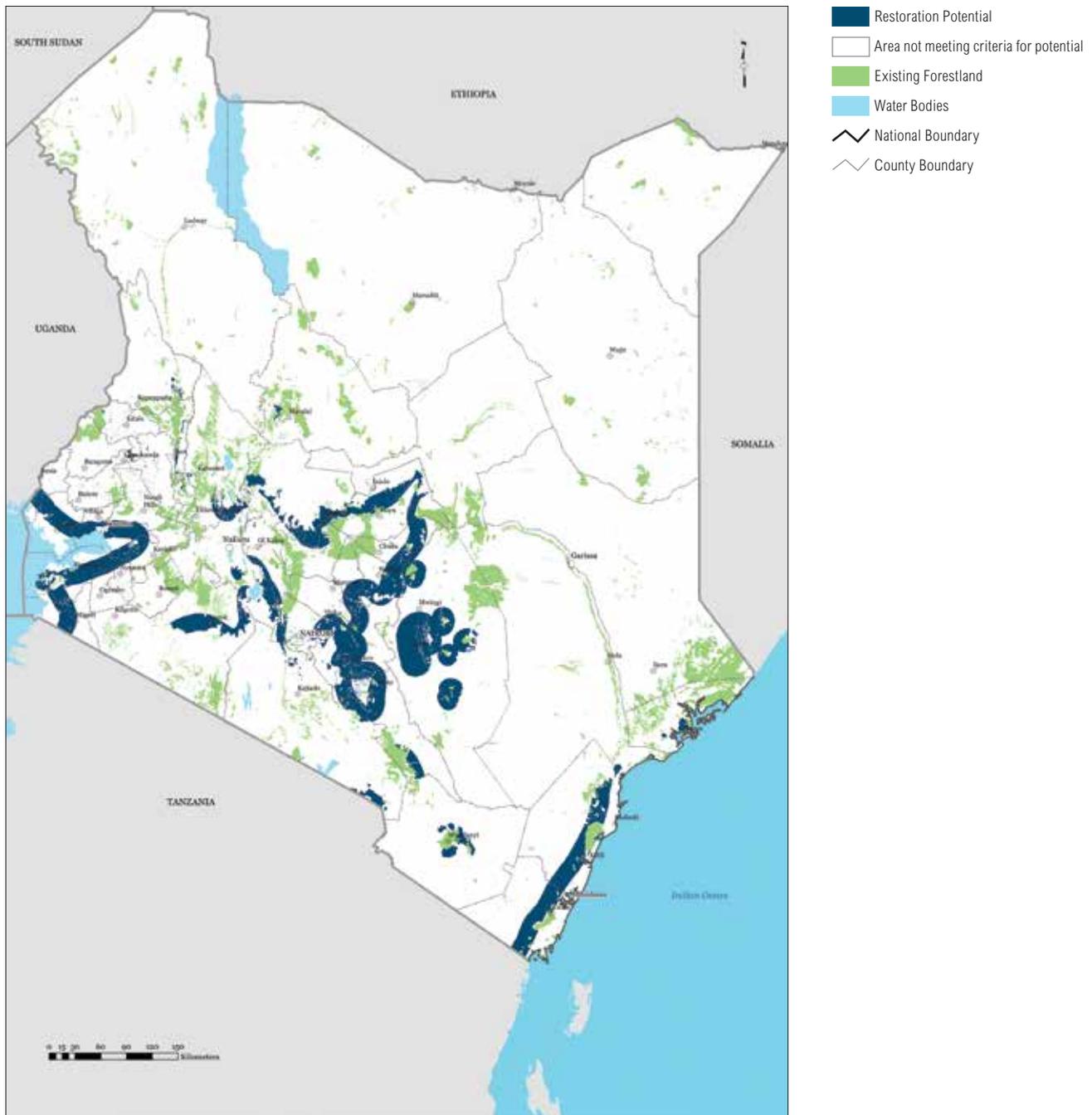
MAP 3A: RESTORATION POTENTIAL FOR AGROFORESTRY ON CROPLAND



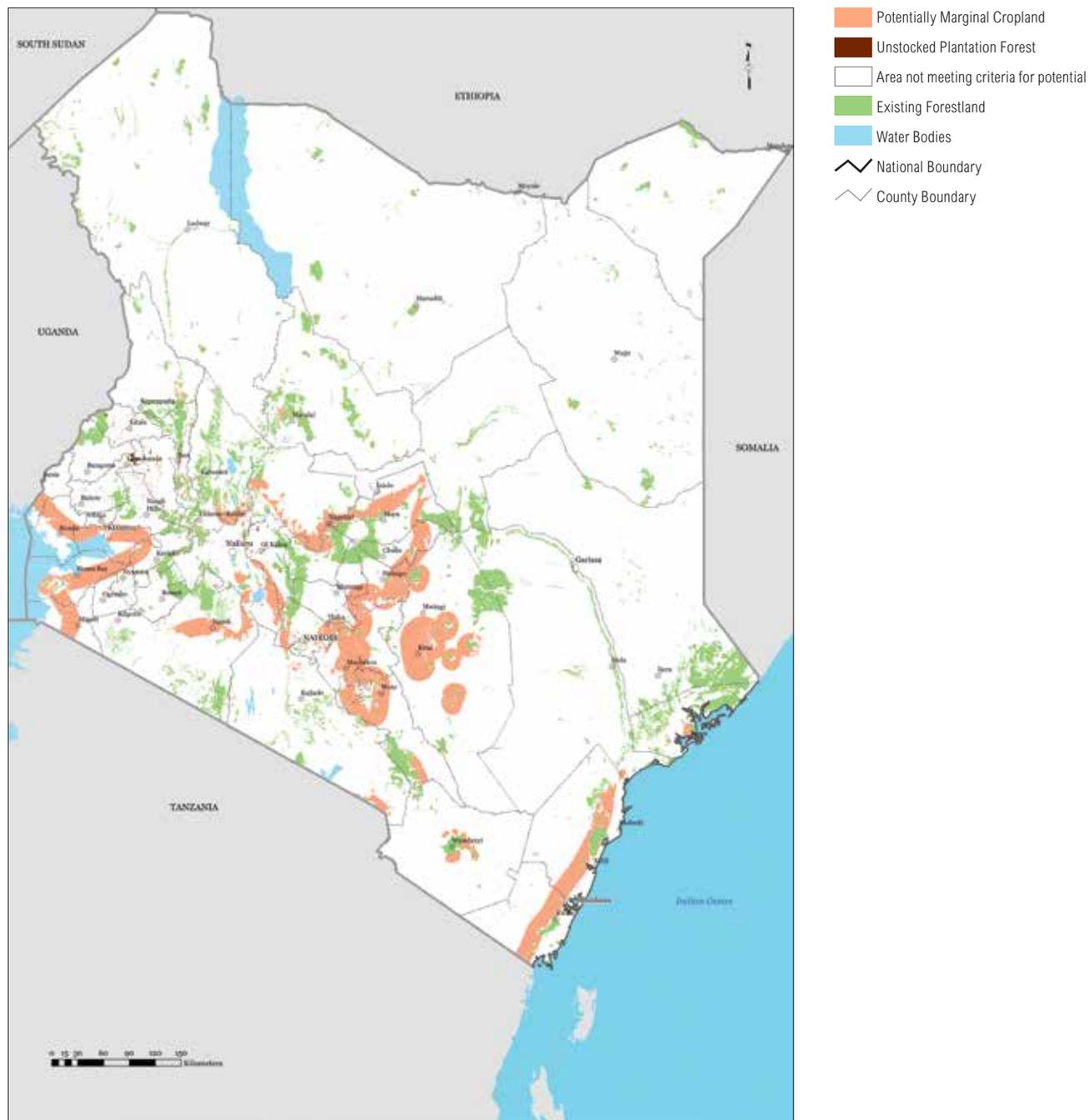
MAP 3B: RESTORATION POTENTIAL FOR AGROFORESTRY ON CROPLAND BY TREE CANOPY COVER



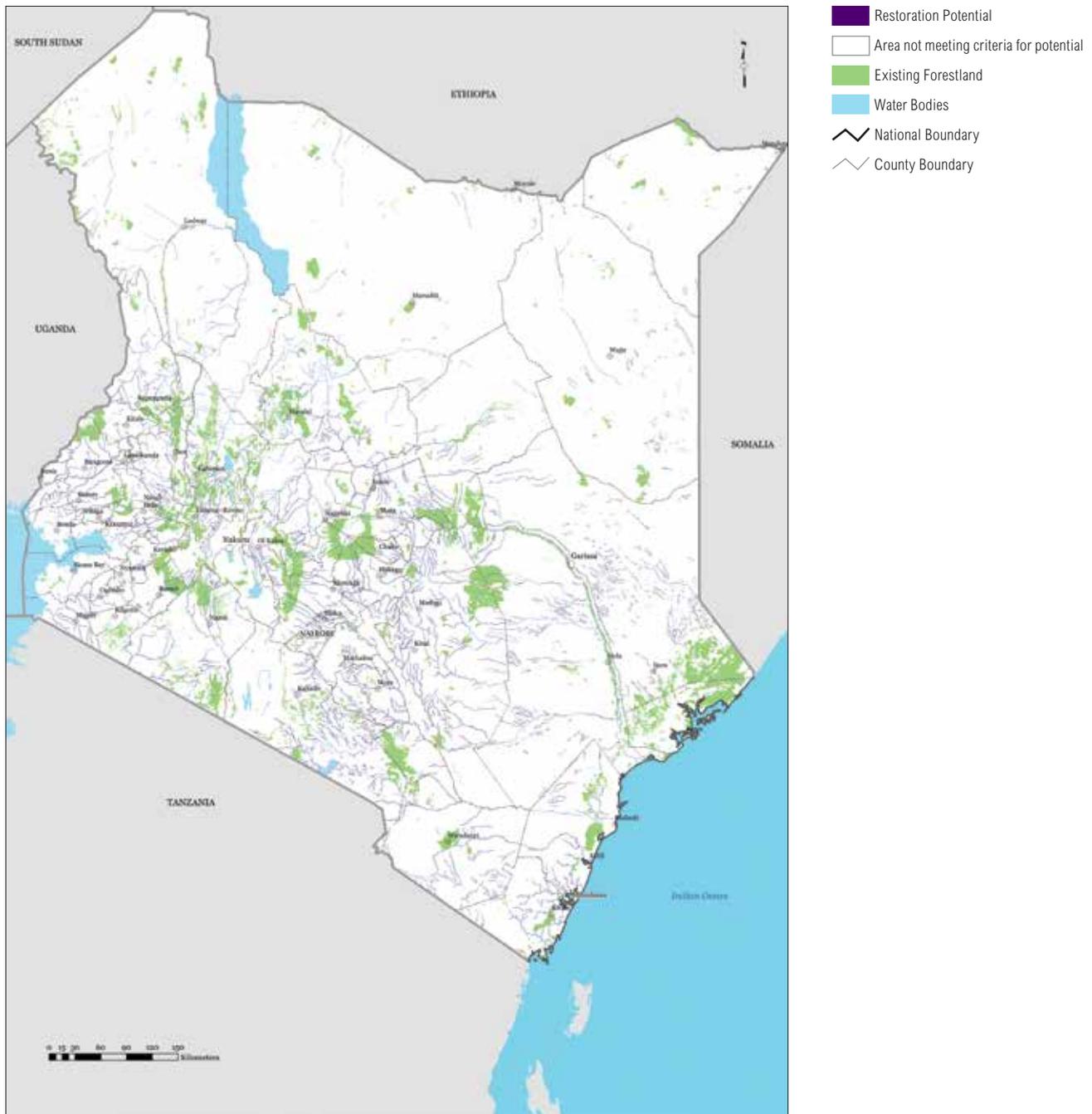
MAP 4A: RESTORATION POTENTIAL FOR COMMERCIAL TREE AND BAMBOO PLANTATIONS ON POTENTIALLY MARGINAL CROPLAND AND UN-STOCKED PLANTATION FORESTS



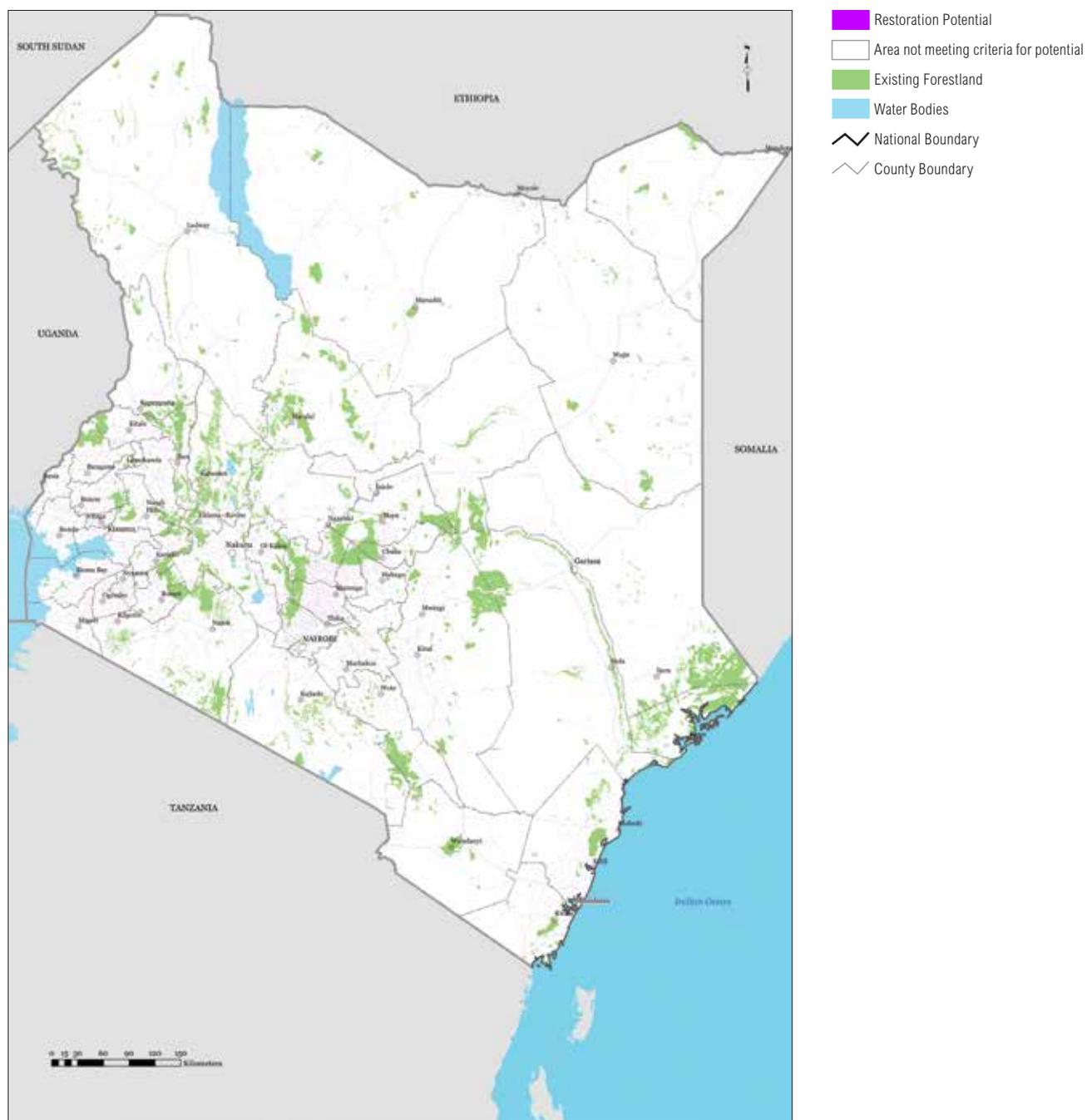
MAP 4B: RESTORATION POTENTIAL FOR COMMERCIAL TREE AND BAMBOO PLANTATIONS ON POTENTIALLY MARGINAL CROPLAND AND UN-STOCKED PLANTATION FORESTS BY LAND USE



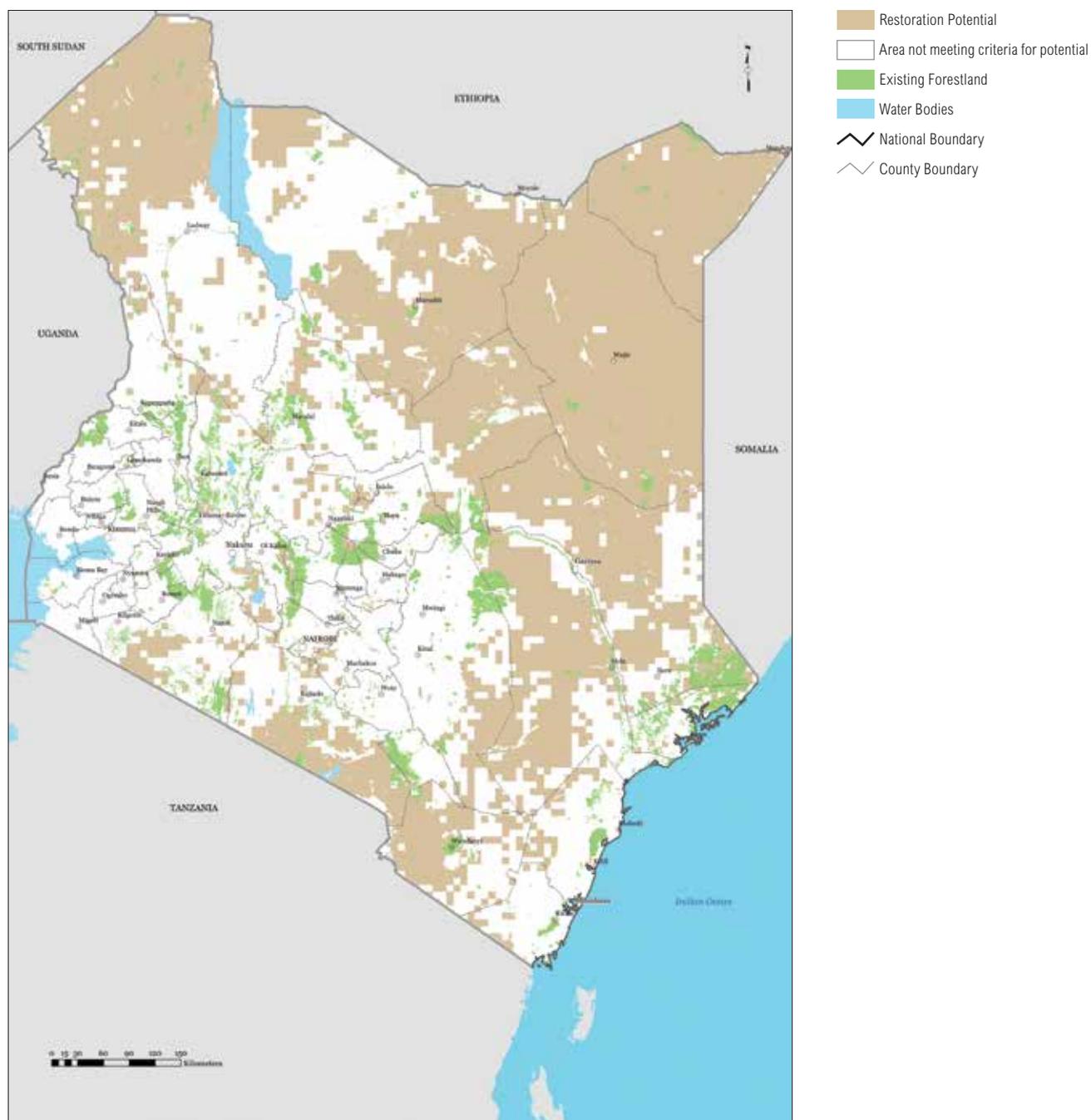
MAP 5: RESTORATION POTENTIAL FOR TREE-BASED BUFFER ZONES ALONG WATER BODIES AND WETLANDS



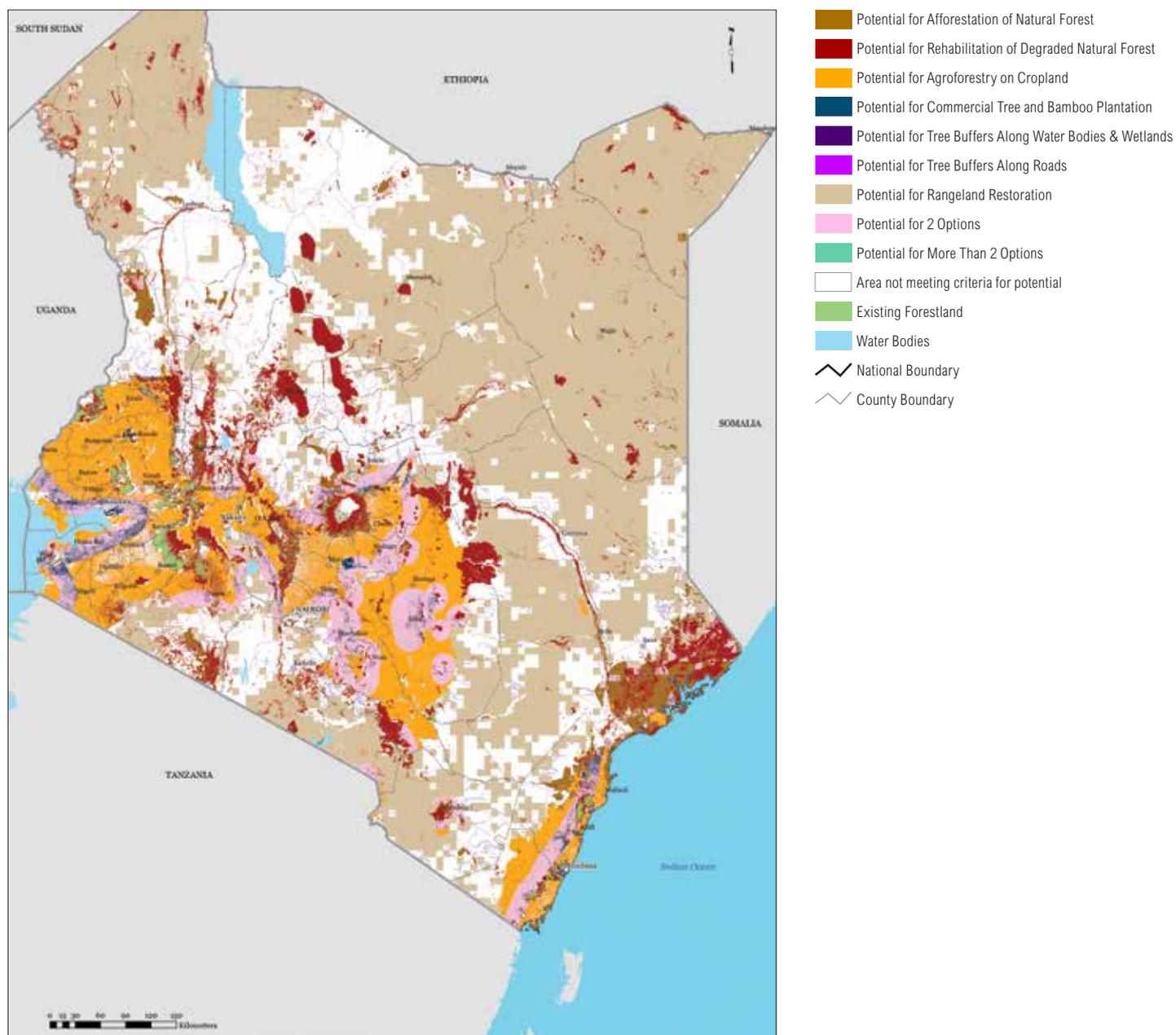
MAP 6: RESTORATION POTENTIAL FOR TREE-BASED BUFFER ZONES ALONG ROADS



MAP 7: RESTORATION POTENTIAL FOR RANGELANDS



MAP 8: POTENTIAL FOR ALL RESTORATION OPTIONS COMBINED



DISCUSSION AND RECOMMENDATIONS

After reviewing the results of the spatial analysis, the LRTWG suggests a phased approach for meeting national restoration commitments. A proportion of the restoration opportunity areas could be targeted for a 2030 timeline, and the remaining areas would be restored in the future. The tables below represent three scenarios, which represent different proportions of each restoration option to be implemented by 2030. The tables should be read in the following manner:

- The first column lists the restoration options, grouping them into land use categories.

- The second column lists the total area in millions of hectares of each land use type. This is meant to provide the reader with context as to the size of each of the different land cover types.
- The third column represents the total area extent in millions of hectares for each restoration option. The numbers in bold are sums of all of the restoration options within that land use type.
- The fourth column represents the proportion of each restoration option that would be implemented by 2030.
- The fifth column represents the restoration target in millions of hectares.

CONSERVATIVE SCENARIO

RESTORATION OPPORTUNITY	TOTAL AREA (MILLION HA)	RESTORATION POTENTIAL (MILLION HA)	PROPORTION IMPLEMENTED BY 2030	TOTAL RESTORATION TARGET FOR 2030 (MILLION HA)
Forest Lands	4	5.2		1.0
Afforestation/reforestation of natural forests and tree-based ecosystems		1.3	10%	0.1
Rehabilitation of degraded natural forests		3.5	20%	0.7
Buffer zones along water bodies and wetlands		0.1	50%	0.1
Commercial tree and bamboo plantations in unstocked forests		0.3	25%	0.1
Croplands	9.9	7.6		2.1
Farm forestry with less than 10% tree cover		2.7	50%	1.4
Farm forestry with tree cover between 10% and 30%		2.2	20%	0.4
Commercial tree and bamboo plantations or agroforests on cropland		2.7	10%	0.3
Rangelands	42.6	25.7		1.9
Silvo-pastoral and grasslands restoration		25.7	7.5%	1.9
Roads		0.3		0.2
Tree buffers along roads		0.3	50%	0.2
Other (Wetlands, Settlements, Barelands)	2.7	n/a	n/a	n/a
TOTAL	59.2	38.8		5.1

This conservative scenario represents a target where a relatively low proportion of each restoration option would be committed to being restored. The final target of 5.1 million ha would increase Kenya's total tree cover by 9%, bringing the total tree cover of the country over the constitutional mandate.

Preliminary conservative analysis suggests that under this scenario, the carbon sequestration potential could be more than 130MtCO₂-e by 2063.⁶

6. Figures provided by System for Land-based Emissions Estimation in Kenya (SLEEK)

INTERMEDIATE SCENARIO

RESTORATION OPPORTUNITY	TOTAL AREA (MILLION HA)	RESTORATION POTENTIAL (MILLION HA)	PROPORTION IMPLEMENTED BY 2030	TOTAL RESTORATION TARGET FOR 2030 (MILLION HA)
Forest Lands	4	5.2		1.4
Afforestation/reforestation of natural forests and tree-based ecosystems		1.3	15%	0.2
Rehabilitation of degraded natural forests		3.5	30%	1.1
Buffer zones along water bodies and wetlands		0.1	75%	0.1
Commercial tree and bamboo plantations in unstocked forests		0.3	38%	0.1
Croplands	9.9	7.6		3.1
Farm forestry with less than 10% tree cover		2.7	75%	2.0
Farm forestry with tree cover between 10% and 30%		2.2	30%	0.7
Commercial tree and bamboo plantations		2.7	15%	0.4
Rangelands	42.6	25.7		2.9
Rangeland Restoration		25.7	11.25%	2.9
Roads		0.3		0.2
Tree buffers along roads		0.3	75%	0.2
Other (Wetlands, Settlements, Barelands)	2.7	n/a	n/a	n/a
TOTAL	59.2	38.8		7.6

The intermediate scenario is more ambitious, multiplying the fractions in the conservative scenario by 1.5. This target would achieve 75% of the Agriculture (Farm Forestry) Rules, 2009 (GoK, 2009) of 10% tree cover on farms, 75% of the required buffer zones along water bodies and roads, as well as 11.25% of the potentially degraded rangeland area.

Preliminary conservative analysis suggests that under this scenario that the carbon sequestration potential could be more than 260MtCO₂-e by 2063.⁷

⁷ Figures provided by System for Land-based Emissions Estimation in Kenya (SLEEK)

AMBITIOUS SCENARIO

RESTORATION OPPORTUNITY	TOTAL AREA (MILLION HA)	RESTORATION POTENTIAL (MILLION HA)	PROPORTION IMPLEMENTED BY 2030	TOTAL RESTORATION TARGET FOR 2030 (MILLION HA)
Forest Lands	4	5.2		1.9
Afforestation/reforestation of natural forests and tree-based ecosystems		1.3	20%	0.3
Rehabilitation of degraded natural forests		3.5	40%	1.4
Buffer zones along water bodies and wetlands		0.1	100%	0.1
Commercial tree and bamboo plantations in unstocked forests		0.3	50%	0.2
Croplands	9.9	7.6		4.1
Farm forestry with less than 10% tree cover		2.7	100%	2.7
Farm forestry with tree cover between 10% and 30%		2.2	40%	0.9
Commercial tree plantations and agroforests (including bamboo)		2.7	20%	0.5
Rangelands	42.6	25.7		3.9
Silvo-pastoral and grasslands restoration		25.7	15%	3.9
Roads		0.3		0.3
Tree buffers along roads		0.3	100%	0.3
Other (Wetlands, Settlements, Barelands)	2.7	n/a	n/a	n/a
TOTAL	59.2	38.8		10.2

This scenario represents the most ambitious target, completely achieving all of the Agriculture (Farm Forestry) Rules, 2009 (GoK, 2009) and buffer zone requirements as well as restoring 15% of the potentially degraded rangelands. This is a doubling of the fractions used in the conservative scenario, and represents 17% of the area of the country and would be one of the largest restoration targets pledged to the Bonn Challenge, the New York Declaration on Forests, or AFR100.

Preliminary conservative analysis suggests that under this scenario the carbon sequestration potential could be more than 320MtCO₂-e by 2063.⁸

⁸ Figures provided by System for Land-based Emissions Estimation in Kenya (SLEEK)

REFERENCES

1. Buck, Louise E. and Ian D. Bailey. 2014. *Managing for resilience: framing an integrated landscape approach for overcoming chronic and acute food insecurity*. Washington, DC: EcoAgriculture Partners on behalf of the Landscapes for People, Food and Nature Initiative.
2. IPCC, 2000 - Robert T. Watson, Ian R. Noble, Bert Bolin, N. H. Ravindranath, David J. Verardo and David J. Dokken (Eds.) Cambridge University Press, UK. pp 375. *Land Use, Land-Use Change, and Forestry*. http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=47. Accessed January 29, 2016.
3. IUCN and WRI (2014). *A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. Working Paper (Road-test edition)*. Gland, Switzerland: IUCN.
4. Kathleen Buckingham, Sean DeWitt and Lars Laestadius, Chapter 7.3 - The Global Restoration Initiative, In *Land Restoration*, edited by Ilan Chabay, Martin Frick, Jennifer Helgeson, Academic Press, Boston, 2016, Pages 483-494, ISBN 9780128012314, <http://dx.doi.org/10.1016/B978-0-12-801231-4.00031-8>.
5. "Kenya Forest Service (KFS) – History of forestry in Kenya" Kenya Forest Service. N.p., n.d. Web. http://www.kenyaforestservice.org/index.php?option=com_content&view=article&id=406&Itemid=563. Accessed June 16, 2016.
6. Maukonen, P., L. Runsten, J. Thorley, A. Gichu, R. Akombo and L. Miles (2015). *Mapping to support land-use planning for REDD+ in Kenya: integrating additional benefits and safeguards*. Cambridge, UK: UNEP- WCMC.
7. The Government of Kenya (GoK). (1965). *Agriculture (Basic Land Usage) Rules, 1965 (Rev. 2012)*.
8. The Government of Kenya (GoK). (1986). *Agriculture Act, 1986 (Rev. 2012)*.
9. The Government of Kenya (GoK). (1999). *Environmental Management and Co-ordination Act, 1999 (EMCA)*.
10. The Government of Kenya (GoK). (2002). *Water Act, 2002 (Rev. 2012)*
11. The Government of Kenya (GoK). (2007). *Kenya Vision 2030, The Popular Version*. Chapter 5.2
12. The Government of Kenya (GoK). (2008). *Kenya Vision 2030, First Medium Term Plan (2008-2012)*. Chapter 5.5.2, Youth
13. The Government of Kenya (GoK). (2009). *Agriculture (Farm Forestry) Rules, 2009*.
14. The Government of Kenya (GoK). (2010a). *The Constitution of Kenya*. Article 69, Sec. 1b
15. The Government of Kenya (GoK). (2010b). *National Climate Change Response Strategy*. Chapter 4.2.1
16. The Government of Kenya (GoK). (2013). *National Environment Policy, 2013*.
17. The Kenya Gazette Vol. CV-No. 59 06 June, 2003. *Gazette Notice NO. 3632. The Ministry of Roads, Public Works and Housing, Encroachment on Classified Road Reserves*.

APPENDIX 1

HIGH-LEVEL LANDSCAPE RESTORATION WORKING GROUP

NAME	TITLE AND ORGANISATION
Mr. Gideon Gathaara	Secretary of Natural Resources, Ministry of Environment and Natural Resources
Dr. Alice Kaudia	Secretary of Environment, Ministry of Environment and Natural Resources
Mr. Emilio Mugo	Director, Kenya Forest Service

LANDSCAPE RESTORATION TECHNICAL WORKING GROUP

NAME	ORGANISATION
Rose Akombo	Kenya Forest Service (KFS)
Jackson Bambo	Kenya Forest Working Group (KFWG)
Dennis Garrity	World Agroforestry Center (ICRAF)/United Nations Convention to Combat Desertification (UNCCD)/World Resources Institute (WRI)
Alfred Gichu	Kenya Forest Service (KFS)
Samuel Guto	Ministry of Agriculture
Collins Handa	National Museums of Kenya
Safi Ibrahim	Kenya Forest Service (KFS)
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APPENDIX 2: GIS DATA

1. Department of Resource Surveys and Remote Sensing (DRSRS). Undated. Wetlands.
2. Food and Agriculture Organisation (FAO) and Department of Resource Surveys and Remote Sensing (DRSRS). 2008. Land use/ Land cover Aggregated Africover 2008.
3. Food and Agriculture Organisation (FAO). 2008. Global change in Rain-Use Efficiency 1981-2003.
4. Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O., and Townshend, J.R.G., (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342(6160), 850-853. doi:10.1126/science.1244693. Tree Cover 2010.
5. Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis. 2005. Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology* 25: 1965-1978. Available at <http://www.worldclim.org> (last access: 04/26/2016).
6. IUCN and UNEP-WCMC. 2015. The World Database on Protected Areas (WDPA) [On-line], [October, 2015], Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net
7. Kenya Agricultural Research Institute (KARI). Undated. Agro-ecological Zones.
8. Kenya Forest Service (KFS). 2013. Forest Legal Status.
9. Kenya Forest Service (KFS). 2013. Forest Type 2010.
10. Kenya Forest Service (KFS). 2013. Land use/land cover 2010.
11. Kenya Roads Board (KRB). Undated. Road
12. Kenya Wildlife Service (KWS). Undated. Wildlife Parks.
13. Ministry of Water and Irrigation (MWI). Undated. Rivers.
14. Shuttle Radar Topography Mission (SRTM). 30m resolution digital elevation model (DEM). Available at <http://earthexplorer.usgs.gov> (last access: 04/13/2015).
15. Survey of Kenya (SoK). 2016. Kenya Country Boundary.
16. Survey of Kenya (SoK). 2016. Kenya County Boundaries.
17. UNEP-WCMC. 2015. 90m resolution slope model derived from SRTM.
18. van Breugel P, Kindt R, Lillesø JPB, Bingham M, Demissew S, Dudley C, Friis I, Gachathi F, Kalema J, Mbago F, Moshi HN, Mulumba, J, Namaganda M, Ndangalasi HJ, Ruffo CK, Védaste M, Jamnadass R and Graudal L (2015) Potential Natural Vegetation Map of Eastern Africa (Burundi, Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Version 2.0. Forest & Landscape Denmark and World Agroforestry Centre (ICRAF). URL: <http://vegetationmap4africa.org>.
**Additional information about the vegetation map, types and species can be found on the project website*
Kindt, R., van Breugel, P., Lillesø, J-P.B., Gachathi, F., Omondi, W., Jamnadass, R. and Graudal, L. 2014: Potential natural vegetation of eastern Africa. Volume 8. Atlas and tree species composition for Kenya. Department of Geosciences and Natural Resource Management, University of Copenhagen. URL: http://vegetationmap4africa.org/Documentation/Country_docs.html
19. Water Resource Management Authority (WRMA). 2011. Wetlands.

PHOTO CREDITS

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