ENVIRONMENT, FOREST AND CLIMATE CHANGE COMMISSION,
THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

ADDIS ABABA UNIVERSITY

Forest Landscape Restoration (FLR) Options for Southern Nations, Nationalities and Peoples (SNNP) Regional State

30 May 2020
Addis Ababa, Ethiopia

Submitted to: Ethiopian Environment, Forest and Climate Change Commission (EFCCC) and World Resources Institute (WRI)

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Acronyms

AFR100	Africa's 100Mha restoration program
ANR	Assisted natural regeneration
CBD	Convention for biological diversity
CGRE	Climate Resilient Green Economy
CSA	Central Statistical Agency
ENACT-NMA	Enhancing National Climate Services (ENACTS) from Columbia University and NMA of Ethiopia
ERA	Ethiopian Road Authority
FDRE	Federal Democratic Republic of Ethiopia
FLR	Forest and landscape restoration
GDP	Gross domestic product
GIS	Geographic Information System
GTP II	Growth and Transformation Plan second phase
INBAR	International Bamboo and Rattan Organization
IPCC	Intergovernmental panel for climate change
LULC	Land use and land cover
MEFCC/EFCCC	Ministry of Environment Forest and Climate Change/ Environment, Forest and Climate Change Commission
Mha	Million hectares
NDVI	Normalized difference vegetation index
NFPAs	National Forest Priority Area
NMA	National Meteorological Agency of Ethiopia
NP	National parks
NTFP	Non-timber Forest Products
PA	Protected area
PES	Payment for ecosystem services
PFM	Participatory Forest Management
REDD+	Reducing emissions from deforestation and forest degradation

SDGs	Sustainable development goals of the United Nations
SLM	Sustainable land management
SNNP	Southern Nations, Nationalities and Peoples (SNNP) Regional State
SRTM	Shuttle Radar Topographic mission of the United States
SWC	Soil and water conservation
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
USGS	United States Geological Survey
WDPA	World Database Protected Areas
WLRC-AAU	Water and Land Resource Center of Addis Ababa University
WRI	World Resources Institute

Executive Summary

Environmental deterioration and land degradation are two of the most pressing global environmental and developmental challenges of the 21st century. To curb these serious challenges, countries are developing various adaptation and mitigation programs and executing them in coordination with international collaborators. Ethiopia has launched several initiatives and programs to protect the environment and reduce land degradation as part of its growth and transformation plans (GTP) to boost the economic development of the country. One of the country's biggest initiatives is the climate resilient green economy (CRGE) strategy, which is part its economic development agenda. The government of Ethiopia is working in collaboration with an international alliance to enhance CRGE strategy and programming to respond to the above-mentioned climate challenges. One program affiliated with the CRGE is the forest landscape restoration (FLR) initiative. The FLR program was initiated by Environment, Forestry and Climate Change Commission (EFCCC) and the World Resources Institute (WRI) in 2016, with the goal of identifying forest landscape restoration options at the national level. The activities in this report, conducted by the EFCCC, WRI, and Water and Land Resources Center-Addis Ababa University (WLRC-AAU), were part of the effort to refine forest landscape restoration options at a regional level to accommodate regional criteria, challenges, and priorities. Working in collaboration with EFCCC, WRI and WLRC-AAU carried out all the technical and stakeholder analysis of this regional level work with supervision and support from WRI and EFCCC. We conducted both stakeholders participatory planning and validation workshops before and after biophysical analyses to identify spatial locations, where appropriate restoration options can be executed.

During participatory planning, we identified ten restoration potential options and a set of mapping criteria for each option at regional scale (SNNP). Based on these criteria, we identified and mapped suitable locations where those ten FLR options can be implemented. Our results show that SNNP has highest potential area for agroforestry (2.43 Mha), lowland bamboo restoration (1.88 Mha), highland bamboo potential (0.76 Mha), firewood plantation (0.69 Mha), and commercial plantation (0.68 Mha), respectively. The potential area for the other six options ranged from 0.001 to 0.4Mha (Table 6). In some cases, areas may be suitable for more than one intervention. For example, areas which are suitable for agroforestry could also be suitable for home gardens and woodlots. Hence, we tried to combine and prioritize interventions based on the stakeholders' preferences on environmental, social, and economic benefits in the given area and the region at-large. Our analysis of combined potential for tree-based restoration shows that over 6 Mha of land is suitable for one or more potential restoration option in SNNP region (Table 7).

Based on the combined analysis outcome, we identified that about 2.1 Mha of the region is suitable exclusively (no overlapping with others) for agroforestry expansion, while 1.4 Mha is suitable exclusively for lowland bamboo. The same approach was applied for other options to generate the statistics on Table 7. That said, we recommend further refinement of these options during action plan development at district/woreda level taking into consideration non-biophysical socio-economic and environmental needs and priorities.

1 Introduction

Land degradation is one of the most pressing global environmental and developmental challenges of the 21st century (Gashaw et al., 2014). Recognizing that healthy ecosystems on land are essential to the future of both people and the planet, Sustainable Development Goal 15 aims to "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." Section 15.3 of the goal specifically addresses the issue of land degradation, setting the target to "combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world" by 2030 (SDG15.3). Progress made towards each SDG target is measured using a specific indicator framework developed for each goal. In the case of SDG 15.3, progress towards a land degradation-neutral world will be assessed by measuring the "proportion of land that is degraded over total land area". Despite the targets set by SDG 15, the global rate of land and forest degradation and deforestation continues to increase, resulting in desertification and decreased land productivity, and contributing to overall climate change (URL1). However, various land restoration and conservation efforts are underway at different scales to reverse the tide of land degradation and implement more sustainable land use practices. Many countries have made commitments to restore millions of hectares of degraded and deforested land under the Bonn Challenge, which is an international effort to restore 150 million hectares around the globe by 2020 in Bonn Challenge and 350 million by 2030 in the New York Declaration (MEFCC, 2018).

Since the 1970s, Ethiopia has implemented comprehensive land management practices to curb land degradation in the country. However, considering the existing scope and severity of the country's land degradation, and its negative impact on food security and economic development, the Ethiopian government is now more heavily investing in one of the world's largest land restoration efforts as a means of climate change adaptation and mitigation. Afforestation and reforestation, assisted natural regeneration and conservation and management of remaining forests through participatory farmer management, are some of the approaches Ethiopia is implementing. Several soil and water conservation (SWC) and sustainable land management (SLM) programs have been implemented across the country (Abera et al., 2019). Moreover, the 2018 report by the Ministry of Environment, Forest, and Climate Change (MEFCC, 2018) stated that increasing the number of trees in Ethiopia would also contribute to Ethiopia's international commitments.

These include Ethiopia's commitments to the Sustainable Development Goals' objectives of ending poverty, promoting prosperity and well-being for all, protecting the environment, and addressing climate change; the Convention on Biological Diversity's pledge of restoring at least 15 percent of degraded ecosystems (CBD, 2010); the United Nations Convention to Combat Desertification's ambition of achieving zero net land degradation (UNCCD, 2012); the objective set forth by the United Nations Framework Convention on Climate Change (UNFCCC) of limiting net greenhouse gas emissions; and the African (AFR100) and global (Bonn Challenge and New York Declaration on Forests) restoration targets. (MEFCC, 2018)

The government has also included the Climate Resilient Green Economy (CRGE) Strategy in Ethiopia's current five-year national development plan, the Growth and Transformation Plan II (GTP II 2015-2020). The CRGE Strategy aims to ensure that the country's development goal to reach middle-income status by 2025 is achieved through the creation of a robust, climate resilient green economy.

The GTP II aligns with the CRGE Strategy by aiming to reduce land degradation and improve the productivity of natural resources by promoting sustainable forest production and increasing investments to improve product quality and processing (Streck et al., 2015). Under the Bonn Challenge and New York Declaration, Ethiopia has committed to restore 15 Mha of degraded land, 3 Mha of afforestation and 4 Mha of forest management (PFM), which accounted altogether 22 Mha by 2030 in the CRGE forestry target (MEFCC, 2018). Of which, the GTP II also aims to put 2 million hectares of existing forests under Participatory Forest Management (PFM) and identify and demarcate 4.5 million hectares of degraded land for afforestation or reforestation. Additionally, the country will sponsor national tree planting initiatives to increase national forest cover by 4.5% (Leminih & Kassa 2014).

Protecting and augmenting existing forests, through assisted natural regeneration (ANR) and other tree-based landscape restoration interventions, are central to achieving the goals outlined in the GTP II, since tree-based restoration initiatives not only contribute to economic development by raising incomes and living standards, but also help communities mitigate the effects of climate change. Consequently, one of the main focuses of Ethiopia's restoration program is to increase forest cover by adding more trees to various landscapes. Another component of the restoration program is the National REDD+ Investment Program, which aims to implement large-scale community forest programs, increase capacity in the forest sector, secure additional funding for the forest sector, and design more profitable forestry-related livelihoods. The ultimate goals of the REDD+ program are to increase the forest sector's contribution to Ethiopia's GDP to 8% and to sequester/reduce carbon emissions by 26MM tCO_2e by 2020.

Despite the government's commitment to tree-based restoration, the spatial distributions of potential restoration options have not been previously modelled and identified according to the biophysical requirements of each option. Therefore, the goal of this project was to identify the potential restoration options for SNNP Regional State that could enhance the implementation of restoration efforts and achieve desired ecosystem services in the region.

2 Objectives

The project was carried with the following objects in mind.

1. Identify biophysical challenges
2. Identify potential forest and landscape restoration (FLR) options
3. Identify criteria and best, readily available data to map the potential of identified restoration options
4. Compile best available data and assess its suitability to map potential restoration options
5. Map spatial distributions of the identified potential restorations options in SNNP region
6. Validate that the outputs and identified tree-based restoration options reflect the context on the ground.

3 Approach and Methodology

The methodology and approach combined stakeholder engagement and expert analysis using Geospatial mapping tools. National and regional stakeholders were engaged throughout the process of achieving objectives 1, 2, 3, and 6. WLRC experts conducted the data organization, quality control and mapping task to achieve objects 4 and 5.

Workshops were held on 21 and 22 August 2019 in SNNP region to initiate participatory planning with stakeholders and carry out several of the aforementioned steps, including identifying challenges and potential restoration options and setting criteria for datasets.

During the participatory planning workshops, stakeholders (listed in Appendix 1) broke into working groups and participated in six sessions. The goal of the first session was to identify biophysical challenges in the region that hinder ecosystems services and decrease the productivity of a given area, watershed, region or the country at-large. The goal of the second session was to identify potential restoration options for the region. The third and fourth sessions were dedicated to identifying datasets and setting criteria for each potential restoration option. During the fifth and sixth sessions, participants mapped potential stakeholders and identified local, regional, national, or international data owners (both data holders and creators).

Finally, the project team conducted a validation workshop on 20 December 2019 with stakeholders who participated in the initial workshop. During the validation workshop, participants agreed on the mapping methodology, reviewed input datasets, and analyzed whether the outputs reflect current and future expectations. Feedback from the participants is included in Appendix 2.

3.1 Identifying Biophysical Challenges

During the first session of the participatory workshop, local experts identified the most pressing challenges to natural resource management their communities were facing. The identified challenges were categorized into two major types: biophysical and other (e.g., institutional, political, social challenges).

Table 1 lists, in no specific order, the major biophysical challenges identified by the three working groups. Using this list, the project team identified which biophysical challenges could be mapped to show their potential for restoration.

Table 1 | Identified biophysical challenges

- Overgrazing & free grazing
- Extensive farming
- Destruction of wildlife habitat
- Biodiversity loss
- Urbanization
- Forest fire hazards
- Land fragmentation
- Loss of production and productivity
- Drought and flood (climate change)
- Deforestation
- Water logging and wetland degradation
- Lack of rehabilitation after mining
- Lack of alternative energy sources
- Unplanned plantations
- Soil degradation
- Ecosystems disturbances
- Soil erosion (resulting in landslides and gullies)
- Invasive species expansion (e.g. *Prosopis, Lantana*, etc.)
- Lack of restoration interventions for degraded lands

Other important challenges related to natural resource management were also reported during the working group discussions and are listed in Table 2. While the project team was unable to map the restoration potential for these challenges in the same manner as the biophysical challenges, they are crucial to understanding the local context of the region.

Table 2 | None-biophysical (socio-political, Institutional and legal) challenges related to natural resource management

- Determining and securing land tenure
- Lack of emphasis on agroforestry
- Illegal investment on behalf of youth
- Lack of legal framework for man-made forests
- Weak investment plan and implementation
- Widespread unemployment and poverty
- Technological limitations
- Internal migration
- Limited law enforcement in protected areas
- Absence of law enforcement
- Absence of robust and inclusive land use policy and strategy
- Lack of data
- Lack of coordination among stakeholders
- Population density (pressure on land)
- Lack of awareness, knowledge, and technical skill
- Lack of environmental policy and enforcement
- Lack of livelihood diversification
- Lack of benefit sharing to community from investment
- Poor upkeep of established plantations
- Weak institutional framework and accountability
- Lack of inter-institutional and sectoral integration

• Lack of contribution to payment for ecosystem services (PES) • Absence of resources (technical skill, funding, & technology) to generate and use data • Limited resources (human, financial, and technological)	• Disparity between natural resource management and youth interest and investment • Political intervention on investment land (e.g., mining permits given for forest areas) • Poorly planned investment in southwestern forests (e.g., establishment of coffee and tea plantations)

3.2 Identifying Restoration Options to Restore Landscapes

After thorough discussions with the three working groups, we summarized the potential restoration options to be considered for the region. Several potential restoration options were identified and suggested and are listed in Table 3 below.

Table 3 | Identified potential restoration options

• Restocking degraded natural forests • Agroforestry on cropland • Water harvest • Home gardens • Establish nursery sites • Buffer zones along wetlands, rivers, lakes, roads, towns • Bamboo restocking and rehabilitation • Silvopastures • Assisted Natural Regeneration (ANR) and area exclosure • Afforestation and secondary forest restoration • Promote the production of Non-timber Forest Products (NTFP) in lowlands (e.g., gum and essence) Commercial plantation • Buffer zones around national parks, protected areas, and National Forest Priority Area (NFPAs)	• Create business plans for water management • Commercial and fuelwood plantations • Value-add and improved quality for bamboo businesses • Participatory forest management (PFM) • Identify potential plantation sites • Promote fuel saving technology • Urban greening • Monitor established seedlings • Development of incentives programs for restoration • Invasive species control • Provision to improve the variety of tree species included in restoration programming • Establish Greening and Gardening (GG) zones around mountain chains (i.e., mountain developments)

Not every potential restoration option listed could be easily mapped at the regional level. Several interventions, such as nursery sites, require less than 0.5 ha and are more easily mapped at the site-specific level. Though not included in the maps developed for this regional exercise, the project team acknowledges the importance of small coverage interventions and notes that they should be included in local mapping exercise. From the options listed in Table 3, we selected and mapped ten potential restoration options:

1. **Potential for afforestation and secondary forest restoration:** Establish forests, such as natural high forests and woodlands, through reforestation, tree planting on land that recently had tree cover, or afforestation, tree planting on land that has long been deforested (adapted from IPCC 2014). These interventions will reestablish forests' ecosystem services. In Ethiopia, common practices to restore secondary forests include assisted natural regeneration and area exclosure (MEFCC, 2018).
2. **Potential for restocking degraded natural forests:** Increase the stock of existing degraded natural forests, including degraded high forests and woodlands. Common practices to restock degraded natural forests are enrichment planting and assisted natural regeneration (MEFCC, 2018).
3. **Potential for agroforestry on cropland:** Use agroforestry techniques to increase the number of trees on existing croplands in highland areas (agri-silviculture) and in lowland areas (agro-silvo-pastoralism).
4. **Potential for commercial plantations:** Expand income-generating commercial plantations for the production of wood and other timber products. This includes establishing commercial plantations on communal/public, state-owned, and private land (MEFCC, 2018).
5. **Potential for fuelwood plantations:** Expand fuelwood plantations to meet Ethiopia's growing demand for firewood. If established in strategic locations close to villages, these plantations will not only satisfy rural and urban demand for cooking fuel and protect natural forests but will also benefit women and girls who often have to travel far distances to collect fuelwood.
6. **Potential for home gardens and woodlots:** Expand private and small-scale production of wood (e.g., timber used in construction) and non-timber forest products (e.g., fruits, forage) for domestic and commercial use on both communal and private land (MEFCC, 2018).
7. **Potential for expansion and restocking of highland and lowland bamboo:** Restock existing natural bamboo forests and establish new bamboo forests in highland and lowland areas with suitable bamboo species.
8. **Potential for tree-based buffer around rivers, lakes, and wetlands:** Develop and restock buffer zones around bodies of water.
9. **Potential for tree-based buffer along National Parks, Protected Areas, and National Forest Priority Areas:** Increase tree-based plantations within 1000 m of national parks and protected and priority areas. National park management plans and strategies are already in place inside these areas.
10. **Potential for tree-based buffer along roads and around towns:** Establish rehabilitation programs to restore areas that were deforested due to the construction of roads, towns, and other infrastructure.

3.3 Identified Criteria and Data for Mapping Potential for Restoration Options

In collaboration with stakeholders at the participatory workshop and using data from the national potential map (MEFCC, 2018), we set the criteria for each potential restoration option (Table 4). The spatial models are presented in Appendix 2. Various biophysical, infrastructure, and population datasets were used as inputs for the models to accurately identify potential areas for restoration.

Table 4 | Criteria and datasets for each potential restoration option

SN	Options	Criteria	Rationale	Data sets	Sources
1	Potential for afforestation and secondary forest reforestation	Valleys at mountain escarpment and large gullies with >50% slope	Mountain gully treatment reduces soil erosion and enhances ground water recharge. Rural lands whose slope is more than 60% shall not be used for farming and free grazing; they shall be used for development of trees, perennial plants, and forage production (FDRE 2005)	Slope	Derived from SRTM, USGS, 2017
		Include bareland and shrub/bushland above 50% slope	This option should be implemented in areas not used for other purposes	Land use-land cover	WLRC, 2016
		Exclude altitude > 3500m	Agro-ecological above tree-line is not suitable area for tree planting	Altitude	SRTM, 2017
		Include cropland of slope > 60%	Rural lands whose slope is more than 60% shall not be used for farming and free grazing; they shall be used for development of trees, perennial plants, and forage production (FDRE 2005)	Land use-land cover Slope	WLRC, 2016 Derived from SRTM, USGS, 2017
		Include rainfall > 250mm	Afforestation/reforestation would be easily established with enough rainfall	Rainfall	ENACT-NMA, 2016
2	Potential for restocking degraded natural forests	Include moderate forests, sparse forests	It doesn't include grassland and wooded grassland	Land use-land cover	WLRC, 2016
		Include tree cover <30%	Proxy to degraded natural forest	Tree cover	Global Tree cover, 2010

SN	Options	Criteria	Rationale	Data sets	Sources
		Include areas with Average annual rainfall > 250 mm	Optimum rainfall is required for restocking degraded forest; rainfall below 250 mm may not be suitable for restocking	Rainfall data	ENACT-NMA, 2016
		NDVI < 0.6	NDVI less than 0.6 indicates the forest is degraded (based on expert input)	NDVI calculated from Landsat 8 Image of 2017	USGS, 2017
		Land productivity decline, sign of decline and stressed categories	Land productivity status is a proxy for vegetation status. Land productivity is the biological productive capacity of the land, the source of all the food, fiber and fuel that sustains humans (United Nations Statistical Commission 2016). Net primary productivity (NPP) is the net amount of carbon assimilated after photosynthesis and autotrophic respiration over a given period of time (Clark et al. 2001) and is typically represented in units such as kg/ha/yr	Land productivity	Trends.earth
3	Potential for agroforestry on cropland	Include annual and perennial croplands	Enriching both highland and lowland cropland areas with proper planting	Land use esp. cropland maps	WLRC, 2016
		Exclude areas with tree cover > 30%	Tree cover greater than 30% indicates an already well-stocked agroforestry system	Tree cover	Global Tree cover, 2010
		Exclude mechanized and large-scale farming	Mechanized and large-scale farming may not be feasible with agroforestry as we assume that owners will have their own plan	Data on mechanized and large-scale farming not readily available	

SN	Options	Criteria	Rationale	Data sets	Sources
		Average annual rainfall > 250 mm	Optimum rainfall is required for restoration	Rainfall	ENACT-NMA, 2016
		Slope <60%	Rural lands whose slope is more than 60% will not be used for farming and free grazing; they will be used for development of trees, perennial plants, and forage production (FDRE 2005)	Slope	Derived from SRTM, USGS, 2017
4	Potential for commercial plantations	Road network <10km	Access to market and transportation is required	Road network	ERA, 2006
		Exclude areas with average annual rainfall ≤ 800 mm	There should be enough amount of moisture for fast growth of commercial plantations	Rainfall	NMA, 2016
		Exclude areas with altitude ≤ 800 m or >2300m	The optimum agro-ecology for fast growth of commercial plantation	Altitude	SRTM, 2017
		Exclude areas with slopes > 60 %	Accessible topography is preferred; rural lands whose slope is more than 60% will not be used for farming and free grazing; they will be used for development of trees, perennial plants, and forage production (FDRE 2005)	Slope	Derived from SRTM, USGS, 2017
		Include open shrubland	Only open shrubland should be considered; closed shrublands are healthy ecosystems by themselves	Land use-land cover	WLRC, 2016
		Include bare and shrub/bushland with slope below 60%	Non-forested areas can be turned into commercial plantation areas if they fit both the suitability and accessibility requirements	Land use-land cover Slope	WLRC, 2016 Derived from SRTM, USGS, 2017

SN	Options	Criteria	Rationale	Data sets	Sources
		Population density <200 people per sq. km	Highly populated areas should be excluded from commercial plantations, as there would be different services and demands for the land	Woreda population density	CSA, 2007
5	Potential for fuelwood plantations	Include bareland, and shrub/bushland above 30% slope	Wasted lands can be developed for fuelwood by the community	Land use-land cover	WLRC, 2016
		Include population density <200 people per sq. km	There could be a challenge to implement this option in the densely populated areas due to population pressure for settlement and other priorities	Woreda population density	CSA, 2007
		Within 5km of roads	Fuelwood plantations located farther than 5 km from roads would result in challenges to the daily lives of children, girls and women, since these groups are primarily responsible for fuelwood collection	Road network	ERA, 2006
		Include tree cover <30%	Areas with tree cover <30 % are assumed to be degraded areas that require restoration	Tree cover	Global Tree cover, 2010
6	Potential for home gardens and woodlots	Rural settlement areas with population density <200 people/ sq.km	Home gardens are within the vicinities of individual households, but highly populated areas are challenging to spare areas for home-garden unless landowners are committed to the intervention. Less populated areas are preferred since there is more available space for home-gardens	Woreda population density	CSA, 2007

SN	Options	Criteria	Rationale	Data sets	Sources
		Within 2kms of homesteads/villages	Areas within a radius of 2 km can be considered as home gardens. Areas located at farther locations could have mixed land use types and be difficult to monitor regularly	Homestead/village	CSA, 2007 and 2018
		Include cropland, bareland, and settlement areas	Croplands, bareland, and settlement areas are suitable land use types for home garden practices	Land use-land cover	WLRC, 2016
7	Potential for expansion and restocking of highland (altitude between 1500-3200 m) and lowland (altitude between 800-1500 m) bamboo	Include areas that currently have lowland or highland bamboo	Existing bamboo areas are assumed to be degraded and could be restocked	Natural bamboo extent	INBAR, 2018
		Include areas with potential for bamboo	Areas where new bamboo sites can be developed for ecosystem services and other socio-economic benefits	Bamboo potential	National Potential and Priority Maps for Tree-Based Landscape Restoration in Ethiopia, 2018
8	Potential for tree-based buffer around rivers, lakes, and wetlands	Up to 50 m around lakes, rivers & wetlands	The areas in close proximity to a body of water play a critical role in protecting it from erosion (based on expert judgment).	Rivers, lakes & wetlands	WLRC, 2016
		Exclude forest and tree cover >30% around lakes, rivers and wetlands	Forests and other land with tree cover greater than 30% are already considered to have good tree cover.	Land use-land cover Tree cover	WLRC, 2016 Global Tree cover, 2010

SN	Options	Criteria	Rationale	Data sets	Sources
		Exclude population density > 200 people/ sq.km	Higher population densities increase pressures on the trees	Woreda population density	CSA, 2007
9	Potential for tree-based buffer around National Parks, protected areas, and national forest priority areas	Up to 1000 m buffer around NFPAs, NPs and PAs	Reserving 1000 m buffer area around existing NPs, and Pas, and NFPAS is fundamental to protect the core areas from degradation	Protected areas and national priority areas	World Database Protected areas (WDPA)
		Exclude forest and tree cover >30% NFPAs, NPs and PAs	Forests and other land with tree cover greater than 30% are already considered to have good tree cover	Land use-land cover Tree cover	WLRC, 2016 Global Tree cover, 2010
		Exclude population density > 200 people/ sq.km	Higher population densities increase pressure on trees	Woreda population density	CSA, 2007
10	Potential for tree-based buffer along roads and around towns	100m from roads and 1km from towns	Re-greening roads and urban areas is contributing to restoration and microclimate regulation	Roads and towns	ERA, 2006 and CSA, 2007
		Exclude forest and tree cover >30% around roads and towns	Forests and other land with tree cover greater than 30% are already considered to have good tree cover.	Land use-land cover Tree cover	WLRC, 2016 Global Tree cover, 2010

Table 5 | Major variables (datasets) used to model to identified spatial distributions of potential restoration options

Variable	Descriptions	Source
Land use land cover (LULC)	To mask out non-used LULC types and extract only important ones	Water and Land Resource Center, 2016
Rainfall	Rainfall is one of the constraints for different restoration options (annual average 1983 - 2016)	Enhancing National Climate Services (ENACTS data) from Columbia University and NMA of Ethiopia
Slope	Slope governs the intervention types	Derived from SRTM-30m

Variable	Descriptions	Source
Altitude	Altitude affects both rainfall and temperature	SRTM-30m
Existing bamboo extent	Existing bamboo map is a base for restocking of degraded bamboo	INBAR, 2018
National potential for bamboo	Areas that meet criteria for growing lowland and highland bamboo	MEFCC, unpublished
Tree cover	A threshold of less than 30% tree cover is assumed degraded and can sustain more trees	Global data, Tree cover, 2010
NFPA, PA and National parks	National Forest priority area, protected areas and national parks	WDPA regional office (global data)
Rivers, lakes, wetlands	Bodies of water such as rivers, lakes, and wetlands	CSA, 2007 and EthioGIS II, 2015
Roads and cities	Road infrastructure and accessibility are very important for market and access	ERA, 2006 and CSA, 2007
Settlement/villages	Settlement areas were a good proxy for homestead areas	CSA, 2007 & 2018
Population density	Population density affects the implementation of restoration	CSA, 2007
Land productivity	Land productivity indicates the status of vegetation changes 2016	Trends.earth
Normalized difference vegetation index (NDVI)	Vegetation index of a given area at a given period	Derived from Landsat 8, 2017
Administrative boundaries	SNNP regional boundaries for mask-out he area extents of those restoration options: (Note: administrative boundaries are not authoritative)	CSA, 2007

The datasets used for this model were collected from a variety of sources which use different projections, data formats (raster, shapefile, etc.), and resolutions. The team standardized all data sets and projected them into "WGS_1984_UTM_Zone_37", using a spatial resolution of 30 m.

During the validation workshop, criteria and respective outputs for all restoration options were presented to participants from a number of different agencies in the region (Appendix 2). They discussed each of the criterion and outputs in detail and presented their comments and feedback. The majority of their comments concerned afforestation and secondary forest restoration and fuelwood plantations. They revised the criteria from 60% slope to 50% slope for afforestation and secondary forest restoration, and from 50% slope to 30% slope for fuelwood plantations. The group also decided to decrease the distance from villages to fuelwood plantations from 5km from 2km.

3.4 GIS Mapping Spatial Distribution of the Identified Restoration Potential Options

Geoinformation System (GIS) experts from WLRC mapped the identified FLR options (Table 3) using the mapping criteria and data (Table 4) identified by the stakeholders during the workshop and additional criteria, when necessary, from secondary data sources such as the "National Potential and Priority Maps for Tree-Based Landscape Restoration in Ethiopia" work (MEFCC, 2018). Model Builder of an ESRI ArcGIS software was used to map the identified FLR options by translating the mapping criteria (Appendix 2). Best efforts were made to collect the input data required for analysis from local, national and global sources (Table 4), but these efforts were by no means exhaustive. Improving the product should be an iterative process as newer and better-quality data becomes available. With this in mind, the GIS database and models are delivered with this report.

Photo credit: Aaron Minnick, WRI

4 Results

4.1 Summary Statistics and Spatial Distribution Maps

Based on information collected during the two-day workshop in SNNP region, the project team decided to map the potential of ten potential restoration options (enumerated in Section 3). The potential area of each intervention is listed in Table 6. Some potential restoration options were divided into two categories to provide more accurate results. Overall, approximately 7.6M hectares (Mha) was identified as potential area for restoration. The potential restoration options with the largest area of potential implementation are agroforestry on cropland (2,429,174 ha or 32% of the total potential) and lowland bamboo expansion or restocking (1,879,029 ha or 24.7% of the total potential). However, several potential restoration options can overlap in a specific area. Out of the 7.6M hectares identified, 450,196 hectares have the potential for more than one restoration option (see Figure 11 and Appendix 3).

Table 6 | Tree-based landscape restoration potential area (ha) for SNNP Region, including double counted areas that have potential for multiple options

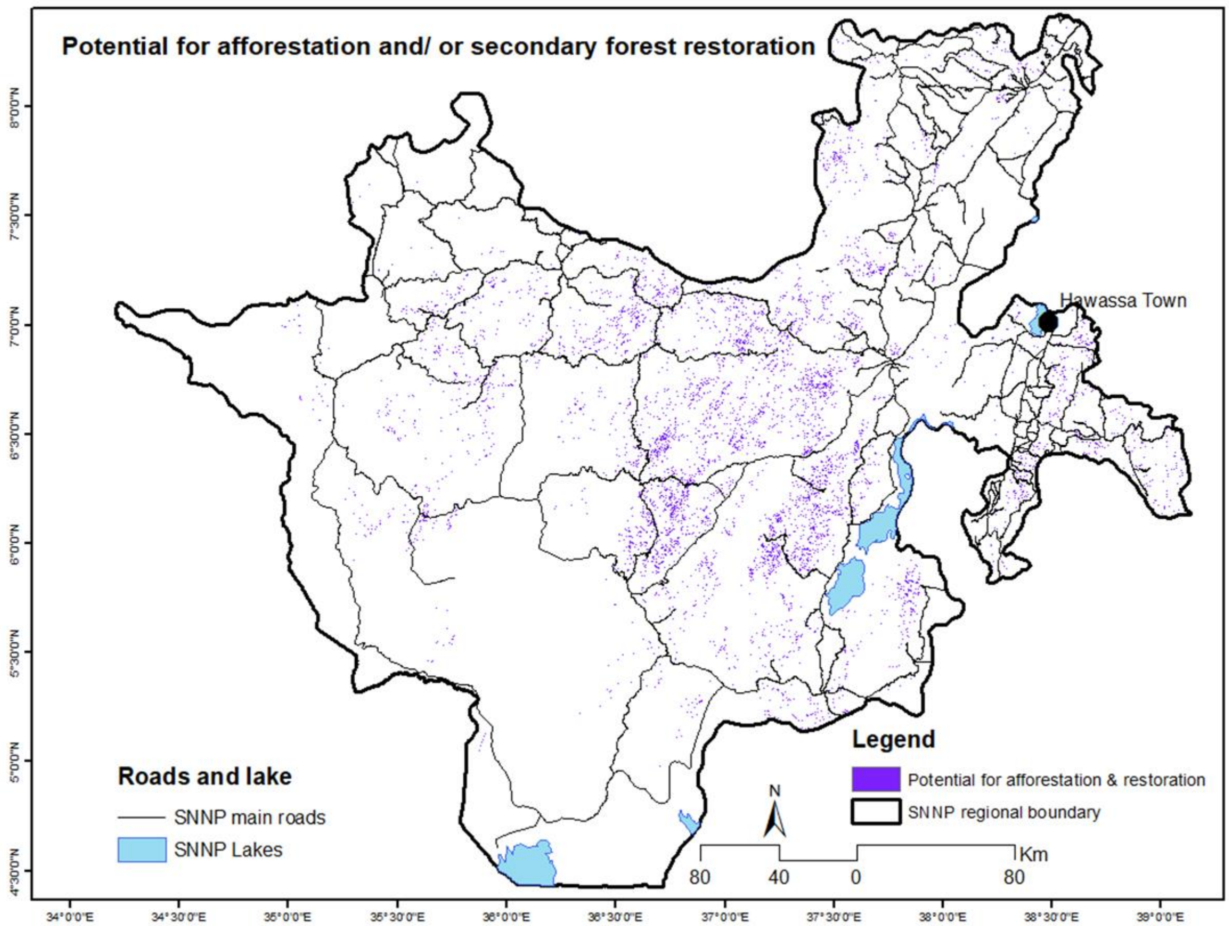
Option	**Potential Area (ha)**	**% of total restoration potential**
1. Afforestation and secondary forest restoration	195,124	2.57
2. Restocking degraded natural forests	57,765	0.76
3. Agroforestry on cropland	2,429,174	31.95
4. Commercial plantations	682,709	8.98
5. Fuelwood plantations	690,323	9.08
6. Home-garden and woodlots	417,424	5.49
7. Bamboo expansion and restocking: highland	760,745	10.01
8. Bamboo expansion and restocking: lowland	1,879,029	24.71
9. Buffer around rivers, lakes, and wetlands	1,274	0.02
10. Buffer around National Parks, protected areas, and NFPA	378,682	4.98
11. Buffer around roads	63,562	0.84
12. Buffer around towns	47,576	0.63
Total[1]	**7,603,387**	

[1] Including double counted areas that have potential for multiple options

4.2 Potential for Afforestation and Secondary Forest Restoration

There is a potential of 195,124 ha of land for afforestation and secondary forest reforestation in SNNP Region (Table 6). Most of the potential area is located within the central section of the region (Fig. 1).

Figure 1 | Spatial location for potential afforestation and secondary forest restoration for SNNP region

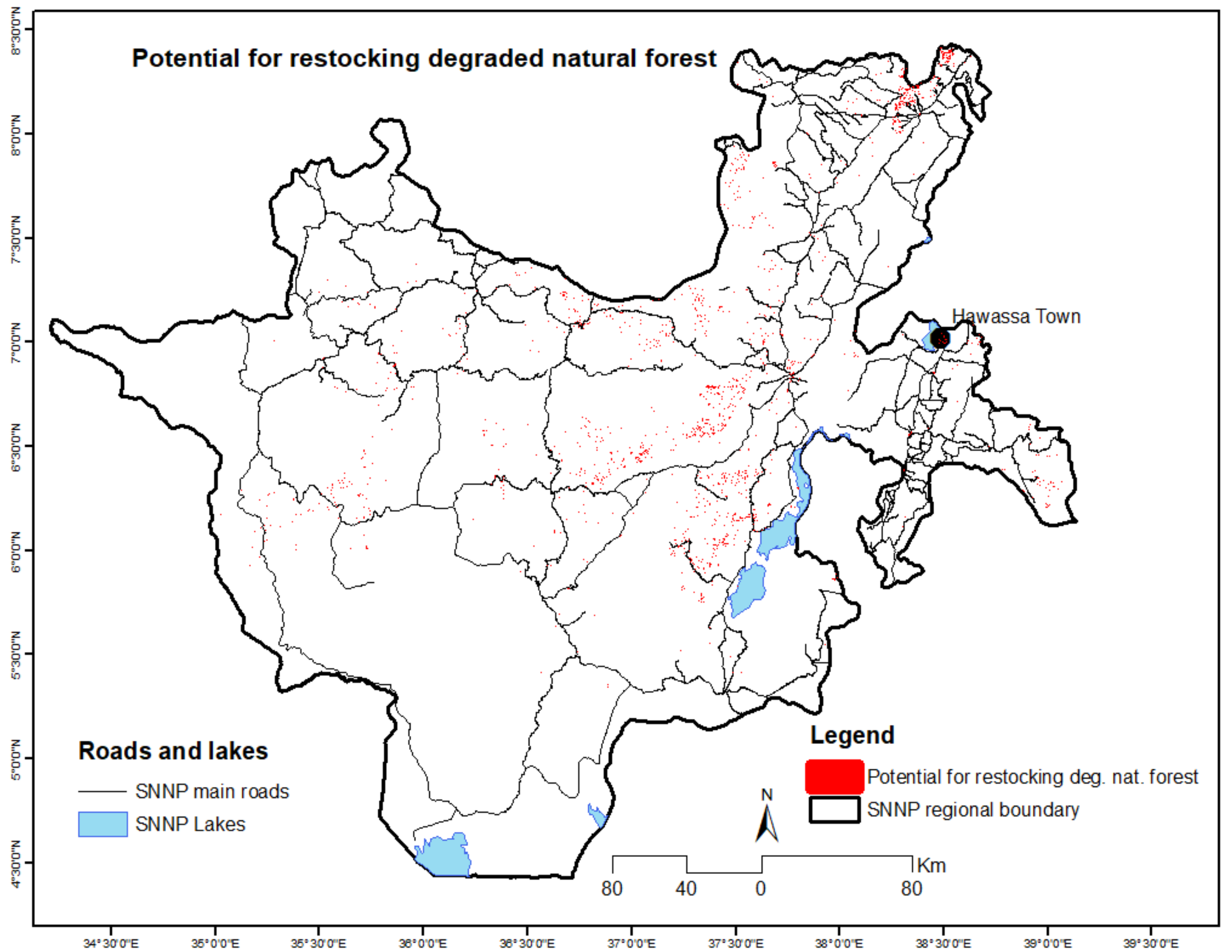


Note: The administrative boundaries used in this map are not authoritative.

4.3 Potential for Restocking Degraded Natural Forests

In SNNP, there are approximately 57,765 ha of degraded natural forests with the potential to be restocked (Table 6 and Fig. 2).

Figure 2 | Location of potential for restocking degraded natural forest areas in SNNP region

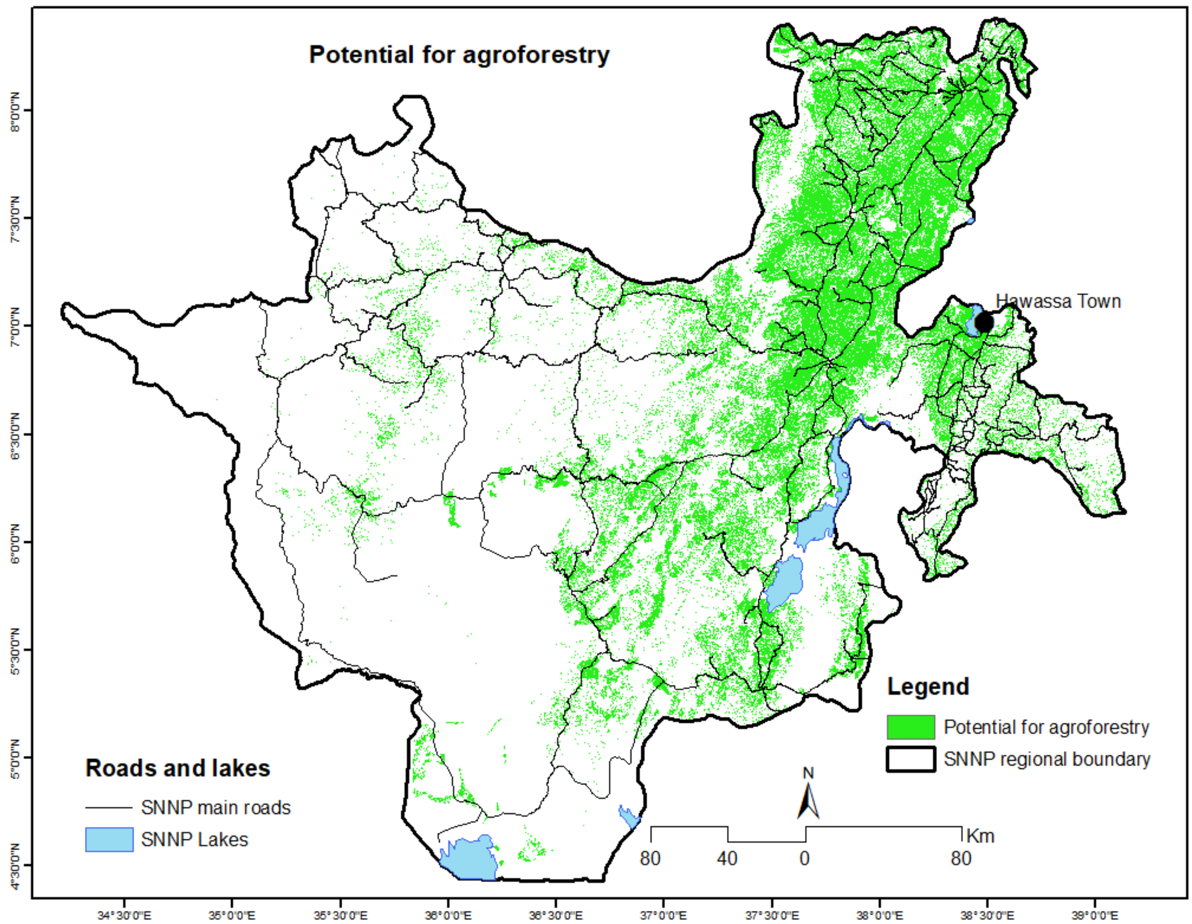


Note: The administrative boundaries used in this map are not authoritative.

4.4 Potential for Agroforestry on Cropland

Based on the results of the spatial modeling analysis, there are approximately 2,429,174 ha of potential land for agroforestry development and enrichment in SNNP region (Table 6). The eastern and northeastern sections of SNNP, known to have existing agroforestry practices, have the most potential for agroforestry expansion (Fig. 3). Our analysis shows both areas where current agroforestry practices can be *expanded* (if tree cover is less than 30%) and areas where agroforestry practices can be *initiated*.

Figure 3 | Spatial location for potential agroforestry on cropland in SNNP region

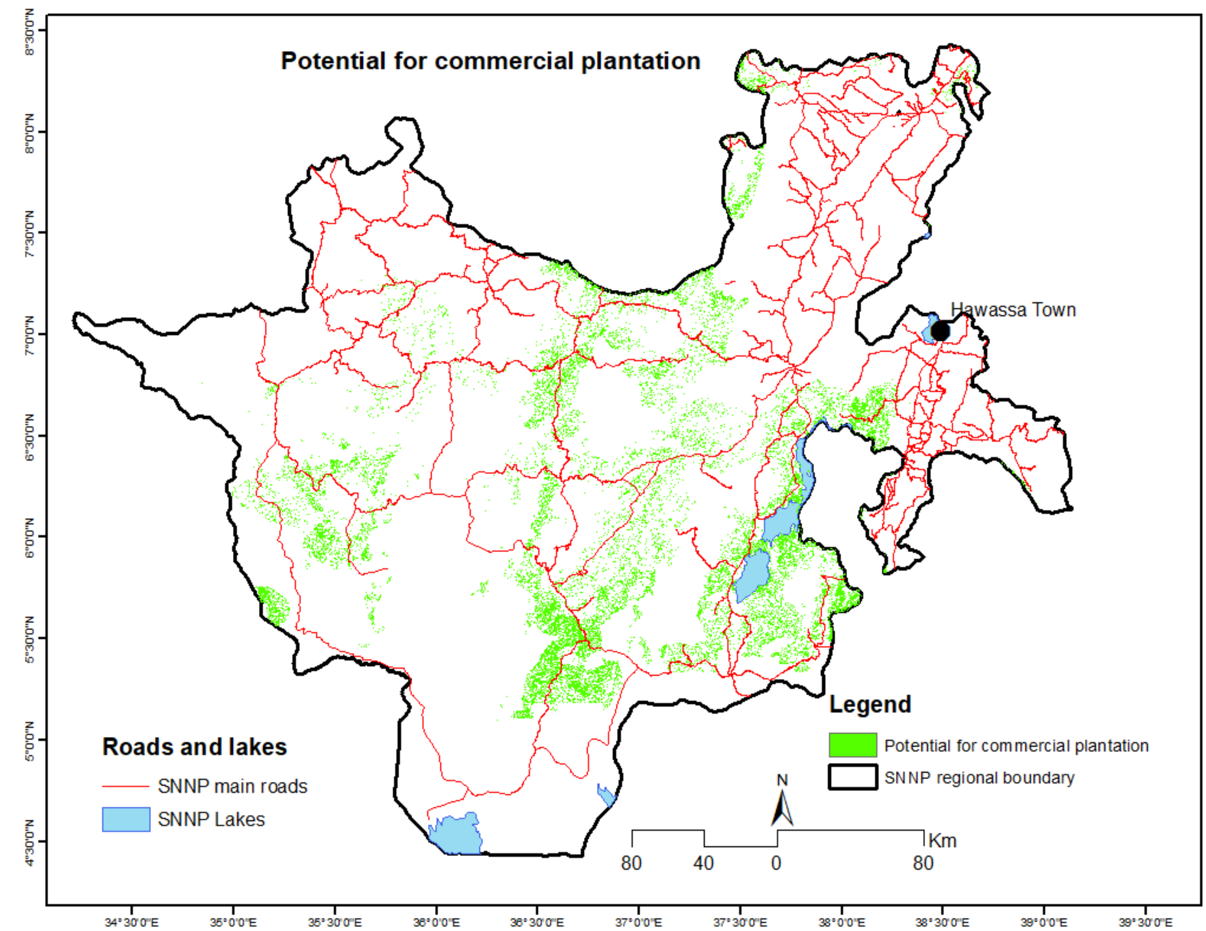


Note: The administrative boundaries used in this map are not authoritative.

4.5 Potential for Commercial Plantations

The creation of more commercial plantations was also identified as a potential tree-based restoration option. Although established for commercial purposes and cleared when needed, these plantations provide natural vegetation, particularly forests, relief from deforestation. From this analysis, about 682,709 ha of land was identified for this purpose in SNNP region (Table 6). Commercial plantation potential areas are found in the central and eastern part of the region where there is more access to roads and markets (Fig. 4).

Figure 4 | Commercial plantation development sites in SNNP region

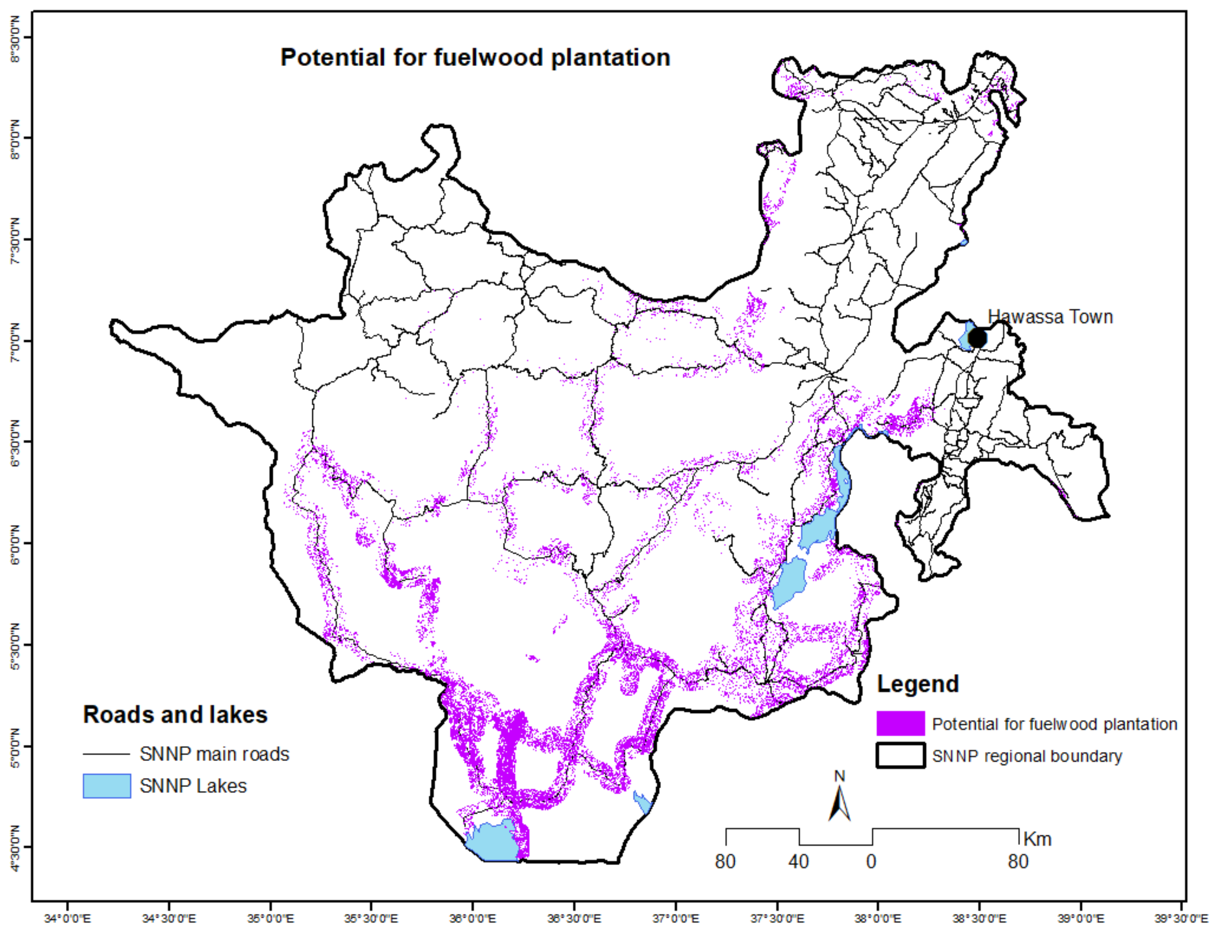


Note: The administrative boundaries used in this map are not authoritative.

4.6 Potential for Fuelwood Plantations

The expansion of fuelwood plantations is considered an integral part of the tree-based landscape restoration program, since greater availability of fuelwood could protect natural forests from being cut for this purpose. Additionally, this option will be implemented in close proximity to villages, saving local communities time and energy during the collection process. In SNNP region, there are approximately 690,323 ha of land with the potential for fuelwood development (Table 6 and Fig. 5).

Figure 5 | Location of potential fuelwood plantations in SNNP region

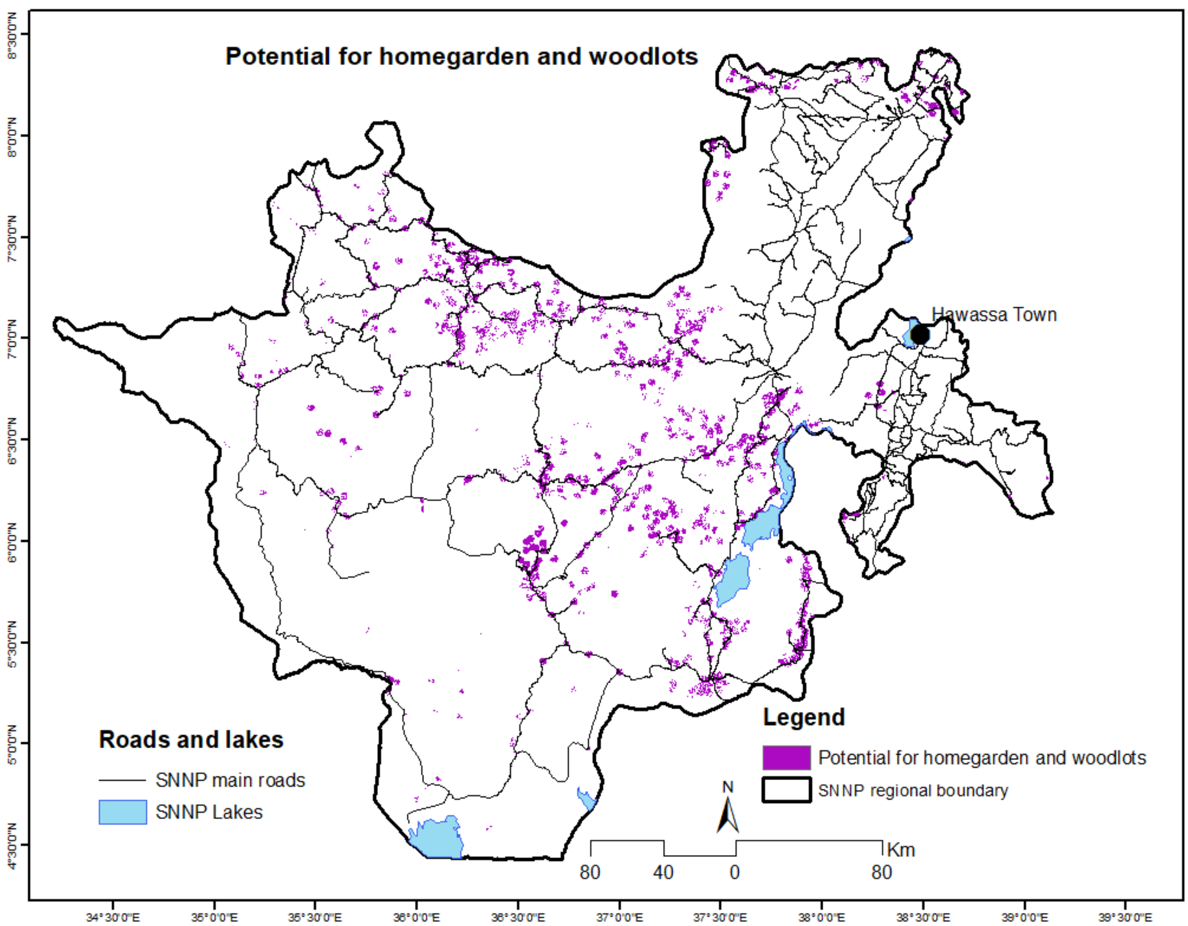


Note: The administrative boundaries used in this map are not authoritative.

4.7 Potential for Home Gardens and Woodlots

Based on our analysis, there are approximately 417,424 ha of land that can potentially be used for home gardens and woodlots in the SNNP region (Table 6 and Fig. 6).

Figure 6 | Location of potential home-garden and woodlot areas in SNNP region

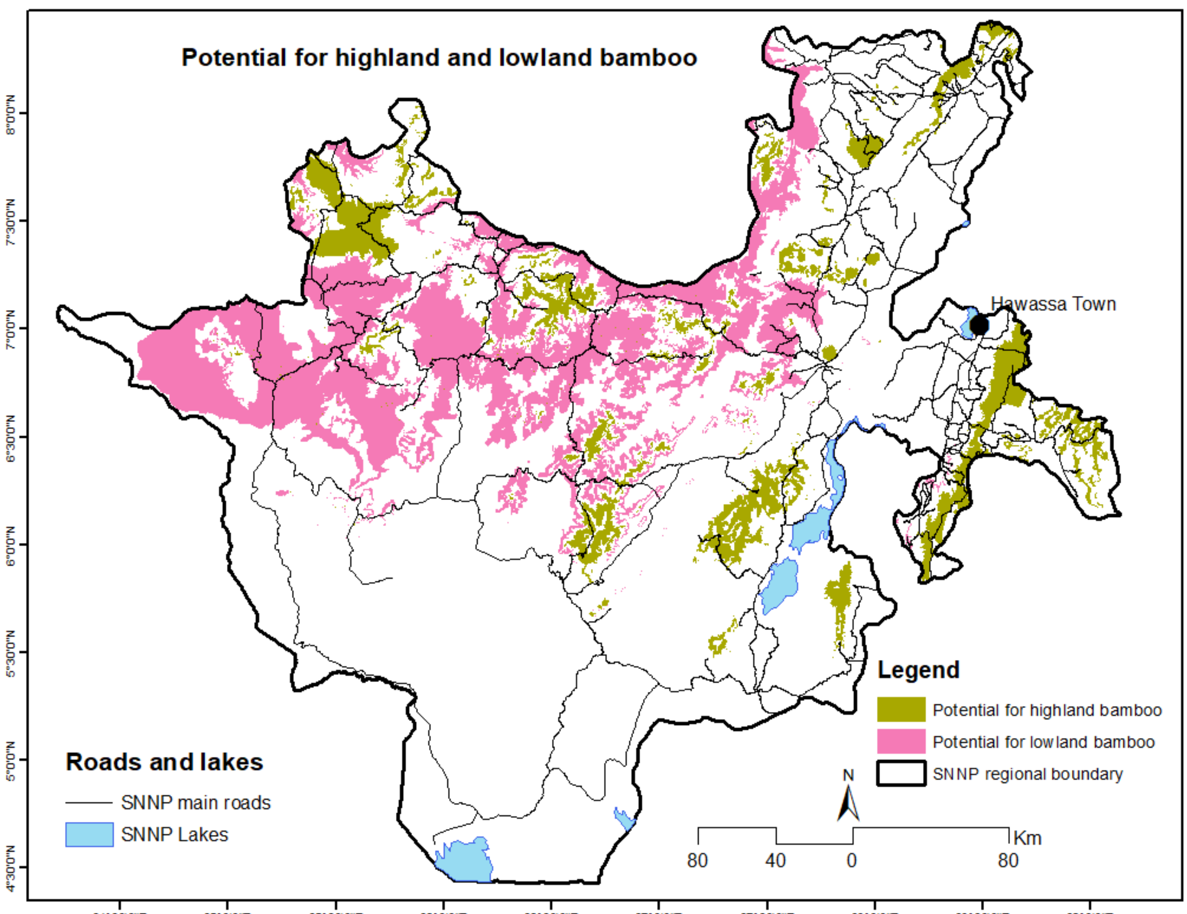


Note: The administrative boundaries used in this map are not authoritative.

4.8 Potential for Expansion and Restocking of Highland and Lowland Bamboo

Using the national restoration potential map (WRI. 2018), the project team combined areas of existing degraded bamboo stocks and potential areas for bamboo expansion in both highland and lowland areas. In SNNP region, there are 760,745 ha and 1,879,029 ha that have potential for highland and lowland bamboo restocking and expansion, respectively (Table 6). The northern part of the region is most suitable for lowland bamboo restocking and expansion. Areas with potential for highland bamboo development are more scattered throughout the region, but its South-West corner (Fig. 7).

Figure 7 | Spatial location of areas with potential for expansion and restocking of highland and lowland bamboo in SNNP region

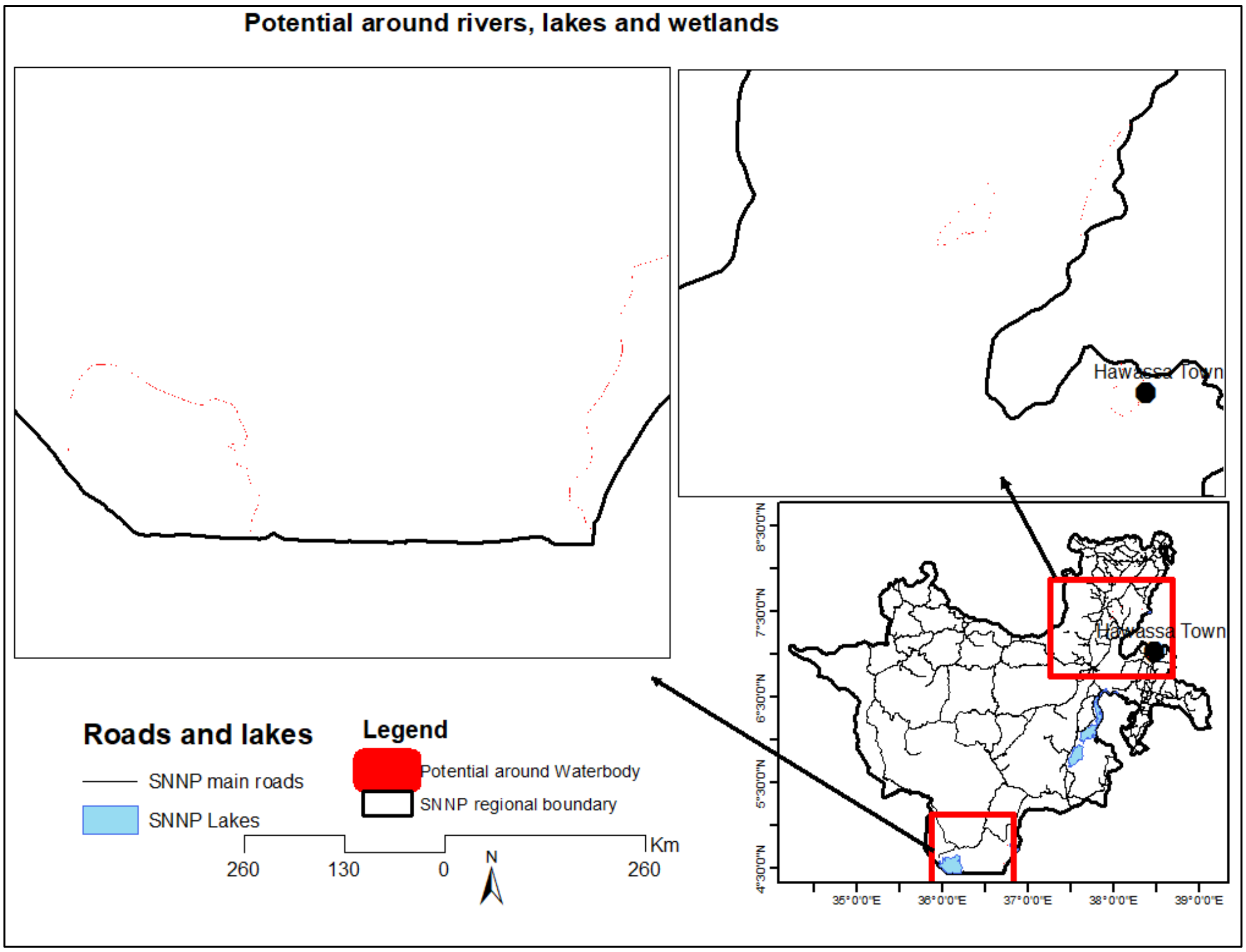


Note: The administrative boundaries used in this map are not authoritative.

4.9 Potential for Tree-Based Buffer Around Rivers, Lakes, and Wetlands

Tree-based restoration has a potential to be implemented along the peripheries of lakes, rivers, and wetlands. The potential area for this restoration intervention in SNNP region is estimated to be 1,274 ha of land (Table 6). These potential areas are limited and sporadically located along riparian areas in the region (Fig. 8).

Figure 8 | Spatial location for buffer around lakes, rivers and wetlands in SNNP region

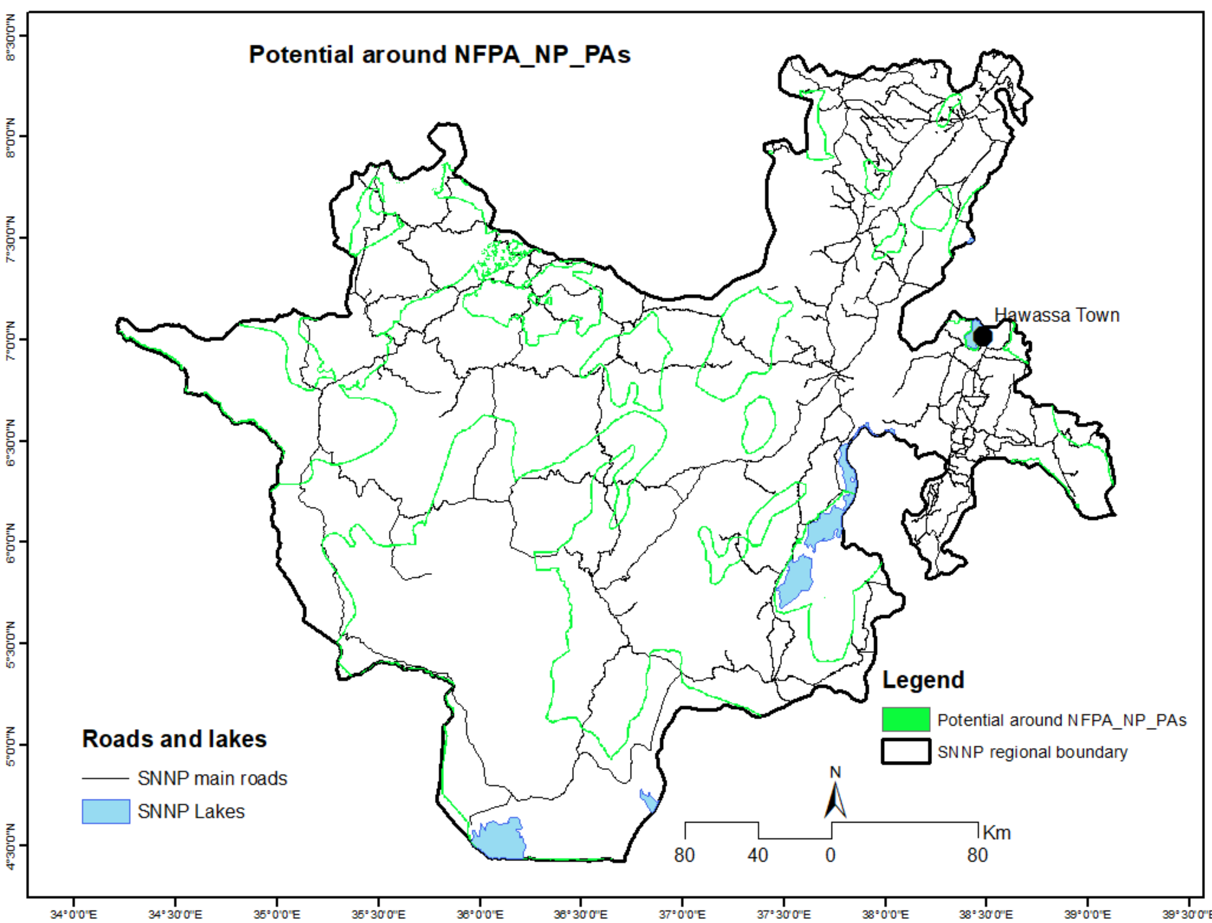


Note: The administrative boundaries used in this map are not authoritative.

4.10 Potential for Tree-Based Buffer Along National Parks, Protected Areas, and National Forest Priority Areas

Most national parks, protected areas, and nation forest priority areas have their own management plans and strategies for land rehabilitation and restoration. However, these plans lack provisions to extend restoration practices along the peripheries of such areas. The project team created a 1km buffer around each area that we recommend be considered as potential restoration sites. Restoring buffer zones will help strengthen the ecosystem services derived from these areas and create an additional layer of protection around the core areas within each zone. In total, the estimated potential for this intervention is 378,682 ha of land (Table 6). The potential areas for this intervention are spread throughout SNNP region due to the substantial number of national parks, protect areas, and national forest priority areas in the region (Fig. 9).

Figure 9 | Spatial location for potential tree-based buffer along National Parks, Protect Areas, and National Forest Priority Areas in SNNP region

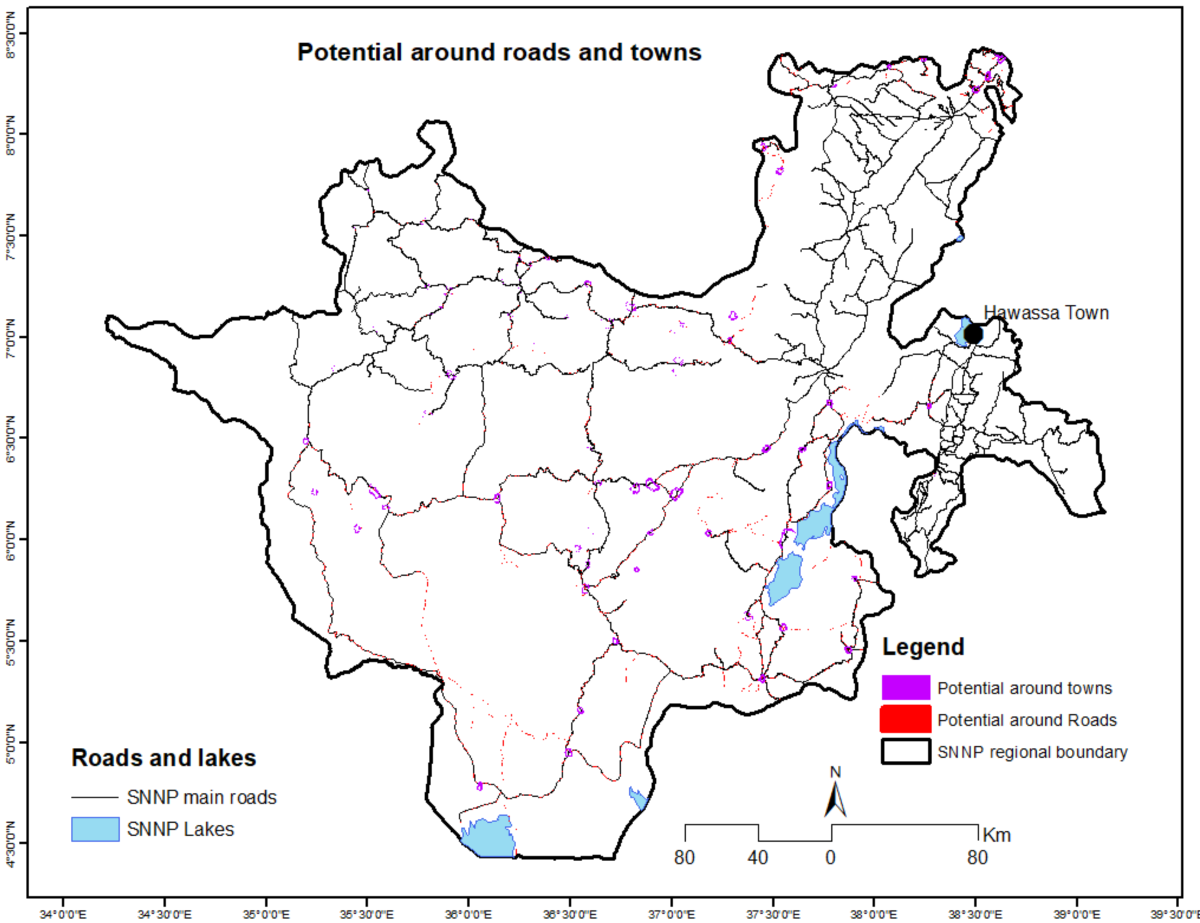


Note: The administrative boundaries used in this map are not authoritative.

4.11 Potential for Tree-Based Buffer Along Roads and Around Towns

The project team also analyzed areas for potential tree-based restoration along road and around towns. This option was considered for areas within a 100m radius of rural roads and 1km from town polygons. Approximately 63,562 ha and 47,576 ha of land were identified as potential tree-based buffer zones along roads and around towns, respectively (Table 6). Because SNNP region is relatively undeveloped and lacks substantial amounts of infrastructure, including roads and towns, this potential restoration option is fragmented and sparsely found throughout the region (Fig. 10).

Figure 10 | Spatial location for potential tree-based buffers along roads and towns in SNNP region

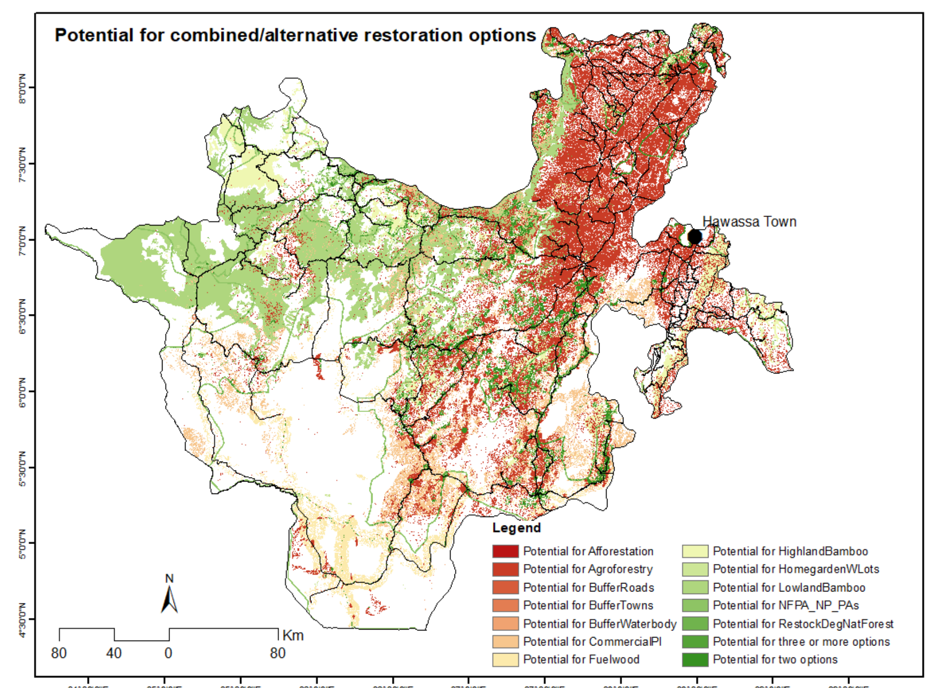


Note: The administrative boundaries used in this map are not authoritative.

4.12 Combined Potential for Tree-Based Restoration

Our analysis of combined potential for tree-based restoration shows that over 6 Mha of land is suitable for one or more potential restoration option in SNNP region (Table 7)[2] . This number differs from the total number of hectares described in Table 6 because that analysis did not account for areas where potential restoration options may overlap. After combining and mapping all potential restoration options, we see that specific areas have potential for multiple options. In these cases, the potential restoration option(s) will be prioritized based on the stakeholders' desired environmental, social and economic benefits in the given area, and the region at-large. From this analysis, we have found approximately 415 separate combinations of how potential restoration options (Fig. 11) can be implemented in the region based on set criteria. For example, 2.1 Mha of the region is suitable solely for agroforestry expansion, while 1.4Mha is suitable solely for lowland bamboo. However, major areas in the region are suitable for two or more restoration options. In terms of hectares covered, the largest combined options we observed are: potential for agroforestry on cropland and home-garden and woodlots (235,880 ha); Potential for agroforestry on cropland and expansion and restocking of lowland bamboo (177,224 ha); potential for agroforestry on cropland and expansion and restocking of highland bamboo (159,741 ha); and potential for expansion and restocking of lowland bamboo and commercial plantations (110,689 ha). In total, approximately 400,179 ha of land were suitable for at least two potential restoration options and 50,017 ha of land were suitable for three or more potential restoration options (Table 7).

Figure 11 | Combined map of potential restoration options in the SNNP region



Note: The administrative boundaries used in this map are not authoritative.

[2] SNNP's areas of potential in the regional and national (MEFCC, 2018) assessments differ because the criteria and input data used were different.

Table 7 | Summary of combined and individual potential restoration options

Potential restoration options	Area (ha)
Potential for afforestation and secondary forest restoration only	87,946
Potential for restocking degraded natural forest only	53,816
Potential for agroforestry on cropland only	2,079,190
Potential for commercial plantation only	649,783
Potential for fuelwood plantation only	429,822
Potential for home-garden and woodlots only	111,258
Potential for highland bamboo expansion and restocking only	479,298
Potential for lowland bamboo expansion and restocking only	1,407,389
Potential for tree-based buffer around rivers, lakes & wetlands only	643
Potential for tree-based buffer around NFPA, NP & Pas only	268,605
Potential for tree-based buffer around roads only	18,419
Potential for tree-based buffer around towns only	10,115
Potential for two options	400,179
Potential for three or more options	50,017
Total	**6,046,481**

5 Conclusions

In total, there are over 6 Mha of land in SNNP that are suitable for one or more than one forest and landscape restoration option. The largest potential restoration options by size are agroforestry on cropland (2.01 Mha) and expansion and restocking of lowland bamboo (1.41 Mha). There is also substantial potential for the expansion and restocking of highland bamboo (0.48 Mha) and the development of commercial plantations (0.65 Mha). Although its total area is relatively small compared to other regions in Ethiopia, SNNP Region has, overall, a high potential for various tree-based restoration options. Given the data collected as part of this project, and the urgent need to address land degradation in the region, it is imperative to begin planning and implementing these tree-based restoration options. Doing so will not only maintain and contribute to more sustainable land management practices, but also deliver additional ecosystem services and socio-economic benefits to local communities.

6 Recommendation

These are still regional level analyses based on biophysical and infrastructure assessment set by stakeholders and literature review. They do include socio-economic preferences and livelihood options. Therefore, before implementing these identified ten restoration options, we recommended that district level action plans, including both biophysical and socio-economic feasibilities of each district, should be developed.

7 Acknowledgements

First and foremost, we appreciate the efforts of the Environment Forest and Climate Change Commission (EFCCC) of Ethiopia, particularly H.E. Ato Kebede Yimam, for supporting the vision to carry out a broad, tree-based landscape restoration plan, developed in coordination with the World Resources Institute (WRI), the Water and Land Resource Center (WLRC), and local partners.

During this project, the WLRC of Addis Ababa University, in collaboration with EFCCC (delegated by Mr. Adugna Abebe) and WRI, was responsible for all technical work. The WLRC, particularly Dr Gete Zeleke, was fully committed to the project and played an instrumental role in stewarding the technical aspects of the assignment.

We would like to recognize the contributions of regional and local stakeholders from SNNP, who have supported the project from its inception through the validation stage. We also appreciate the support of the WRI staff, particularly Tesfay Woldemariam, Meseret Shiferaw and Florence Landsberg, whose contributions were helpful in achieving the planned objectives of the project. We also thank Mary Gronkiewicz of WRI for editing the report.

Finally, this work would not have been possible without the generous financial support of the Government of Norway.

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9 Appendix 1: List of Participants

9.1 Planning Workshop Participants

S N	Name	Institution
1	Tesema Awono	Envt, Forest & CC
2	Assefa Ataro	EFCCC Authority
3	Tamerat Tesfaye	EFCCC Authority Gurage Zone
4	Taye Tesfaye	Gurage Zone Agriculture and Natural Resource Dept.
5	Kassu Juhar	Gurage Zone Agriculture and Natural Resource Dept
6	Mohammed Fegessa	Silite Zone Ag. And Nat.
7	Chaka Kumssa	Silite Zone Environment.
8	Seid Kesisa	Halaba Zone Agr. Nat. Dept.
9	Tsegaye Leta	Gamo Zone Agr. Nat.
10	Demeke Kuke	Wolaita Zone ANRM Office
11	Mohammed Kedir	Halaba Zone Office Head
12	Lenin Raya	Yem Nat.Res. Head
13	Zerihun Workineh	EF
14	Solomon Mengesha	ANR SNNPR
15	Getachew Dira	Agricultural Dept
16	Tesfagegn Getachew	SNNPR Water, Mines & Energy
17	Fantahun Bilate	Kaut Agri. Department
18	Melkamu Outa	Gofa Agr. Dept.
19	Tomas G/Hana	Gamo Zone EPR Office
20	Tanu Yineda	Sidama Zone EPFO
21	Eoyel Tadesse	Hadiy Zone Agr.
22	Daniel Dutiso	Hadiy Zone Agr.
23	Muluneh Amanuel	Dawuro Zone Arg & Nat. Res. Dept.
24	Wondafrash Nigussie	Office Head
25	Tekile Tiribo	Kembata Tembaro Zone EPF
26	Wondimagegn Debisa	Kembata Tembaro Zone NRM
27	Gizachew Walena	Kembata Tembaro BOANPR
28	Tegegn Tadesse	Gedeo Zone Farm & Nat. Dept.
29	Sileshi Begaye	Gedeo Zone Farm & Nat. Dept.

9.2 Validation Workshop Participants

S N	Name	Institution
1	Tamerat Tesfaye	EFCCC Authority Gurage Zone
2	Mohammed Fegessa	Silite Zone Ag. And Nat.
3	Chaka Kumssa	Silite Zone Environment.
4	Seid Kesisa	Halaba Zone Agr. Nat. Dept.
5	Tsegaye Leta	Gamo Zone Agr. Nat.
6	Demeke Kuke	Wolaita Zone ANRM Office
7	Mohammed Kedir	Halaba Zone Office Head
8	Tesfagegn Getachew	SNNPR Water, Mines & Energy
9	Melkamu Outa	Gofa Agr. Dept.
10	Tomas G/Hana	Gamo Zone EPR Office
11	Wondimagegn Debisa	Kembata Tembaro Zone NRM
12	Gizachew Walena	Kembata Tembaro BOANPR
13	Getachew Sileshi	EPFD
14	Tanu Yineda	Sidama Zone EPFD
15	Kasahun Errkocho	Hadiya Zone Agr
16	Ketsela Doboch	Kembata Tembaro Zone EPF
17	Yishak Rase	Gofa Agr. Dept.
18	Tamene Tesfaye	Dawuro Zone Arg & Nat. Res. Dept.
19	Zerihun Workneh	Wolaita Zone Env Forest
20	Mesfin Bogale	Hadiy Zone Agr.
21	Mirat Alemu	Hadiya Zone Agr Office
22	Sultan Sirmolo	Agr. Nat Res Office

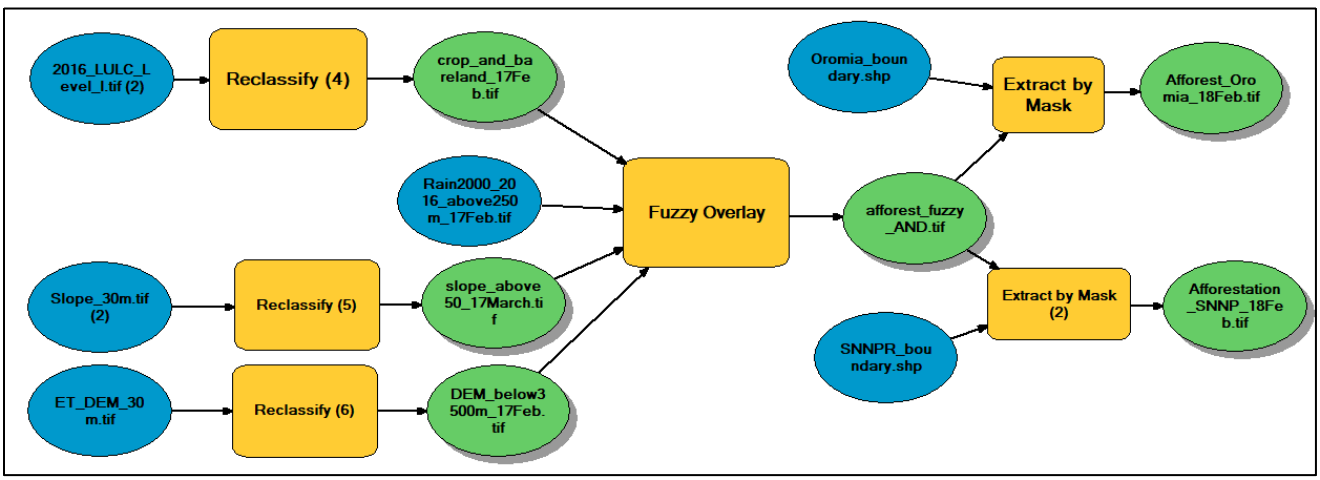
10 Appendix 2: Spatial Modelling

We developed spatial modelling tools using ArcMap Toolbox to identify potential areas for each restoration option. The spatial assessment tools include, but are not limited to, buffering, extracting, reclassifying, masking, mosaicking, and overlay (e.g., Fuzzy Overlay with AND option) to identify areas that satisfied all the given criteria for each restoration option. We list each potential restoration option alphabetically in the sections that follow.

10.1 Afforestation and Secondary Forest Restoration Potential

Afforestation refers to the process of adding trees to areas that are currently not forested. Areas considered for afforestation may previously been forested in the past. In these cases, it may not be possible to afforest an area using the original vegetation species or to the extent of its original forest cover due to changes in climate and other dynamic variables. The project team used four major datasets to model and identify the potential areas for afforestation and secondary forest restoration (Fig. 12).

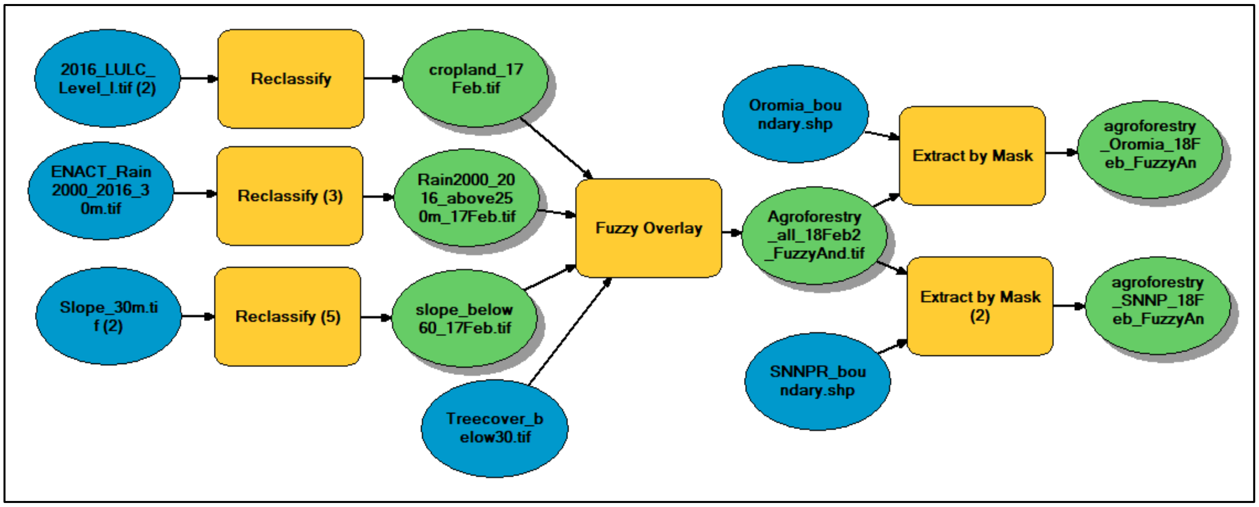
Figure 12 | Spatial modelling to identify afforestation and secondary forest restoration



10.2 Agroforestry on Cropland Potential

Agroforestry on cropland refers to intercropping tree-based landscape restoration with either temporal or permanent crops, or both. Four major input datasets were used to identify areas to potential agroforestry. The implemented spatial modeling tool for agroforestry potential is presented in Figure 13.

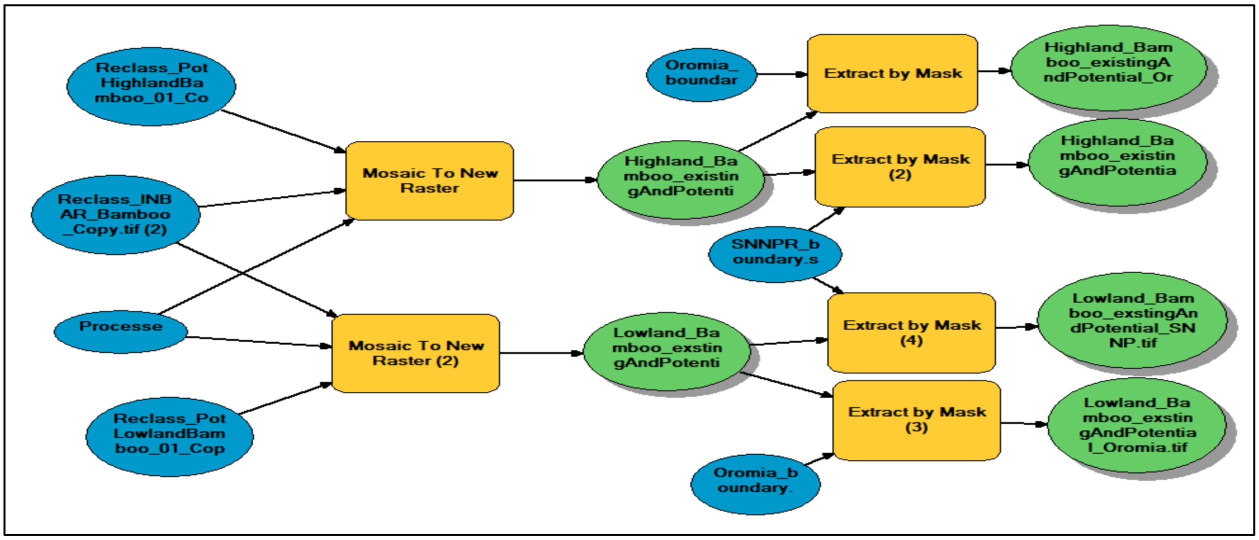
Figure 13 | Spatial modeling to identify agroforestry on cropland restoration areas



10.3 Bamboo Expansion and Restocking: Highland and Lowland Potential

For this option, we focused on highland and lowland bamboo restoration in areas with existing, degraded bamboo stocks. We also identified potential areas for new bamboo development. The datasets we used to create this potential map are from the national potential map and the existing bamboo map from the International Bamboo and Rattan Organization (INBAR). We then combined the maps of existing and potential bamboo sites to illustrate where stocks can be replenished and where they can be expanded and developed (Fig. 14).

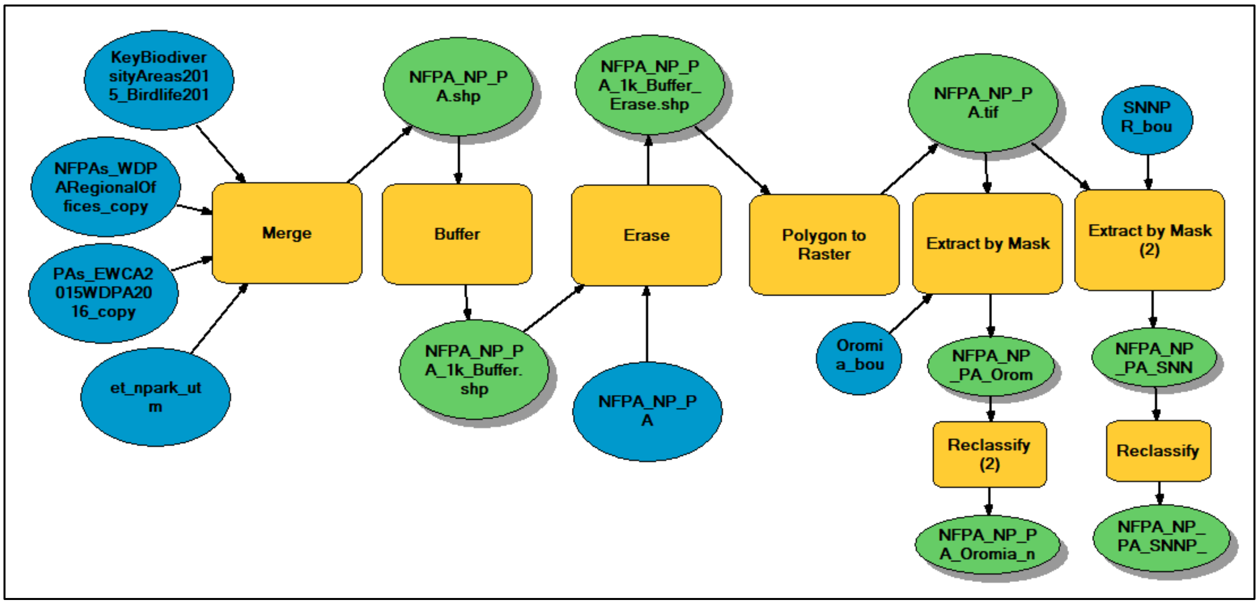
Figure 14 | Spatial location for both existing and potential bamboo forest sites



10.4 Buffering Around National Parks, Protected Areas, National Forest Priority Areas

For this option, it was assumed that national parks, protected areas, and national forest priority areas have their own management plans and restoration projects. However, these plans do not extend along the boundaries of the areas, even though they are suitable for tree-based restoration. To remedy this, the team established 1km buffer zones along the edges of the national parks, protected areas, and national forest priority areas that can add an additional layer of protection to the managed areas.

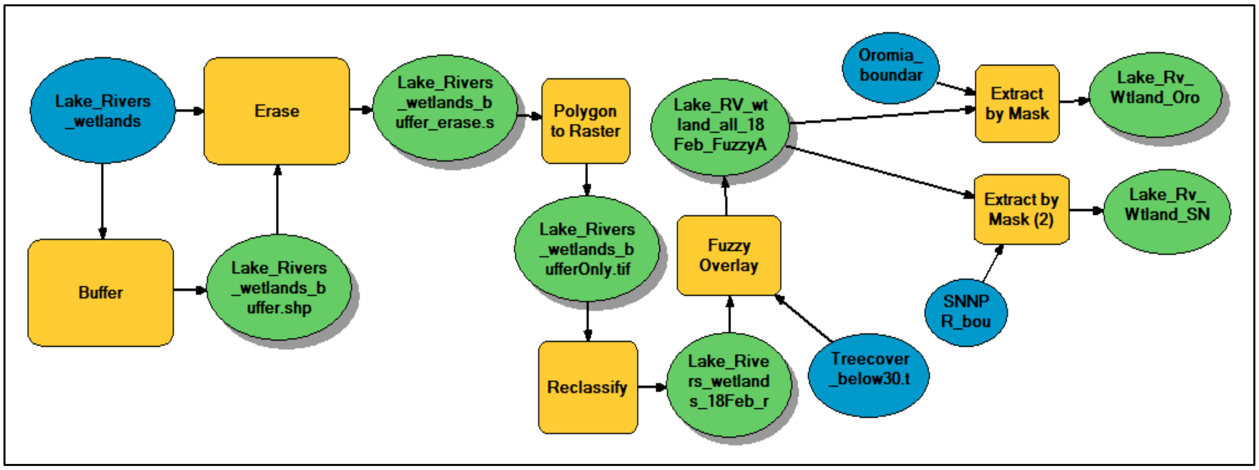
Figure 15 | Spatial modelling to identify tree-based landscape restoration potential in buffer areas around national parks, protected areas, and national forest priority areas



10.5 Buffer Around Lake, Rivers and Wetlands

The team established buffer zones with a 50 m radius around lakes, rivers and wetlands to model this potential restoration option (Fig. 16).

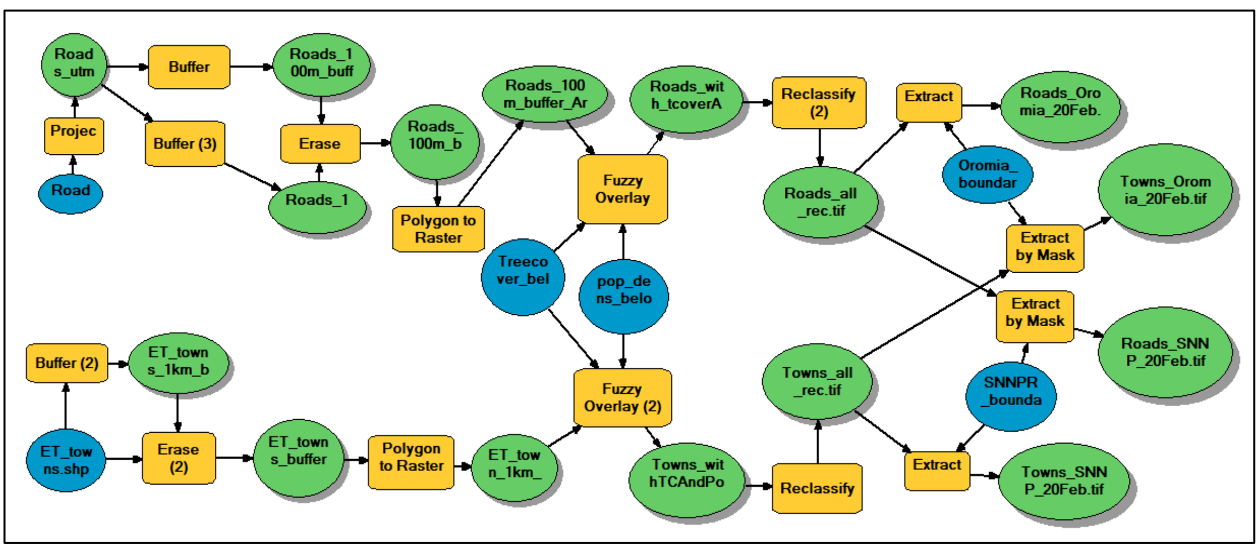
Figure 16 | Spatial modelling of buffer zones around lakes, rivers and wetlands



10.6 Buffer Around Roads and Towns

The team created buffer zones with a 1km radius around towns and a 100m radius around roads to model this potential restoration option. (Fig. 17).

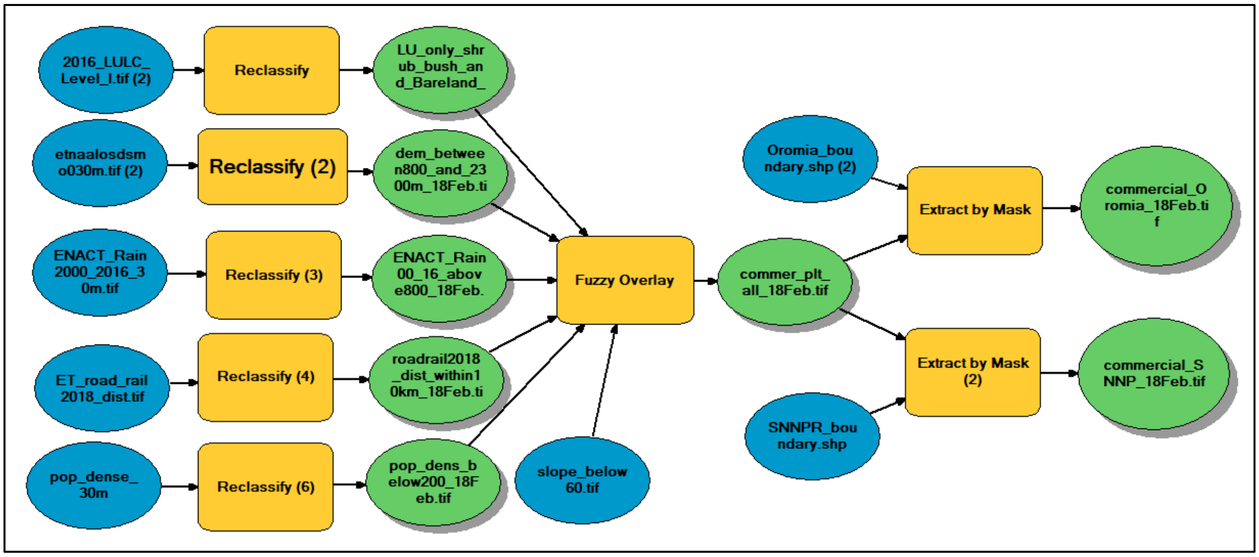
Figure 17 | Spatial modelling of buffer zones around roads and towns



10.7 Commercial Plantation Potential

Participants at the August workshop considered the establishment of more commercial plantations an important restoration option in order to enhance investment in the production of timber and non-timber related products. This development could decrease or replace the demand for imported wood materials while diversifying the local economy and creating jobs for local individuals. Six datasets were considered to identify potential commercial plantation sites: shrub/bushland and bare land, altitude between 800 and 2300m above sea level (the ideal altitude range for fast growth), mean annual rainfall above 800 mm, road access within 10km, population density below 200 people per square kilometer, and slope below 60% (Fig. 18).

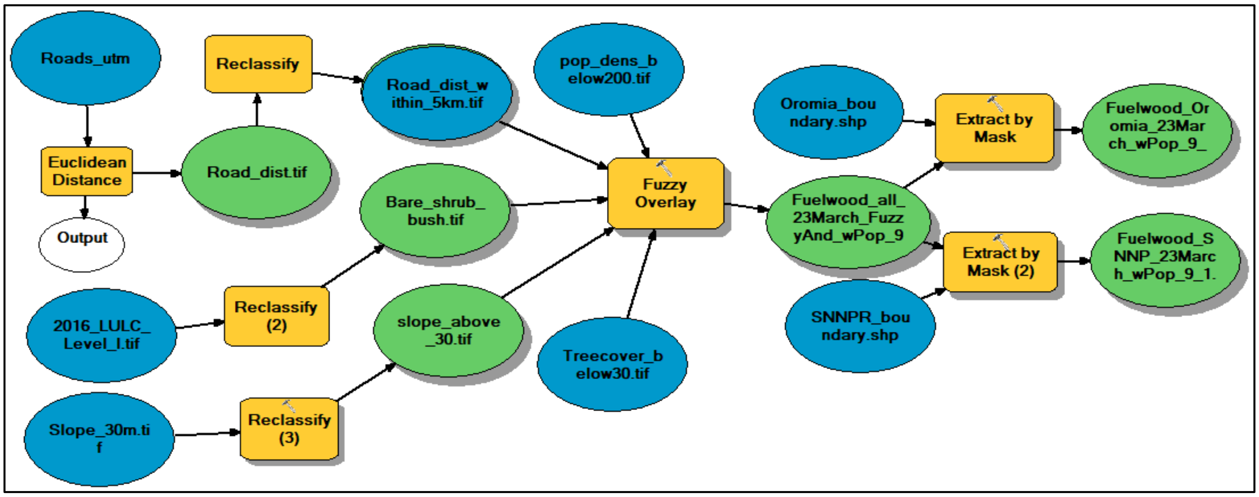
Figure 18 | Spatial modeling to identify commercial plantation potential sites



10.8 Fuelwood Plantation Potential

Stakeholders at the participatory workshop noted the development of fuelwood plantations as an important potential restoration option, since a greater availability of fuelwood could reduce pressure from inhabitants on native forests. Potential fuelwood sites were identified using the following criteria: road access within 5km, slope above 30%, population density below 200, shrub/bushland and bare land, and tree cover of below 30% (Fig. 19).

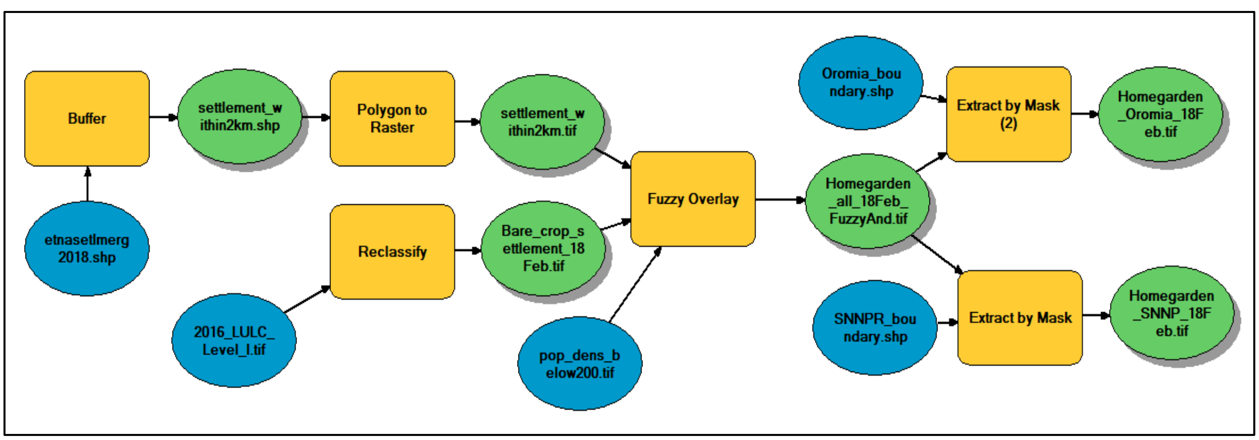
Figure 19 | Spatial modeling to identify potential fuelwood plantation sites



10.9 Home Garden and Woodlots Potential

For this potential restoration option, it was assumed that home gardens and woodlots contribute to economic, social, and ecosystems service values. Three major datasets were used to identify potential areas for this option: location of bare land, cropland, and settlement areas; proximity within 2km radius of settlement areas (villages); and population density of the woreda below 200 people per square kilometer (Fig. 20).

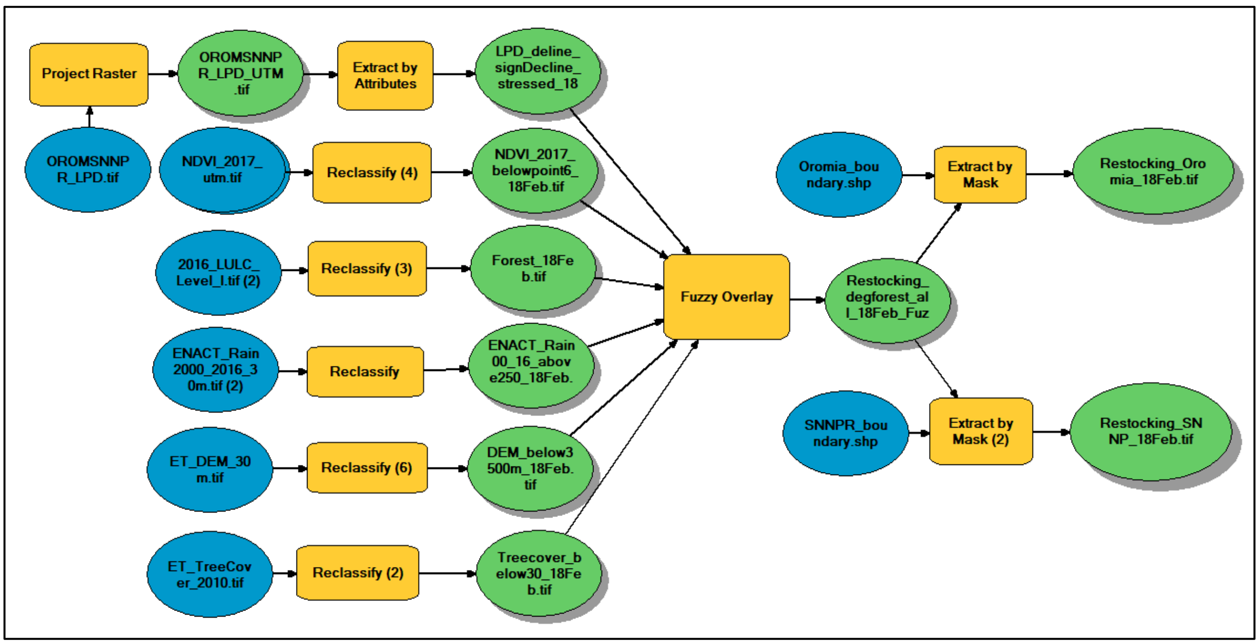
Figure 20 | Spatial modeling to identify potential areas for home-gardens and woodlots



10.10 Restocking Degraded Natural Forest

This potential restoration option refers to adding trees, either through assisted natural regeneration or by strategically planting trees within specific forest blocks, to degraded or deforested natural forest areas. To identify the potential areas for this restoration option, we focused on assessing the status of existing natural forests. To design the spatial model (Fig. 21), we combined the following six variables: tree cover less than 30%; altitude below 3500m above sea level; land use type; mean annual rainfall above 250mm; normalized difference vegetation index (NDVI) below 0.6; and land productivity in decline, early stages of decline, or stressed categories (trends.earth).

Figure 21 | Spatial modeling tool to identify potential areas to restock degraded natural forests



10.11 Combined Restoration Options

After identifying each potential restoration option based on set criteria, the spatial model of each option was mapped together to produce one map. A single cell (site) could be a candidate for multiple restoration potentials. This can inform how to prioritize the potential restoration options based on the size of the area and suitability of option for a defined site (Fig. 22). Finally, we used pivot table to summarize individual and combined potential restoration options.

Figure 22 | Spatial model for combined tree-based restoration potential map