



BioCarbon Fund

Initiative for Sustainable Forest Landscapes

ISFL Emission Reductions Monitoring Report Template

Name of the ISFL ER Program and Country:	Oromia Forested Landscape Program (OFLP), Oromia National Regional State Federal Democratic Republic of Ethiopia
Name of the Program Area	Oromia National Regional State
Reporting Period covered in this report	01-01-2024 to 31-12-2024
Applicable ERPA Phase and sequence of this Reporting Period <i>(for example 2nd Reporting period of ERPA Phase 1 that runs from DD-MM-YYYY to DD-MM-YYYY)</i>	2nd Reporting period of OFLP ERPA phase 1
Subcategories included for ISFL Accounting	1. Grass land converted to Forest land 2. Crop land converted to Forest land 3. Forest land converted to Grass land 4. Forest land converted to Crop land 5. Shrub land Converted to Forest land 6. Forest land Converted to Shrub land
Number of ISFL ERs:	6,503,931 tCO ₂ eq
Quantity of ERs allocated to the Uncertainty Buffer	985,443 tCO ₂ eq
Quantity of ERs allocated to the Reversal Buffer:	722,658 tCO ₂ eq
Date of submission	16-05-2025

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List of acronyms

AD	Activity Data
AGB	Above Ground Biomass
AGC	Above Ground Carbon
AGP	Agricultural Growth Program
AFOLU	Agriculture Forest and Other Land Use
ANR	Assisted Natural Regeneration
API	Application Programming Interface
AR	Afforestation Reforestation
BAU	Business As Usual
BERSMP	Bale Eco-Region Sustainable Management Program
BGB	Below Ground Biomass
BGC	Below-ground Carbon
BioCF ISFL	BioCarbon Fund Initiative for Sustainable Forest Landscape
BioCF T3	BioCarbon Fund Tranche Three
BoA	Bureau of Agriculture
BoF	Bureau of Finance
BoL	Bureau of Land
BoWE	Bureau of Water and Energy
BSOM	Benefit Sharing Operational Manual
BSP	Benefit Sharing Plan
CALM	Climate Action Through Landscape Management
CATS	Carbon Assets Tracking System
CBOs	Community Based Organizations
CDA	Cooperative Development and Association
CDM	Clean Development Mechanism
CEO	Collect Earth Online
CHS	Community Health and Safety
CI	Confidence Interval
CIG	Common Interest Group
CO2	Carbon Dioxide
CPA	Cooperative Promotion Agency
CPP	Consultation & Participation Plan
CRGE	Climate Resilience Green Economy
CSA	Climate Smart Agriculture
DA	Development Agent
DP	Development Partner
DW	Dead Wood
EDA	Environmental Development Association

ECFF	Ethiopian Coffee Forest Forum
EEPA	Ethiopian Environmental Protection Authority
EF	Emission Factor
EFCCC	Environment, Forest and Climate Change Commission
EFD	Ethiopian Forestry Development
EHS	Environmental, Social, Health, and Safety
ESDDA	Environmental and Social Due Diligence Audit
ESF	Environmental and Social Framework
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESRM	Environmental and Social Risk Management
ESCP	Environmental and Social Commitment Plan
EWNRA	Ethiopian Wetland and Natural Resource Association
FAO	Food and Agricultural Organization
FCPF	Forest Carbon Partnership Facility
FCC	False Color Composite
FGRM	Feedback Grievance Redress Mechanisms
FMC	Forest Management Cooperative
FMP	Forest Management Plan
FMT	Facility Management Team
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
FSD	Forest for Sustainable Development Program
FSDP	Forest for Sustainable Development Program
GAP	Gender Action Plan
GDP	Gross Domestic Product
GEE	Google Earth Engine
GHG	Greenhouse Gas
GLI	Green Legacy Initiative
GPG	Good Practice Guidance
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism Manual
GTP	Growth and Transformation Plan
GWDDDB	Global Wood Density Database
HH	Household
ICS	Improved Cook Stove
IDPM	Institute for Development Policy and Management
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
ISFL	Initiative for Sustainable Forest Landscapes

ISFL ER	Initiative for Sustainable Forest Landscape Emission Reduction
LFSDP	Livestock and Fisheries Sector Development Project
LIFT	Land Investment for Transformation
LLRP	Lowlands Livelihood Resilience Project
LMP	Labor Management Procedure
LUC	Land Use Cover
LUCF	Land Use Change and Forestry
LULC	Land Use Land Cover
LULUCF	Land Use and Land Use Change and Forestry
M&E	Monitoring and Evaluation
MCMC	Markov Chain Monte Carlo
MEFCC	Ministry of Environment, Forest and Climate Change
MELCA	Movement for Ecological Learning and Community Action
MoF	Ministry of Finance
MoPD	Ministry of Planning and Development
MoU	Memorandum of Understanding
MR	Monitoring Report
MRV	Monitoring Reporting and Verification
Mt CO ₂ eq	Million Tons of Carbon Dioxide Equivalent
NBPE	National Biogas Program of Ethiopia
NDCs	Nationally Determined Contributions
NDFI	Normalized Difference Fraction Index
NDVI	Normalized Difference Vegetation Index
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NFR	National Forest Regulation
NGO	Non-Government Organization
NICFI	Norway's International Climate and Forest Initiative
NRLAIS	National Rural Land Administration Information System
NRM	Natural Resource Management
NRS	National REDD+ Secretariat
OEFCFA	Oromia Environmental Forest and Climate Change Authority
OEPA	Oromia Environmental Protection Authority
OFLP	Oromia Forested Landscape Program
OFLP-ERP	Oromia Forested Landscape Program Emission Reduction Project
OFWE	Oromia Forest and Wildlife Enterprise
ORCU	Oromia REDD+ Coordination Unit
PDF	Probability Distribution Function / Probability Density Function

PDO	Program Development Objectives
PF	Process Framework
PFM	Participatory Forest Management
PPE	Personal Protective Equipment
PSIDP	Participatory Small-scale Irrigation Development Program
QA/QC	Quality Assurance / Quality Control
rBG/AG	Below Ground Biomass / Above Ground Biomass
REDD+	Reducing Emissions from Deforestation and Forest Degradation
REL	Reference Emissions Level
RLLP	Resilient Landscape and Livelihood Project
RMIP	Rangeland Management and Investment Plans
RPF	Resettlement Policy Framework
RSC	Regional Steering Committee
RTWG	Regional Technical Working Group
SE	Standard Error
SEA	Sexual Exploitation and Abuse
SEAH/GBV	Sexual Exploitation, Abuse, Harassment / Gender-Based Violence
SEDA	Sustainable Environmental and Development Action
SEP	Stakeholder Engagement Plan
SESA	Strategic Environmental and Social Assessment
SH	Sexual Harassment
SIS	Safeguards Information System
SLLC	Second Level Land Holding Certificates
SLMP	Sustainable Landscape Management Program
SLMS	Sustainable Land Management System
SOC	Soil Organic Carbon
SU	Sample Unit
SW	South West
SWC	Soil and Water Conservation
TCC	True Color Composite
TWG	Technical Working Group
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VCS	Verified Carbon Standard
VHR	Very High Resolution
WB	World Bank
WMP	Watershed Management Plan

WoF Woreda Office of Finance
WUA Watershed User Association
YCFBR Yayu Coffee Forest Biosphere Reserve

Executive Summary

Ethiopia is one of the countries in Africa extensively engaged in jurisdictional level REDD+ GHG emission reduction efforts, leading to achieve zero net emissions and promoting sustainable economic development with the role of natural resources conservation, Sustainable Forest Management, and Enhancement of Forest Carbon stock. In line with this, the country signed the Emission Reduction Purchase Agreement (ERPA) on February 9, 2023, with the World Bank. The contract value of the ERPA is US\$ 40 million with an additional for excess ERs under call option of about 20 million USD. According to the agreement, the first phase ERPA contract value is US\$15 million for emission reduction volume of 1,807,229 tCO₂eq. The Monitoring report for the second reporting period (2024) of the first ERPA phase has been developed following the ISFL ER Monitoring report template. To Evaluate the OFLP-ERP emission reduction performance during the reporting period, activity data (AD) collection and analysis was focused on six key land use change classes. The subcategories were forest to cropland, forest to grassland, forest to shrub land, cropland to forest, grassland to forest and shrub land to forest. Most importantly, the same emission factor (EF) values have been used for both baseline and monitoring period emission reduction assessments. Specifically, EF value of 301.43tCO₂eq per hectare was used for forest to cropland and 325.12 tCO₂eq per hectare for forest to grassland transitions whereas 310.86 tCO₂eq per hectare was used for forest to shrub land transitions. Additionally, for all reforestation/afforestation areas, the emission factors were divided by 20 years to calculate the removal factor. This approach ensures consistency in the emission factor values used across the different assessment periods. The collected activity data (AD) and analysis for the baseline period (2008-2017) indicated significant deforestation during that time: Forest converted to cropland: 234,676.75 hectares (70,738,612.75 tCO₂eq), Forest converted to grassland: 48,857.62 hectares (15,884,589.41 tCO₂eq) and Forest converted to shrub land: 29,234.48 hectares (9,087,830.45 tCO₂eq). In total, the baseline assessment showed 312,768.85 hectares of forest were converted to other land uses during the 2008-2017 periods. In the reporting period (2024), significant reduction in deforestation was achieved when compared to the baselines. During this period, the conversion was only from Forest to cropland: 5,875.98 hectares. Thus, emission per year under the baseline and during the monitoring period is 10,663,165.49 tCO₂eq and 2,451,132.16 tCO₂eq, respectively.

Total Emission Reductions achieved during the reporting period is 8,212,032 tCO₂eq including emissions reduced through removals. Emission Reductions estimate after uncertainty buffer (985,443 tCO₂eq) and Reversal Risk (722,658 tCO₂eq) set-aside is 6,503,931 tCO₂eq. Accordingly, Potential Emission Reductions that can be reported to the ISFL would be 6,503,931 tCO₂eq.

1 Implementation status of the ISFL ER Program

1.1 Implementation status of the ISFL ER Program

The Oromia Forested Landscape Program (OFLP) is a jurisdictional initiative addressing Agriculture, Forest, and Other Land Use (AFOLU) drivers promoting integrated low-carbon landscape management to reduce deforestation, land-use emissions, and enhance forest carbon stocks via afforestation, reforestation, and participatory forest management aligning with Ethiopia's Climate-Resilient Green Economy (CRGE) Strategy and Nationally Determined Contributions (NDCs). The program fosters multi-level collaboration to achieve emission reduction goals supported by the ISFL and other investment contributing to federal goals on climate risk reduction, sustainable forestry, and biodiversity preservation, advancing green financing and resilient, low-carbon growth while reducing poverty and forest degradation through the following intervention.

♣ Forestry Sector Interventions

- **OFLP - Forest Management Investment (2017–2022):** Managed 210,592 hectares of natural forest through 129 PFM cooperatives and restored 9,673 hectares of communal and privately pooled lands for afforestation/reforestation activities.
- **REDD+ Investment (2018–2026):** Protected 278,296 hectares of degraded forestland through Assisted Natural Regeneration (ANR); Afforested/reforested 23,472 hectares of land and Managed 516,500 hectares of natural forest under PFM.
- **Oromia Forest and Wildlife Enterprise (OFWE 2007 to now):** Ongoing activities include managing 62,918 hectares of plantation forests and 144,854 hectares of PFM established under the OFLP grant; a total of 1,678,530 hectares of forest managed by 581 CBOs/Cooperatives.
- **Bale Eco-region REDD+ Pilot Project (2012–2021):** Managed 671,397 hectares of forest, including 583,823 hectares under PFM (established before 2017) and 87,574 hectares newly established PFM post-2017.
- **REDD+ Joint Forest Management in South West Ethiopia -EWNRA (2017-2025):** Managed 186,221 hectares of natural forest under PFM, including expansion from prior achievements.

♣ Energy Sector Interventions

- **National Biogas Program of Ethiopia (NBPE II- 2014-2019) and (NBPE+ -2017-2020):** Facilitated energy technology distributions similar to NBPE, enhancing household-level energy sustainability.
- **Oromia Bureau of Water and Energy (OBWE 2014-2020):** Established 7,571 biogas digesters; distributed 3,716,417 Improved Cook Stoves (ICS) and 319,940 Solar Home Systems (SHS).
- ♣ **Land Use and Conservation Interventions**
- **FARM AFRICA and SOS Sahel Ethiopia (2017 to 2026):** ongoing activities on management of 671,397 hectares of natural forest under 128 PFM structures.
- **Digital Green Foundation:** Ongoing activities focus on deforestation prevention, forest degradation management, and biodiversity conservation to improve forest-dependent livelihoods.
- **Mass Mobilization for Natural Resource Management (NRM 2018 to now):** Supported afforestation with 1,217,122 hectares planted under the Green Legacy Initiative (GLI).
- **Sustainable Land Management Project II (SLMP II) (2014–2019):** Covered 196,134 hectares under improved land management and issued second-level landholding certificates to 118,315 people (82,829 female holders).
- ♣ **Agriculture and Livelihood Interventions**
- **Extension of SLMP 2 - Resilient Landscape and Livelihood Project (RLLP) Phase I (2014-2018) & II (2018 to 2024):** Managed 93,182 hectares under sustainable practices and benefited 269,363 individuals with improved natural resource access, supported rangeland management, livestock veterinary services, and youth engagement.
- **Techno Serve Ethiopia (2021–2026):** Focuses on modern coffee management with stumping of old coffee trees, targeting sustainable production in Jimma zone and West Guji Zones.
- **Solidaridad Ethiopia (2022–2025):** Promotes climate-smart dairy farming with emphasis on sustainability and resilience.
- **Participatory Small-scale Irrigation Development Program II (PASIDP II) (2017–2024):** Conducted soil and water conservation (SWC) on over 19,000 hectares of farmland and Introduced agroforestry and alternative energy solutions.
- ♣ **Cross-Sector Interventions**

- **Climate Action through Landscape Management (CALM 2019 -2025):** Issued over 3 million second-level landholding certificates (SLLCs), Managed 867,877 hectares of land under sustainable landscape practices, Established National Rural Land Administration Information Systems (NRLAIS) in 157 woredas.
- **Land Investment for Transformation (LIFT 2014-2021):** Certified millions of parcels of land for household and communal schemes.
- ♣ **Coffee Management and Biodiversity Conservation**
- **Ethiopian Coffee Forest Forum (ECFF 2009- 2025):** Protected the Yayu Coffee Forest Biosphere Reserve, maintaining 167,021 hectares sustainably; Increased dense forest coverage by 8,469 hectares while addressing deforestation.
- **Nespresso-East Africa Coffee Project (2013–2023):** Trained 69,619 farmers on sustainable coffee practices, with over 25,000 adopting new techniques.

Regarding the organizational structures and partner involvement, The OFLP-ERP is hosted by Oromia Environmental Protection Authority (OEPA) instituted by the regional Proclamation no. 242/2021 with roles and responsibilities similar to the previous Oromia Environment, Forest and Climate Change Authority (OEFCCA). The Oromia REDD+ Coordination Unit (ORCU) is housed within OEPA and is the implementing unit coordinating all the landscape initiatives that contribute for OFLP Emission reduction project. The OFLP-ERP Steering Committee is chaired by the Regional Vice President and brings together relevant government institutions like the Bureau of Agriculture (BoA), Bureau of Water and Energy (BoWE), Bureau of Land (BoL), Cooperative promotion Agency (CPA) and the Oromia Forest and Wildlife Enterprise (OFWE). These bureaus and agencies are also implementing bodies of activities of the OFLP-ERP on the ground in coordination with their respective woreda level subsidiary offices and kebele DAs (extension agents). At the federal level, the Ethiopian Forestry Development (EFD) an autonomous federal institution is mandated to lead overall forest resources management and development in the country. The EFD constitutes among others, the National REDD+ Secretariat, the National Forest Demarcation, Inventory and Monitoring Unit, The Forest Sector Transformation Unit, and Forestry Research, where all of these EFD's segments, in one form or another, provide support to the implementation of OFLP-ERP including, in MRV, E&S Risk Management, and policy and regulatory support. To this end, a Memorandum of Understanding (MoU) has been signed among these federal and regional entities defining their shared roles and

responsibilities, obligations and mandates in rolling out the OFLP-ERP activities. A wider Coordination Platform also exist to facilitate synergy and joint planning, for stakeholders' consultation and engagement purposes, encompassing other institutions outside of the above entities (the Private Sector, NGOs, DPs, other programs, initiatives and projects).

There are no major changes or deviations in key design features of OFLP-ERP nor in key assumptions made since the time of 1st ERPD formulation; the key program design elements such as drivers and strategic actions to address the drivers remain the same, the program scope and related aspects are still the same. It is a jurisdictional ER program that coordinates all key interventions in the jurisdiction and leveraging existing technical, institutional and resource capacities from existing initiatives and programs to attain the envisaged final goal, i.e. conserving and enhancing the resource base (forest landscape), generating ERs to benefit those who are responsible for delivering the outcomes. However, along the way, few minor changes were made which won't alter the final outcome or are generally inconsequential: such as the ERPA period reducing to 8 years from the 10 years period as initially planned, and few changes in program financing due to phasing out or emergence of new programs and initiatives, etc.

1.2 Update on major drivers and lessons learned

Ethiopia's remaining forest (to which Oromia contributes the largest part) is considered a safety net for those whose livelihoods depend on it and is an asset for development, ecosystem service provisioning and climate change regulation. Poor valuation of forest ecosystem services significantly undermines the contribution of forests to the GDP of Ethiopia.; on one hand the traditional GDP calculations focus on marketable forest goods such as timber and fuel woods ignoring non-marketable forests services (carbon sequestration water regulation soil conservation and biodiversity). On the other hand, the indirect contribution of forests to agriculture (pollination, erosion control and water flow regulation) and tourism are rarely quantified in the national accounts. This makes it a challenging task to properly capture the significance and real value of forests in economic terms. Given such shortcomings in valuation, the National Forest Sector Development program (NFSDP) of Ethiopia (MEFCCC, 2018 volume II) estimates the contribution of forests to the economy at 12.9% of the measured value of the GDP. However, deforestation, forest degradation, and other land use changes continue to be the greatest

challenges of preserving the resource base so that it continues providing goods and services expected from it including climate change regulation and resilience at local and global level.

The ERPD identified that sources and agents that contribute to emissions from deforestation and degradation in the Oromia Regional State include expansion of agricultural land, use of inorganic fertilizers, increased demand for fuel wood, poor management of forest coffee plantations, unsustainable logging, excessive grazing, the high demand for forest products, lack of restoration of ecosystems (removal), lack of improvement in the livestock value chain, poor livestock management, and inadequate extension services.

Other drivers include a complex combination of economic social and policy related issues, including absence of national level policy direction for land-use planning and enforcement, lack of cross-sectoral policy and investment coordination, technological & climate change factors; unfavorable socio-political situations particularly the recent insecurity and conflict occurrence in some parts of the region affecting policy implementation and enforcement. The implementation of OFLP-ERP is primarily geared to contribute towards addressing these drivers and agents of emission while creating opportunities for enhanced removals, thus complementing to the objectives of the Climate Resilient Green Economy (CRGE) Strategies targets in which all sectoral plans and programs are aligned and integrated in the national plan.

The updated Ethiopia NDC (2021) indicates interventions in Land Use Change and Forestry (LUCF) sectors have the largest mitigation potential because of the highly ambitious reforestation and forest restoration targets of the government in line with the National Forest Sector Development Program and the Green Legacy Initiative (GLI); Oromia contributing the largest share in these interventions. The updated NDC stipulates that interventions in the LUCF sector will reduce nationally the emission level in 2030 to -99.9 Mt CO₂eq (under the conditional pathway) which turns the entire sector into a significant GHG sink. This equals a relative reduction of emissions of 171% (-240.1 Mt CO₂eq) compared to BAU emissions in LUCF by 2030. The unconditional pathway foresees a reduction of emission levels to 91.8 Mt CO₂eq, which represents a relative reduction of 34.6% of sectoral BAU emissions in 2030 (48.4 Mt CO₂eq).

The potential for net emission reduction and removals in LUCF as described above is to be realized through massive reforestation and restoration work of a total of up to 15 million hectares (ha) as a long-term national forestry sector goal, attained based on targets set in Ethiopia's Forest Sector Development Program, the Green Legacy Initiative and the National REDD+ Strategy. In the Climate Resilient Green Economy (CRGE) strategy and major country documents of Ethiopia Such as the Ten years (2021-2030) development plan (MoPD, 2021) and the National Forest sector development program (MFCC, 2018 Volume II) emphasize massive investment attentions and dispositions put to the forest sector for its potential contribution to climate change mitigation, economic development and environmental resilience. The documents indicate the ambitious move of the country to increase the forest cover to 30% by 2030 targeting to GHG emission reduction from land use, build climate resilient economy. Major contributions to these changes are expected to come from the Oromia Region where OFLP-ERP has the greatest role to play.

The other most important driver of LUCF emissions is biomass energy use for cooking and baking, which according to international inventory guidelines are accounted under LUCF. Thus, replacing or improving household biomass energy use for cooking and baking would lead to substantively reduced pressure on forest resources. All in all, these portray the policy options the sector has for the coming ten years.

Characterization of subcategory level main (direct) drivers (emission and removal), the mitigation and enhancement measures as identified in the 1st ERPD (Table 5 and Annex 1), remain largely unchanged. This means that the types of drivers previously identified during the baseline period have stayed the same and have not shifted to other types. However, their magnitude in terms of emissions and removals has been significantly changed.

In addition to the efforts made at the national level, numerous mitigation measures have been planned and implemented at the regional level by the OFLP and other initiatives to address the major drivers of deforestation identified during the baseline period namely expansion of small-scale agriculture, illegal logging, fuel wood collection, and population growth and drivers to enhance existing removal measures. Based on this, 2,204,004 community members were consulted, 1,217,122 hectares of land were covered by tree plantations (BoA report, 2024),

3,716,417 Integrated Cook Stoves (ICS) and 319,940 Solar Home Systems (SHS) were distributed. 7,571 biogas digesters were installed at the household level over the last ten years (BoWE annual reports, 2024).

Additionally, the OFLP disbursed a revolving fund of approximately 100,000,000 birr to improve the livelihoods of rural communities living in and around forests. Similarly, other initiatives have been involved in different livelihood supports of forest dependent communities for the last decade. These efforts have significantly reduced internal pressures on the region's forests and minimized deforestation.

As a result, rate of deforestation has decreased from baseline estimate of 31,277 ha/year to 5,876 ha/year rate at the monitoring period (i.e. 2024).

Regarding land-use changes: The conversion of forestland to cropland decreased from 23,467.7 hectares to 5,876 hectares, the conversion of forestland to grassland dropped from 4,885.8 hectares to 0 hectares, and the conversion of forestland to shrubland reduced from 2,923.4 hectares to 0 hectares during the monitoring period.

The Green Legacy initiative currently implemented in the region has also made a significant impact in creating a sustainable land-use system, which is expected to continue in the future.

Overall, the community has gained valuable insights from the impacts of both the OFLP and other initiatives over the past decade. Communities living around forests are now taking their own initiatives to organize participatory forest cooperatives, establishing internal bylaws to guide the development, protection, and utilization of forest products within their vicinity.

2 System for Measurement, Monitoring and Reporting Emissions and Removals occurring within the Monitoring period

2.1 Forest Monitoring System

A comprehensive national framework for conducting forest inventory, monitoring, overseeing, documenting, and verifying forest carbon emissions by sources (deforestation and forest degradation) and removals by sinks (AR, ANR) was established by the Federal Democratic Republic of Ethiopia (FDRE) in 2013 with the launch of the national REDD+ Secretariat.

At the federal level, Ethiopia Forest Development (EFD) is mandated with developing reliable forest resource information for application in creating national forest policies, planning and sustainable development. The national forest monitoring and carbon measurement desk within the EFD is responsible for producing maps, collecting GHG inventory data, and collaborating with federal and regional institutions to carry out MRV activities. It is also responsible to solidify technical support for regional structures which includes discussing technical options and practical solutions for the generation and dissemination of data, and for supporting domestic momentum toward improved forest monitoring and management. The National REDD+ Secretariat within EFD is mandated with technical back stopping for the National and State level government structures including for MRV activities.

At the regional level, the comprehensive MRV framework expects that regional units will be established that adopt a similar monitoring approach as the one adopted by the national forest monitoring and carbon measurement desk in their activities. This ensures continuity in monitoring and reporting processes between the federal and the regional level and reliability in tracking progress towards emission reduction goals. In addition, relevant government sectors and initiatives operating at both the zonal and woreda levels, are responsible for supporting activity data gathering and delineating forested areas. This includes for example the zonal office and woreda offices of the Environmental Protection Authority. These institutions play a crucial role in enforcing laws and regulations while also focusing on the sustainable development of forest-based cooperatives, associations, and private forest developers. Their proactive involvement and support are instrumental in reducing the risks associated with potential reversals in forest management and conservation efforts. Their active engagement in Forest monitoring and reporting system, not only ensures compliance with environmental regulations but also fosters the growth of local enterprises that rely on forest resources. Their comprehensive approach to capacity building and risk mitigation is vital for promoting sustainable practices within the community, ultimately contributing to the long-term Emission reduction activities.

Within this framework, the ORCU MRV unit is tasked with gathering both primary and secondary data on the Oromia level, related to program interventions under the OFLP-ERP. This includes collecting geographical information on A/R activities, program-level biomass survey data, and other relevant data sources. In collaboration with National Forest Monitoring desk in

EFD, the regional ORCU MRV unit has also collected the activity data on land use and land use change in this report.

On the national level, other institutions that are part of the MRV framework include the Ethiopia Statistical Service (ESS), the Ethiopian Environment and Forest Research Institute (EEFRI) and the Wondo Genet College of Forestry and Natural Resources. The ESS collects, processes, and disseminates official statistical data. EEFRI provides technical support for the OFLP-ERP as part of its mandate to develop national capacities to conceptualize, design and implement a national and regional SLMS for forestry and LULUC and to monitor area changes including the development of NFI. Wondo Genet College of Forestry and Natural Resources is serving as a center of excellence for education, training and research in forestry and other natural resource management areas.

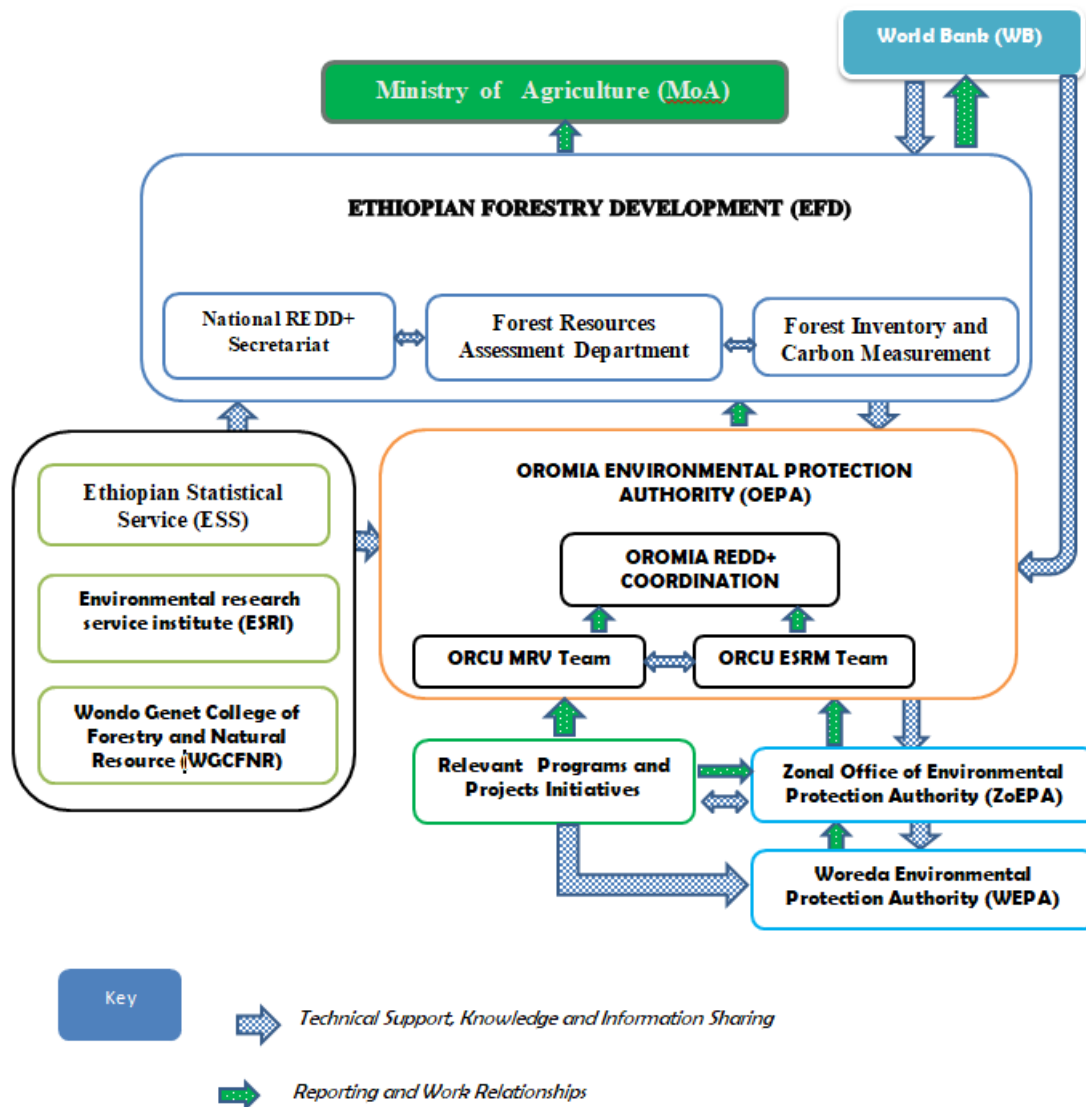


Figure 1: Institutional arrangement for monitoring and reporting

2.2 Measurement, monitoring and reporting approach

The following figure provides a general overview of the measurement, monitoring and reporting approach. Details of the different steps are provided in the rest of this section.

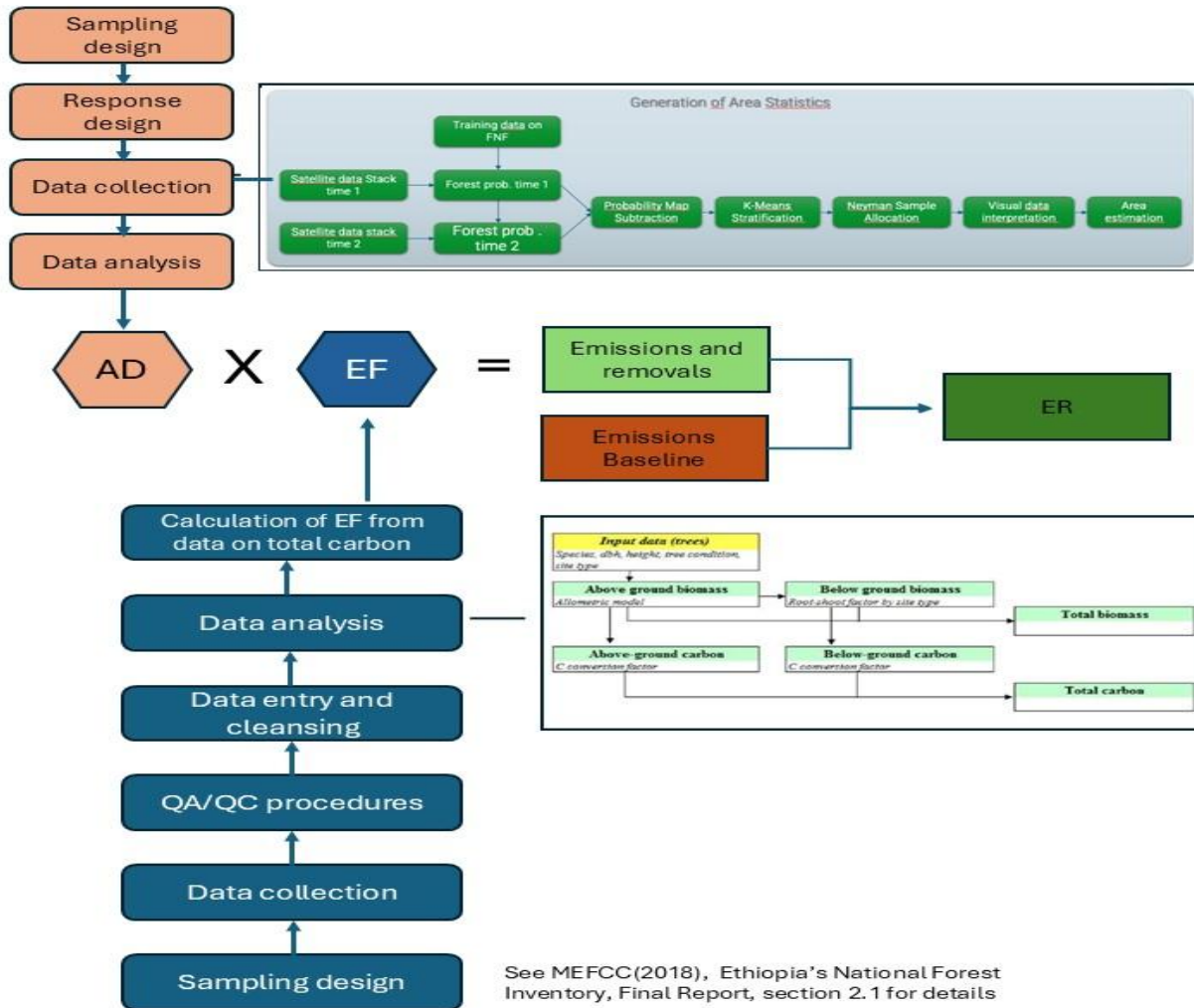


Figure 2 : General line diagram of the measurement, monitoring and reporting approach.

Land use definitions

Ethiopia has adopted a new forest definition in February 2015 that forest defined as a ‘Land spanning at least 0.5 ha covered by trees (including bamboo) (with a minimum width of 20 m or not more than two-thirds of its length) attaining a height of at least 2 m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course. This definition reduced the tree height criteria from 5m in the previous definition to 2m. The main reason for this change was to capture natural forest vegetation types like the dry-land forests which host woody species that typically reach a height of around 2-3m.

The new definition was used in the land use and land use change analysis that was part of the ERPD of the Oromia Forested Landscape Program. The resulting emissions baseline considered the following categories:

- Forest to cropland
- Forest to grassland
- Cropland to forest
- Grassland to forest

In these categories, grassland included 2 types of vegetation namely (1) 'grassland' which includes both rangelands and pastureland and (2) 'shrubland' which includes ecosystems with vegetation that falls below the threshold used in the forest land category and are categorized under the grassland, the threshold used in the grassland category. Since the first ERPD, improvements have been made to the baseline (see section 3.1 and Annex 4) https://drive.google.com/drive/folders/172JbZbmNefkxQqUQNkrMnfpB1crE3SJT?usp=drive_1 [ink](#). As part of these improvements, it was decided to have a separate subcategory for shrubland, allowing for a more accurate use of emission factors. This means that the improved baseline and this monitoring report now consider the following subcategories:

- Forest to cropland
- Forest to grassland
- Forest to shrubland
- Cropland to forest
- Grassland to forest
- Shrubland to forest

For this the following updated definitions were consistently used between the updated Emissions Baseline in Annex 4 and the monitoring:

- **Forest land:** 'Land spanning at least 0.5 ha covered by trees (including bamboo) (with a minimum width of 20 m) attaining a height of at least 2m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course and excluding land that is predominantly under agriculture or urban land use.
- **Cropland:** This category includes arable and tillage land, and agro-forestry systems. Includes land with tree canopy cover < 5% with shrubs/bushes < 10% or with predominant agriculture/urban land use or with trees <0.5ha. It includes annual crop land, perennial crop land and mixed annual and perennial crop land with tree canopy cover from 0% to 100%.

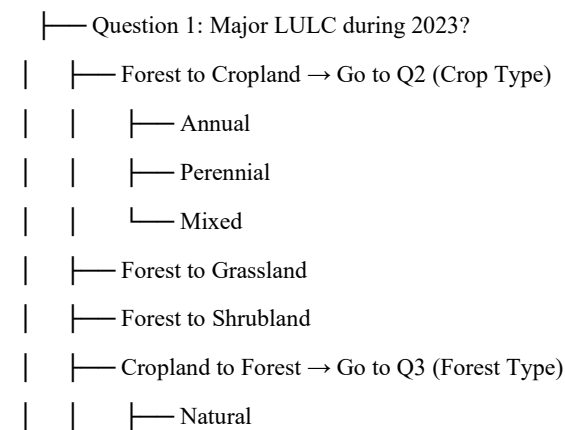
- **Grassland:** This category includes rangelands and pastureland that is not considered as cropland. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvopastoral systems, subdivided into managed and unmanaged. Includes land covered by natural growth of gramineae and herbaceous vegetation, with some scattered trees (tree canopy cover from 5% to less than 20%).
- **Shrub land:** This category includes systems with woody vegetation that fall below the threshold used in the forest land category (i.e., tree canopy cover from 5% to less than 20% or shrubs/bushes canopy cover $\geq 10\%$) and is not expected to exceed, without human intervention, the threshold used in the forest land category. (

During data collection (see below), an interpretation key was used to distinguish between the different land uses, using the definitions above (Land Use Land Cover, Land Use Land Cover Change and Forest Disturbance Interpretation Key for Ethiopia, November /2023, Addis Ababa, Ethiopia).

Land Use and Land Cover Classification Decision Tree for Ethiopia (2023 Interpretation Key)

We have prepared a decision tree figure that illustrates how land areas are classified exclusively into Forest, Cropland, Grassland, Shrubland, Settlement, or Other Land, based on the thresholds defined in Ethiopia’s forest definition and the IPCC categories. This tree ensures that all categories are mutually exclusive. The same logic is embedded in the interpretation key and applied consistently through the CEO tool during activity data collection, ensuring transparency and consistency between the baseline and monitoring

Start: Land Area ≥ 0.5 ha?



- | | | — Plantation
- | | | — Bamboo
- | | — Grassland to Forest → Go to Q3 (Forest Type)
- | | — Shrubland to Forest → Go to Q3 (Forest Type)
- | | — Other Land
- | — Question 4: Majority LULC during 2024?
- | | — Forest to Cropland → Go to Q5 (Crop Type)
- | | | — Annual
- | | | — Perennial
- | | | — Mixed
- | | — Forest to Grassland
- | | — Forest to Shrubland
- | | — Cropland to Forest → Go to Q6 (Forest Type)
- | | | — Natural
- | | | — Plantation
- | | | — Bamboo
- | | — Grassland to Forest → Go to Q6 (Forest Type)
- | | — Shrubland to Forest → Go to Q6 (Forest Type)
- | | — Other Land
- | — Question 7: LULC Change or Disturbance?
- | | — No → End
- | | — Yes → Go to Q8 (Type of Change)
- | | | — Degradation → Go to Q9 (Drivers)
- | | | | — Selective Logging
- | | | | — Grazing
- | | | | — Forest Fire
- | | | | — Infrastructures
- | | | | — Others
- | | | — Forest Loss → Go to Q10 (Drivers)
- | | | | — Large Scale Agriculture
- | | | | — Small Scale Agriculture
- | | | | — Forest Fire
- | | | | — Mining
- | | — Forest Gain
- | | — Non-Forest to Non-Forest LULC

Data collection approach

Activity Data Collection

The approach adopted in the area estimation process is stratified random sampling (Cochran (1977)¹, Olofsson (2014)², Stehman (2013)³), where an auxiliary layer of change probability is used for stratification (Olofsson et al, 2014). The adapted protocol ensures design-based unbiasedness as requested by good practice guidelines of IPCC and GFOI, as well as the ISFL ER program requirements (4.6.2). .

Stratification

A novel approach for the stratification process has been employed using a supervised classification of wall-to-wall satellite data targeted at forest change probabilities, as the uncertainties around the sample-based estimation is highest for such rare events.

The process of stratification is still similar to the good practice guidance from Olofsson et al 2014. It deviates in the way the classification is used, as strata are derived from a statistically optimized process that relies on a continuous variable of forest change probability instead of a categorical map of forest and forest change. The method leverages multi-sensor (optical and radar) satellite data from ESA’s Copernicus program as well as high-resolution data from Planet available through Norway’s NICFI program.

Forest change detection was performed leveraging multi-sensor (optical and radar) satellite data through “stacked generalization” approach that uses a parametric model for the fusion of algorithm outputs (Healey et al, 2018)⁴. The heterogeneous forest landscape of the Oromia

¹ Cochran W.G. Sampling Techniques. New York: Wiley (1977)

² Pontus Olofsson, Giles M. Foody, Martin Herold, Stephen V. Stehman, Curtis E. Woodcock, Michael A. Wulder, Good practices for estimating area and assessing accuracy of land change, Remote Sensing of Environment, Volume 148 (2014)

³ Stehman S.V. Estimating area from an accuracy assessment error matrix. Remote Sensing of Environment 132, 202-211 (2013)

⁴ Sean P. Healey, Warren B. Cohen, Zhiqiang Yang, C. Kenneth Brewer, Evan B. Brooks, Noel Gorelick, Alexander J. Hernandez, Chengquan Huang, M. Joseph Hughes, Robert E. Kennedy, Thomas R. Loveland, Gretchen G. Moisen, Todd A. Schroeder, Stephen V. Stehman, James E. Vogelmann, Curtis E.

region consists of deciduous as well as evergreen forests that are subject to seasonal variation. Bos et al (2019)⁵ have shown that some satellite- based time-series analysis algorithms struggle in that type of open dry forests, and deriving change from such algorithms might be misleading as the indication of change mixes with land outside forests and hence does not result in an efficient stratification. Therefore, a simplified, yet effective approach based on annual mosaics has been adopted. This approach is less prone to seasonal variation and default settings of the applied methods do usually result in acceptable wall-to-wall data suitable for allocating a stratified sample.

In detail, the method used is based on the use of 2 multi-sensor stacks, consisting of a best-pixel mosaic from optical data of Sentinel-2, a radar data time scan from Sentinel-1 All data has been created on FAO's SEPAL platform (sepal.io) and exported at 20-meter resolution to Google's Earth Engine. To further improve classification, an SRTM elevation layer has been added to that stack as an auxiliary layer. The 2 data stacks have been created for 2023 and the beginning of 2025, so that the data does cover all change events that might have occurred in 2024.

To detect land use and land cover changes occurring during the 2024 reporting period, we used two multi-sensor data stacks: one from the last month of 2023 and one from the first month of 2025. Each stack includes an annual best-pixel mosaic from Sentinel-2 optical data, a Sentinel-1 radar time scan, and an SRTM elevation layer as an auxiliary input. All data were processed on FAO's SEPAL platform and exported at 20-meter resolution to Google Earth Engine. This temporal framing ensures that all change events occurring within 2024 are captured. While the stacks span two years, change detection algorithms were calibrated to isolate transitions attributable specifically to 2024. We acknowledge the risk of temporal spillover and have applied conservative thresholds and intra-annual radar signals to minimize misattribution. Where uncertainty remains, it is reflected in the uncertainty analysis and AD confidence intervals.

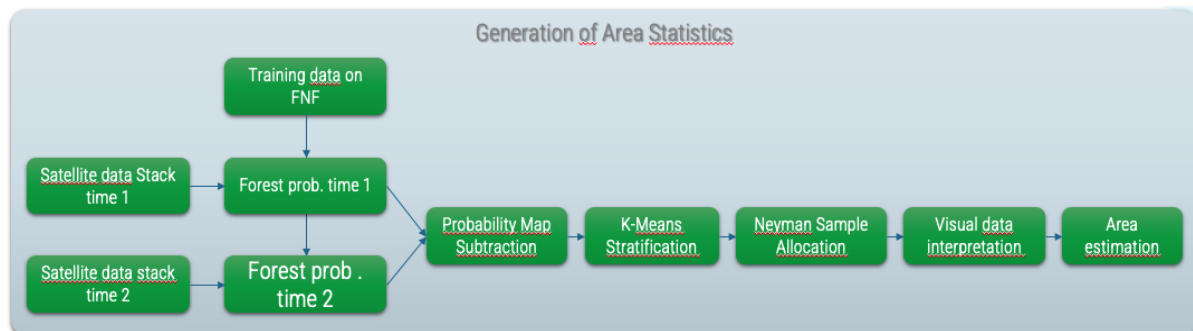
Woodcock, Limin Yang, Zhe Zhu. *Mapping forest change using stacked generalization: An ensemble approach. Remote Sensing of Environment, Volume 204, 2018, Pages 717-728,*

⁵ A.B. Bos, V. De Sy, A.E. Duchelle, M. Herold, C. Martius, N.-E. Tsendbazar. *Global data and tools for local forest cover loss and REDD+ performance assessment: accuracy, uncertainty, complementarity and impact. Int. J. Appl. Earth Obs. Geoinf., 80 (2019), pp. 295-311,*

In a second step, both stacks have been classified into forest and non-forest, using the Random Forest algorithm (Breiman 2001)⁶. The training data used in this classification process, representing stable forest and non-forest, was available through the ERPA phase 2 data collection process as well as other previous data collection exercises both at national as well as regional level, and consisted of more than 5,000 samples. Note that stable forest has not been updated up to 2023, actual training samples of changes were rare and due to the way Random Forests subsets the input samples, the influence of such “outliers” is considered neglectable.

The result of the classification process is two maps of forest probability, ranging from 0 to 100, in 2023 and 2025. Subtracting the 2025 map from the 2023 map can reveal potential areas of change, as forest probabilities may have increased or decreased. For areas of constant forest or non-forest cover, the difference will be close to 0, which is the case for most of the land. This resulting layer reveals a more nuanced way of looking at the classification result and highlights areas of uncertainty that is useful when approaching stratification and defining a strata of stable areas, free of forest change https://drive.google.com/drive/folders/172JbZbmNefkxQqUQNkrMnfpB1crE3SJT?usp=drive_link.

The output of this process, referred here to as Probability Map Subtraction (PROMS), serves as a basis for stratification, i.e. dividing the landscape into more homogenous areas likely to be subject to forest change or being stable. If the variation within the strata is less than the overall variation, the stratification will be effective, and uncertainties are reduced as opposed to a simple random or systematic grid.



⁶ Breiman, L. (2001). *Random Forests*. *Machine Learning*, 45. 5-32. 10.1023/A:1010950718922.

Figure 3: Workflow of the activity data generation, including the PROMS process for a statically optimized stratification of the land area

The actual stratification follows a 2-step approach to optimize the sample allocation for reducing uncertainties around the change estimates. In a first step, an inclusive forest mask has been applied to capture all existent forest in both times. This mask is much larger than the actual forest area but is assumed to not have missed a single forest area. It has been derived by removing areas that in none of the 2 forest probability layers exhibit a value of more than 5% probability of being a forest. This results in a reduced area to look for forest change, which is beneficial in the estimation process, as the proportion of forest change over the reduced area increases.

In a second step, the remaining land was stratified using the K-Means algorithm over the PROMS layer, dividing the area into 5 strata from low to high forest change likelihood. K-Means uses the underlying statistics to derive optimal strata boundaries (Kozak 2011)⁷. As the high likelihood class (stratum 5) has been quite vast, an additional “very high” likelihood change stratum has been added with a change probability of more than 40%. The non-forest area has been attributed with stratum 0, so that the final stratification consisted out of 7 strata.

The approach described above matches the approach used for the first Monitoring Report. However, it is recognized that for shorter monitoring periods (like the one-year period covered in this monitoring report) it can be expected that there are less occurrences of actual changes making the stratification less accurate (ie in longer periods there is a higher likelihood of detecting a change since more changes will have occurred). Therefore, this time, the team started to interpret 2244 samples on a systematic grid with a internode spacing of 12km². This ensures that all stable land use classes are represented adequately in the sampling design. Moreover, it has the advantage that the results from this assessment will be more robust with respect to future assessments as those samples shall be revisited in subsequent monitoring exercises. The systematic sample has then been further intensified using an additional 1497 samples over the 6 low to high likely change classes described earlier. The distribution of samples among the 6 strata used Neyman’s formula for optimized sample allocation. The

⁷ Kozak, Marcin. (2011). Comparison of efficiency of geometric stratification and K-means algorithm in univariate stratification of skewed populations. 7. 341-344.

Neyman allocation uses both strata boundaries and in-strata variation of the PROMS layer to allocate the optimal number of samples and ensures effectiveness in reducing the uncertainty around the final estimates. The process of stratification and sample selection for the intensification can be replicated using.

<https://code.earthengine.google.com/c7434957deba36ef5051d0a5c0422529>

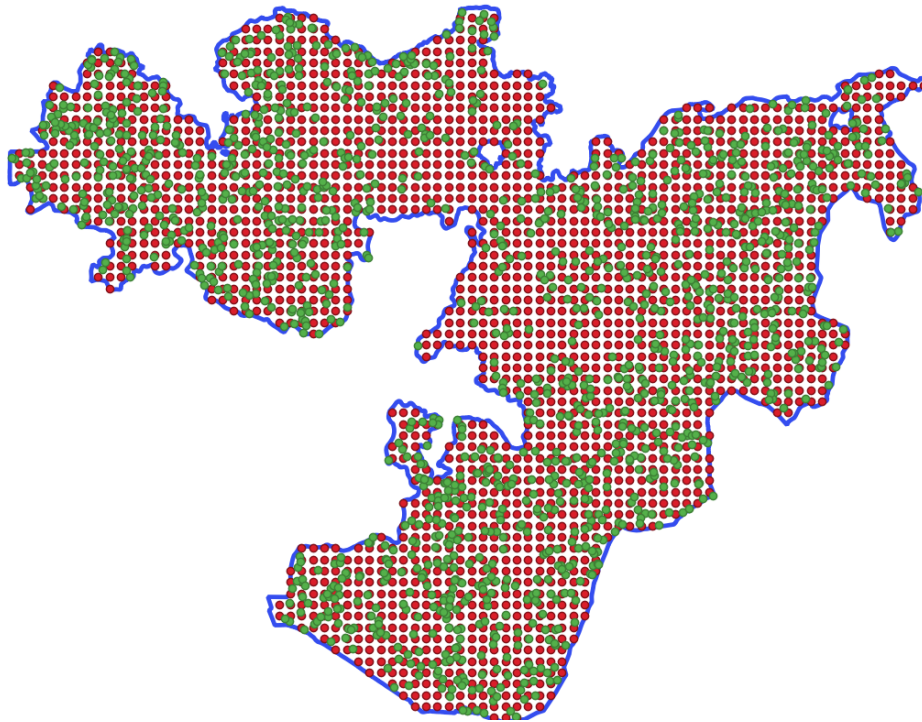


Figure 4: Spatial distribution of the 3,741 samples selected over the Oromia region.

For the final analysis both samples from the systematic and the stratified sample have been combined. This can be easily done, as the sampling intensity of the systematic grid is equal among all strata. In this case the combined sampling design is a stratified random sample and respective statistical estimators for stratified random sampling have been applied in the final calculation. It should also be noted that the systematic grid is covering the areas falling outside the forest mask, so that no additional samples were placed there as done for the first MR.

Response design

This refers to how to handle and interpret the data collected from the sample points. It involves the methods and rules that are used to classify and analyze the information from those points.

Key aspects include:

- **Data Interpretation:** The classification of sample points was guided by the official LULC definitions outlined in the Ethiopian Interpretation Key (2023). While the response design section summarizes the major categories (e.g., Forestland, Cropland, Grassland), the full definitions, including subcategories such as forest type (natural, plantation, bamboo) and crop type (annual, perennial, mixed) were operationalized through the CEO platform’s structured survey flow. This platform incorporated the LULC Interpretation Decision Tree (2023–2024), which ensured interpreters applied standardized thresholds and subcategory logic during classification. For example, if a sample was classified as Cropland, the interpreter was prompted to specify the crop type; similarly, Forestland was further disaggregated by forest type. These subcategories were not repeated in the MR narrative but were fully embedded in the interpretation workflow. For the response design involved a systematic interpretation of the data collected, using predefined criteria and survey questions. This structured approach ensured consistency and reliability across all sample points and between the monitoring reports. Key components of our response design included:
 - **Majority Land Use Land Cover (LULC) Type in December 2023:** Each sample point was categorized based on the predominant land use observed in 2023 using the definitions from the beginning of this section . This included identifying the main land use land cover categories mainly; forestland, shrubland, Grassland, wetland, other land and Cropland (crop type)
 - **Majority Land Use Land Cover (LULC) Type in January 2025:** Similarly, each sample point was reassessed for 2024 to identify any changes in the predominant land use type, using the same categories as the previous year.
 - **LULC Change Disturbance:** If any changes were detected between December 2023 and December 2024, the first disturbance event was noted. This could include deforestation, agricultural expansion, urban development, or other significant changes in land cover.

- **LULC Change Event Type:** The nature of the first disturbance was classified according to the type of event, whether it was a natural disaster, human activity, or other factors that caused the initial change in land use.

By adhering to these predefined criteria, our response design ensured a structured and accurate interpretation of the collected data, providing a comprehensive analysis of forest changes within the specified period.

- **Use of Tools:** For the Land Use Land Cover (LULC) change detection between December 2023 and December 2024, we utilized advanced tools and methodologies. Specifically, we employed the Collect Earth Online (CEO) platform for data collection and interpretation. This process was further enhanced by integrating high-resolution satellite imagery, including Landsat, Google Earth time series, Norway International Climate and Forest Initiatives (NICFI), Normalized Difference Vegetation Index (NDVI), and Normalized Difference Fraction Index (NDFI)
- **Consistency:** To maintain uniformity across the dataset, all interpreters followed standardized guidelines. https://www.biocarbonfund-isfl.org/sites/default/files/202301/ISFL%20ER%20Program%20Requirements_V1.3_2023.pdf, 2006 IPCC Guidelines for National GHG Inventories – Volume 4 (AFOLU)chapter 3 (3.1 – 3.74) and https://drive.google.com/drive/folders/172JbZbmNefkxQqUQNkrMnfpB1crE3SJT?usp=drive_link. The same guidelines were applied for the 1st and the 2nd monitoring report. Comprehensive training and awareness programs on Ethiopian interpretation key were provided to all interpreters.

Consistency in interpretation ensures that:

Baseline, RP1, and RP2 use the same definitions and assumptions, making it possible to compare changes over time.

- **Uniform data formats and sources** allow for direct comparison of emission reductions, activity levels, and performance indicators.

- **Trained interpreters apply the same logic and thresholds**, minimizing subjective bias and ensuring that observed differences reflect real changes, not inconsistencies in interpretation.
- **Comparable metrics across reports** support credible Monitoring, Reporting, and Verification (MRV), which is essential for carbon credit issuance and international reporting.

In short, consistency transforms raw data into reliable insights, making it possible to track progress, validate outcomes, and build trust in Ethiopia’s carbon reduction efforts.



Figure 5: sample of activity data on CEO

Data collection

Appropriate sample plot, each measuring 0.5 hectares, were generated across the region using a stratified random approach for AD collection. This method ensures that the samples are representative of the different land-use categories and changes across the entire study area. The optimal sample size generated by systematic sampling allocation was 2,244 and 1497 the spatial distribution of samples is depicted in Figure 4 above.

Four Collect Earth Online (CEO) projects were created under the "OFLP_ERP_MR2_AD_2244" institution, one for 2, 2244 samples with 249 QA/QC and 1,497 samples with 247 AD for QA/QC. Collect Earth online is a free and open-source image viewing and interpretation platform suitable for projects requiring information on land use and cover, including forest area change, particularly for AD collection to estimate emission reductions (FAO, 2019).

A total of 3,741 sample points were distributed among seven interpreters. After training on Ethiopian land use and land cover interpretation keys, the data was collected, interpreted, and submitted.

The sample plots were classified into seven LULC classes: Forest, Cropland, Grassland, Settlement, Wetland, Shrubland, and Other Land. Different satellite imagery sources were integrated into the CEO platform, including Sentinel (10m), Planet NICFI (4.77m), and Landsat (30m), as well as Google Earth/Mapbox, considering their resolution.

The assessment of sample points was conducted through visual interpretation of available high-resolution images and by interpreting vegetation indices derived from medium and high-resolution images. To help with the interpretation of the points, the option to 'Show GEE Script Link on the Collection Page' (GEE stands for Google Earth Engine) was activated. This allows users in to open a new tab with a series of Landsat and Sentinel time series images and charts including vegetation indices such as the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Fraction Index (NDFI) (see image below for general example from [CEO documentation](#)).

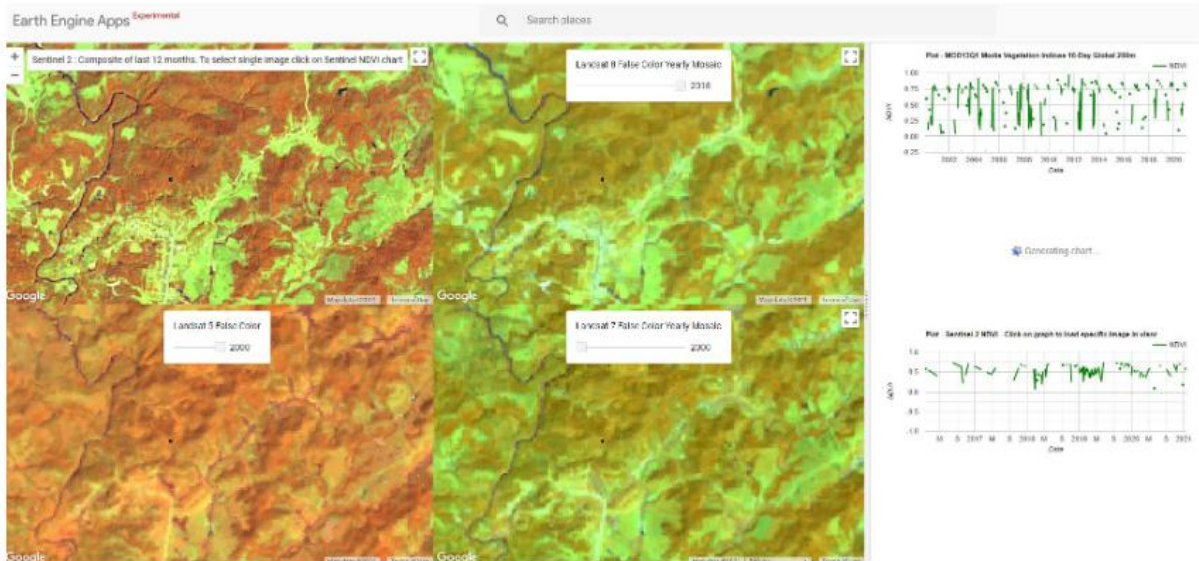


Figure 6: CEO interface showing GEE script results

Furthermore, historical trends in land use/cover from December 2023 to December 2024 were assessed and labeled for each change and unchanged land use/cover class. This comprehensive methodology ensures accurate, reliable data for emissions reduction and land use management in the Oromia Region.

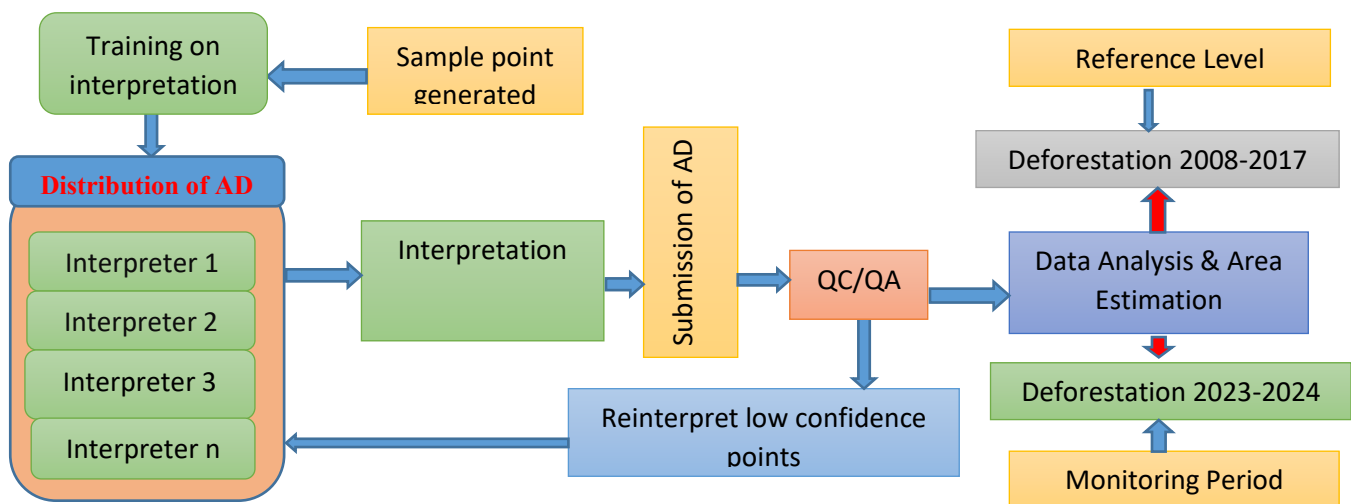


Figure 7: Activity Data collection and Analysis flow diagram

Quality Control/Quality Assurance

A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.

The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists (from ORCU MRV), oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in Oromia. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.

Data Analysis

After data collection, the area estimates, and uncertainty calculation used standard estimators for stratified area estimation as described in Cochran (1977). Olofsson (2014) and Stehman (2013). Calculations have been done for all relevant land use categories and change classes, including the unbiased sample estimate as well as the surrounding uncertainty.

Table 1: Transition matrix of AD analysis result

	Count of plot id	2023 LULC							
		Cropland	Forest land	Grassland	Other land	Settlement	Shrub land	Wetland	Grand Total
2024 LULC	Cropland	12,613,865.1	5,875.9810	15,345.5491	0	0	9,338.65404	0	12,644,425.3
	Forest land	0	11,795,375.3	0	0	0	0	0	11,795,375.3
	Grassland	17,650.113	0	4,870,255.7	0	0	8,530.7375	0	48,96,436.61
	Other land	0	0	0	78,585.84	0	0	0	78,585.8406
	Settlement	0	0	0	0	278,436.35	0	0	278,436.359

Shrub land	0	0	4,160.05515	0	0	2055504.83	0	2,059,664.89
Wetland	0	0	0	0	0	0	547,973.95	547,973.95
Grand Total	12,631,515.2	11,801,251.3	4,889,761.36	78,585.84	278,436.35	2,073,374.23	547,973.95	32,300,898.3

MR1 and MR2 uses the same spatial file delineating the Oromia region originating from the Ethiopian Forest Authority. It has been observed that some differences in area arise from the software and the respective method being used to calculate the area. These differences together with rounding differences in calculations when calculating the weighted areas of the different classes creates some small differences. The difference between the area for MR 1 and MR 2 is 5 ha which is 0.0000162555% of the total land area of Oromia

Emission and Removal Factors

The values of the emission factors have been updated compared to the validated ERPD. The updated value is calculated using the final report (MEFCC, 2018)⁸ of the results of the National Forest Inventory (NFI) that was conducted between 2014 and 2016. In the validated ERPD, four carbon pools were considered: aboveground and belowground biomass, deadwood and soil organic carbon. It was shown in the ERPD that litter could be excluded from the accounting since the contribution of the litter carbon pool is insignificant. The NFI report covers three of the four carbon pools: aboveground biomass, belowground biomass and deadwood. For soil organic carbon, the same values were used as those used in the ERPD.

The NFI was conducted using a stratified systematic cluster sampling approach and following a manual for field data collection.⁹ Because the NFI design is a stratified sampling approach, each stratum has a different sampling intensity defined by the inclusion probability π_k (of each plot). The π_k has been computed by dividing the number of hectares sampled in each stratum by the

⁸ Ministry of Environment, Forest and Climate Change (MEFCC). 2018. Ethiopia's National Forest Inventory, Final Report. Ministry of Environment, Forest and Climate Change, Addis Ababa, Ethiopia : https://www.efd.gov.et/wp-content/uploads/2025/05/National-Forest-Inventory-Final-Report_2018-compressed-compressed-compressed.pdf

⁹ https://www.efd.gov.et/wp-content/uploads/2025/05/NFI-FIELD-MANUAL_NFI-I.pdf

total area of the strata (when the sampling intensity is higher, inclusion probability is higher). All the equations related to this can be found in section 2.7 of the NFI report (MEFCC, 2018).

Using available geospatial layers of Ethiopia and large-scale ecological studies the whole country was classified into five strata. Based on these strata, a total of 627 sampling units were created, of which 221 were located in Oromia. Every sampling unit had an area of 1 km² and was composed of 4 plots (with cumulative plot area of 2 ha). The details of the sample unit and plot design can be found in section 2.1 of the NFI report (MEFCC, 2018). Out of the 627 planned sampling units, 539 were found to be accessible. The remaining 88 SUs were inaccessible due to different factors including excessive remoteness, topography and temporary security problems. Within the accessible sample units, a total of 2,077 accessible sample plots were visited in which about 49,829 trees and 2,029 stumps were recorded and analyzed.

For all the trees and stumps measured, the following variables were collected:

- Position in the plot;
- Tree/stump;
- Species name (scientific names and vernacular names);
- Diameter at 0.3 m level;
- DBH and top height (for trees and stumps greater or equal DBH 10 cm in outside forest and greater or equal to DBH 20 cm in forest) ;
- Bole height;
- Stem quality;
- Tree Health;
- Causative agents;
- Decomposition status.

In 2015 the stratification scheme was changed because Ethiopia decided to adopt a classification that better describes the vegetation characteristics of the country. With this change, the following biomes were adopted as basis for the NFI:

- Acacia-Commiphora
- Combretum-Terminalia
- Dry Afromontane

- Moist Afromontane

This change resulted in the adoption of more specific analysis methods. All the NFI results are thus presented by biome, and not by original NFI strata. Since the biome stratification was introduced when the NFI was already in progress, a post-stratification methodology was applied in order to correctly estimate the results by the biomes. The number of SUs by biomes and strata is presented in table 2-5 of the NFI report (MEFCC, 2018) and reproduced below.

Table 2: Distribution of the sampling units per biome and strata (Table 2-5 from the NFI report)

	<i>Acacia-Commiphora</i>	<i>Combretum-Terminalia</i>	Dry Afromontane	Moist Afromontane	Others	Total
Stratum I	5	13	18	59	-	95
Stratum II	107	-	-	-	-	107
Stratum III	1	93		6	1	101
Stratum IV	36	38	114	29	1	218
Stratum V	15	2	-	-	1	18
Total	164	146	132	94	3	539

As part of the NFI, extensive training events were organized in order to secure that the field crews correctly collected the field data. Quality Assessment/Quality Control (QA/QC) procedures were implemented in order to ensure an adequate standard in the data collection and data entry procedures. Based on a random sub-sampling, 10% of the SUs were re-measured by a semi-independent team composed of experts not involved in the field campaign and specifically trained for QA/QC. At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. The QA/QC team used the original data forms to check any irregularities in the records. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. The data was entered into a database and then subject to cleansing procedures in order to filter all the records considered potentially erroneous.

A robust statistical procedure was applied to analyze the data based on the biomes. The method used was based on the one described by Sarndal et al. (1992)¹⁰. The details and equations are described in section 2.7 of the NFI report (MEFCC, 2018).

The data analysis of the field data results has been done using R language scripts and R scripts in OpenForis Calc¹¹. In the data analysis, the following assumptions and equations have been used:

- Because field conditions do not always allow field crews to successfully determine tree height, a tree height model has been applied for trees whose heights are not measured in the field. Three different models were tested for the Ethiopia NFI dataset. Curtis' model (1967) was ultimately selected as the better fit which uses the follow equation:

$$h = 1.3 + a * \left(\frac{dbh}{1 + dbh} \right)^b$$

h = estimated top height [m];
 dbh = diameter at the breast height (DBH)[cm];
 a, b = parameters.

- In the absence of applicable biomass models for every Ethiopian ecosystem/biome consistent with international requirements, the pantropical model of Chave et al. (2014) was used:

$$AGB = 0.673 (WD \cdot dbh^2 \cdot h)^{0.976}$$

Where:

AGB = Above ground biomass [kg];

WD = Dry wood density [$t \cdot m^{-3}$];

The default value for the WD is $0.615 t \cdot m^{-3}$.

- Wood density data of over 400 tree species found in Ethiopia has been analyzed. For the NFI analysis, the ones with the highest quality have been selected and applied (see

¹⁰ Sarndal, C-E., Swensson, B. and Wretman, J. (1992). "Model assisted survey sampling".

¹¹ Calc is a legacy tool that is part of the OpenForis tool kit. More information and access to the source code can be found at <https://openforis.org/solutions/legacy/>

section labelled as ‘2.2 wood densities’ on page 35 of the NFI report for details). Low quality values and tree species inventoried in Ethiopia and missing in the country databases have been taken from the Global Wood Density Database (GWDDDB)¹². The result was that out of 360 species identified during the NFI cycle, wood densities of 341 species have been selected using a validated value. The same values have been used in Ethiopia’s FREL as can be seen in Annex II of the Ethiopia FREL document¹³.

- For the fallen deadwood volume, De Vries formula was used. Details on the application of this formula can be found in the section labelled ‘2.1 Deadwood’ on page 35 of the NFI report.

The National Forest Inventory Report provides more details of the approach used in the NFI. Although Ethiopia has planned to revise the carbon stock by conducting national forest inventory every five year, currently the previous assessment report announced in 2018 was not changed. This is because the country did not undertake the national forest inventory as planned due to some challenging factors. A new NFI is currently being conducted and the results of this new NFI will be incorporated in phase 2 of the ERPA when the baseline is expanded with additional subcategories.

For this monitoring report, the below-ground biomass (BGB) was estimated using the above-ground biomass values from the National Forest Inventory Report and root-shoot ratios from the Intergovernmental Panel on Climate Change (IPCC) (2006) by the ecological zones. The following root-shoot ratios have been applied.

Table 3: Root-shoot ratios applied for calculating below ground biomass

IPCC ecological zone	Value	Source	Application to Ethiopia biomes
Tropical moist deciduous	0.24	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical moist deciduous	Applicable to Moist Afromontane Forest

¹² Zanne, A.E. et al. (2009). “Global wood density database”. DRYAD. URL: <http://hdl.handle.net/10255/dryad.235>.

¹³ https://redd.unfccc.int/files/ethiopia_frel_3.2_final_modified_submission.pdf

Tropical Dry Forest	0.28	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical dry	Applicable to Dry Afromontane Forest, Combretum-Terminalia, Acacia-Commiphora
Tropical shrubland	0.4	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland	Applicable to other wooded land

To estimate the carbon from the biomass, the following carbon fraction values have been applied from the Intergovernmental Panel on Climate Change (IPCC) (2006).

Table 4: Carbon fractions applied for calculating carbon from biomass

Vegetation type	Carbon fraction	Source
Forest	0.47	2006 IPCC guidelines, vol4, chapter 4, table 4.3
Woody biomass	0.5	2006 IPCC guidelines, Vol 4, chapter 6, suggested default value in step 5 on page 6.29
Herbaceous biomass	0.47	2006 IPCC guidelines, Vol 4, chapter 6, suggested default value in step 5 on page 6.29

Calculation of Emission Reductions and Removals

Emission reductions and removals are calculated as

$$ER = E_{Baseline} - E_{RP}$$

were

ER = Net Emission Reductions during the Reporting Period (tCO₂-e)

E_{Baseline} = Total net Emissions Baseline during the Reporting Period (tCO₂-e)

E_{RP} = Actual net GHG emissions from the ISFL ER Program during the Reporting Period (tCO₂-e)

$$E_{Baseline} = E_{B_FC} + E_{B_FG} + E_{B_FS} + E_{B_CF} + E_{B_GF} + E_{B_SF}$$

Were

E_{Baseline}	=	Baseline net GHG emissions from the ISFL ER Program during the Reporting Period (tCO ₂ -e)
$E_{\text{B_FC}}$	=	Baseline net emissions for forest converted to cropland during the Reporting Period (tCO ₂ -e)
$E_{\text{B_FG}}$	=	Baseline net emissions for forest converted to grassland during the Reporting Period (tCO ₂ -e)
$E_{\text{B_FS}}$	=	Baseline net emissions for forest converted to shrubland during the Reporting Period (tCO ₂ -e)
$E_{\text{B_CF}}$	=	Baseline net emissions for cropland converted to forest during the Reporting Period (tCO ₂ -e)
$E_{\text{B_GF}}$	=	Baseline net emissions for grassland converted to forest during the Reporting Period (tCO ₂ -e)
$E_{\text{B_SF}}$	=	Baseline net emissions for shrubland converted to forest during the Reporting Period (tCO ₂ -e)

And

$$E_{RP} = E_{RP_FC} + E_{RP_FG} + E_{RP_FS} + E_{RP_CF} + E_{RP_GF} + E_{RP_SF}$$

Where

E_{RP}	=	Actual net GHG emissions from the ISFL ER Program during the Reporting Period (tCO ₂ -e)
E_{RP_FC}	=	Actual net emissions for forest converted to cropland during the Reporting Period (tCO ₂ -e)
E_{RP_FG}	=	Actual net emissions for forest converted to grassland during the Reporting Period (tCO ₂ -e)
E_{RP_FS}	=	Actual net emissions for forest converted to shrubland during the Reporting Period (tCO ₂ -e)

E_{RP_CF} = Actual net emissions for cropland converted to forest during the Reporting Period (tCO₂-e)

E_{RP_GF} = Actual net emissions for grassland converted to forest during the Reporting Period (tCO₂-e)

E_{RP_SF} = Actual net emissions for shrubland converted to forest during the Reporting Period (tCO₂-e)

For each subcategory the emissions and removals are determined for all relevant pools.

$$E_i = (\Delta C_{i_ABG} + \Delta C_{i_BGB} + \Delta C_{i_Mineral} + \Delta C_{i_DOM}) * \left(\frac{44}{12}\right)$$

Where

ΔC_{i_ABG} = changes in carbon in above ground biomass (tC)

ΔC_{i_BGB} = GHG emissions from changes in below ground biomass (tC)

$\Delta C_{i_Mineral}$ = GHG emissions from changes in soil organic carbon in mineral soils (tC)

ΔC_{i_DW} = GHG emissions from changes in dead wood (tC)

i = land category i

Above and below ground biomass

For the three subcategories involving changes from forest to other land uses, the emissions from changes in the above ground and below ground biomass have been calculated as

$$\Delta C_{conversion,i} = EF_{i_ABBG} \cdot \Delta A_i$$

Where:

$\Delta C_{conversion, i}$ = change in carbon stocks on land converted from forest to land category i , tonnes CO₂

EF_{i_ABBG} = Emission factor for changes in above ground and below ground biomass in the conversion of forest to land use i , tonnes CO₂ ha⁻¹

ΔA_i = area converted from forest to land category i

The values of EF_{i_ABBG} are calculated as the difference between the carbon values of the above ground and below ground biomass before and after the change.

$$EF_{i_AGBG} = (C_n - C_o) \cdot \frac{44}{12}$$

Where:

EF_{i_ABBG} = Emission factor for changes in above ground and below ground biomass in the conversion of forest to land use i

C_n = above ground and below ground carbon stock under the new land-use category, tonnes C ha⁻¹

C_o = above ground and below ground carbon stock under the old land-use category, tonnes C ha⁻¹

44/12 = factor to convert carbon units to CO₂e

As described above, the NFI provided the basis for the emission and removal factors used for above and below ground biomass. The NFI report (MEFCC, 2018) provides a summary of the information from the NFI per biome, major land use/land cover type and regions. For the purpose of determining the emission and removal factors, the level 1 classification from the NFI has been used since this most closely matches the IPCC categories used in the ISFL (see table A.1.1 of the NFI report for the level 1 categories and description).

For the calculation of the biomass and carbon values for the forest and shrubland categories, the values for 'forest' and 'Other wooded land' respectively were used from the NFI report. Since table A2.3 of the NFI report provides area estimates by regions, biomes and FRA classes, it was

possible to calculate an Oromia specific, weighted biomass/carbon value for forest and shrubland using these areas.

For this, table A9.7 provides values for above ground biomass per Region, Biome and FRA class. Using the root-shoot ratios from table 3 above, the below-ground biomass of the different FRA classes can be estimated as follows:

$$C_{cl,BG} = C_{i,AG} \cdot R$$

Where:

$C_{cl,BG}$ = below ground carbon stock of FRA class cl , tonnes C ha⁻¹

$C_{cl,AG}$ = above ground carbon stock of FRA class cl , tonnes C ha⁻¹

R = Root to shoot ratio, dimensionless

The table below provides an overview of the different Oromia specific values and provides reference to the source tables in the NFI report.

Table 5: Forest and shrubland Area and above ground/ below ground biomass values per biome and FRA Class for Oromia (including the relevant source tables from the NFI report (MEFCC, 2018))

Biome	FRA class	Area (ha)	ag_biomass (t /ha)	root-shoot	bg_biomass (t /ha)	Total biomass (t /ha)
Acacia-Commiphora	Forest	431,237	80.3	0.28	22.48	102.78
	Shrubland /Other wooded land	11,149,959	9.3	0.40	3.72	13.02
Combretum-Terminalia	Forest	205,087	46.8	0.28	13.10	59.90
	Shrubland/ Other wooded land	645,693	25.0	0.40	10.00	35.00
Dry Afromontane	Forest	488,946	69.4	0.28	19.43	88.83
	Shrubland / Other wooded land	7,029,220	9.0	0.40	3.60	12.60
Moist Afromontane	Forest	1,643,917	217.4	0.24	52.17	269.57
	Shrubland Other wooded land	2,747,305	17.8	0.40	7.12	24.92
Sources		<i>NFI report</i>	<i>NFI report</i>			

		<i>table A.2.3</i>	<i>table A9.7</i>			
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From the values above and using the carbon fractions from Table 4, a weighted region specific value region for tree biomass and carbon was calculated as shown in the table below.¹⁴

Table 6 Tree biomass and carbon for forest and shrubland in Oromia

FRA Class	Biomes	Area (ha)	biomass (t /ha)	Carbon fraction	carbon (t /ha)	total carbon (Total)	Weighted carbon t/ha
Forest	Acacia-Commiphora	431,237	102.78	0.47	48.31	20,832,404	
	Combretum-Terminalia	205,087	59.90	0.47	28.15	5,774,200	
	Dry Afromontane	488,946	88.83	0.47	41.75	20,414,004	
	Moist Afromontane	1,643,917	269.58	0.47	126.70	208,285,468	
Weighted value forest		2,769,187				255,306,075	92.2
Other Wooded Land	Acacia-Commiphora	11,149,959	13.02	0.50	6.51	72,586,233	
	Combretum-Terminalia	645,693	35.00	0.50	17.50	11,299,628	
	Dry Afromontane	694,253	12.60	0.50	6.30	4,373,794	
	Moist Afromontane	867,005	24.92	0.50	12.46	10,802,882	
Weighted value Other Wooded Land		13,356,910				99,062,537	7.4

The National Forest Inventory Report (MEFCC, 2018) does not provide specific values for cropland and grassland. Table A1.1 of this report provides a description of the land use/land cover categories used. In this table, different vegetation types related to cropland and grassland are all included under the FRA class ‘Other land’. Since the National Forest Inventory Report still provides the most comprehensive data set available, biomass and carbon values for cropland and grassland have been estimated using the data provided in this report.

Under the definitions of cropland and grassland used in Ethiopia, the following land uses from table A1.1 of the National Forest Inventory Report (MEFCC, 2018) would be included under the IPCC categories of Cropland and Grassland respectively:

¹⁴ The results of a similar calculation are provided in table A8.4 of the National Forest Inventory Report (MEFCC, 2018). However, since this calculation uses different values for the root-shoot ratios and carbon fractions, the outcomes this calculation in the NFI report is different from the numbers presented here

Cropland	Annual crops
	Perennial crops
	Mixed annual and perennial crops
	Coffee plantations
	Fallow land
Grassland	Natural grassland

Table A2.2 of the National Forest Inventory Report provides Ethiopia wide area estimates for each of these land use classes. Table A8.1 of the same report provides (tree) biomass for the same. Using these data, an Ethiopia level weighted biomass and carbon value was calculated for Cropland and Grassland respectively using the root-shoot ratios and carbon fraction from Table 3 and Table 4 above. Since there are no Oromia specific area and biomass values available in the report, it was not possible to calculate an Oromia specific value.

The result of these calculations is shown in the table below.

Table 7 Biomass and carbon for cropland and grassland in Ethiopia

IPCC Class	NFI LUCC	Area (ha) (from NFI report, table A.2.2)	Biomass (t ha ⁻¹) (from NFI report, table A8.1)	Total biomass	Carbon fraction	Total carbon	Total carbon /ha	Weighted carbon (t C/ ha)
Cropland	Coffee plantation	1,073,035.0	214.9	230,595,221.5	0.5	108,379,754.1	101.0	
	Annual crop	28,283,110.0	11.3	319,599,143.0	0.5	150,211,597.2	5.3	
	Perennial crop	1,149,832.0	102.7	118,087,746.4	0.5	55,501,240.8	48.3	
	Mixed annual and perennial crops	393,913.0	37.7	14,850,520.1	0.5	6,979,744.4	17.7	
	Fallow	2,075,917.0	8.5	17,645,294.5	0.5	8,293,288.4	4.0	
Weighted value cropland		32,975,807.0		700,777,925.5		329,365,625.0		10.0
Grassland	Natural grassland	7,464,741.0	7.5	55,985,557.5	0.5	26,313,212.0	3.5	
Weighted value grassland		7,464,741.0		55,985,557.5		26,313,212.0		3.5

For the calculation of the emission factors used for conversions of forest to cropland and grassland, the difference between the carbon stocks of forest in Oromia from Table 6 and that of the Ethiopia wide value for cropland and grassland from Table 7 was used. For the conversion of forest to shrubland, the difference between the carbon stock of forest and that of ‘other wooded land’ in table 6 was used.

For the subcategories involving removals, the removals are calculated using the approach outlined in the ISFL ‘Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period. The guidance note suggests that for change in biomass carbon stocks (above-ground biomass and below-ground biomass) it can be assumed that during the conversion from non-forest to forest, carbon stocks will go from average carbon stocks in non-forest to average carbon stocks in forests during a default period of 20 years. Therefore, the removal factors used were calculated as the emission factors (as described above) divided by 20.

Dead wood

The emission and removals from deadwood have been calculated according to the ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period (Version 1.0). In line with this guidance note, equation 2.23 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories has been used as the basis to estimate annual change in carbon stocks in dead wood due to land conversion.

EQUATION 2.23
ANNUAL CHANGE IN CARBON STOCKS IN DEAD WOOD AND LITTER DUE TO LAND CONVERSION

$$\Delta C_{DOM} = \frac{(C_n - C_o) \cdot A_{on}}{T_{on}}$$

Where:

ΔC_{DOM} = annual change in carbon stocks in dead wood or litter, tonnes C yr⁻¹

C_o = dead wood/litter stock, under the old land-use category, tonnes C ha⁻¹

C_n = dead wood/litter stock, under the new land-use category, tonnes C ha⁻¹

A_{on} = area undergoing conversion from old to new land-use category, ha

T_{on} = time period of the transition from old to new land-use category, yr. The Tier 1 default is 20 years for carbon stock increases and 1 year for carbon losses.

In line with the ISFL guidance note, it has been assumed that the average annual rate of conversion during the Baseline Period would have applied during the ISFL ERPA Phase. The emission reductions are then calculated as the difference between the expected emissions or removals under the Emissions Baseline and the actual emission or removals. Therefore, instead of applying IPCC equation 2.23 directly, a change factor has been calculated (ΔCF_{DOM}) which is used in combination with the projected baseline area change and the actual monitored area change.

$$\Delta CF_{DOM} = \frac{(C_n - C_o)}{T_{on}}$$

Where:

ΔCF_{DOM} = annual change in carbon stocks in dead wood, tonnes C ha⁻¹ yr⁻¹

With the other factor as defined for IPCC equation 2.23 above

Since there are no data to distinguish between the dead wood stocks immediately after the land-use conversion and the later transition period, it is assumed that the changes in the dead wood from one value to another happen in a linear fashion over the IPCC default period of 20 years.

Table 3-24 of the NFI report provides values for carbon in deadwood for different land use/land cover types on the national level as shown below.

Table 8: Carbon in deadwood by Major LUCC types (Table 3-24 of the NFI report (MEFCC, 2018))

FRA class	Major LUCC	Carbon (t ha ⁻¹)
Forest	Natural regenerated forest	15.8
Forest	Plantation	0.5
Other Wooded Land	Other wooded land	1.9
Other Land	Cultivated	2.6
Other Land	Natural	0.9

Since no region-specific values for dead wood are provided in the NFI, the national values have been used for the emission and removal factors.

According to the ISFL guidance note, the values for litter and dead wood pools can be assumed zero in all non-forest categories and dead organic matter in Forest Land shall be assumed to have the value of mature forests at the beginning of the Baseline Period. Since values are available from the NFI, the following emission and removal factors have been as outlines in the table below.

Table 9: Dead wood change factors applied

Baseline subcategory	Corresponding change from LUCC classes in figure 7 above	Change factor (t C ha ⁻¹ yr ⁻¹)
Forest to cropland	Natural regenerated forest to Other land-cultivated	-0.66
Forest to grassland	Natural regenerated forest to Other land-natural	-0.745
Forest to shrubland	Natural regenerated forest to other wooded land	-0.695
Cropland to forest	Other land-cultivated to plantation	-0.105
Grassland to forest	Other land-natural to plantation	-0.02
Shrubland to forest	Other wooded land to plantation	-0.07

Soil organic carbon

Changes in the Soil Organic Carbon pool in mineral soils associated with conversion from and to forest were calculated according to the ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period (Version 1.0). In line with this guidance note, formulation B from box 2.1 in the 2006 IPCC Guidelines, Volume 4, Chapter 2 was used as below.

Formulation B (Approaches 2 and 3 for Activity Data Collection)

$$\Delta C_{Mineral} = \frac{\sum_{c,s,p} \left[\left\{ \left(\begin{matrix} SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \end{matrix} \right)_0 - \left(\begin{matrix} SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \end{matrix} \right)_{(0-T)} \right\} \cdot A_{c,s,p} \right]}{D}$$

Where:

$\Delta C_{Mineral}$ = annual change in carbon stocks in mineral soils, tonnes C yr⁻¹

SOC_0 = soil organic carbon stock in the last year of an inventory time period, tonnes C

$SOC_{(0-T)}$ = soil organic carbon stock at the beginning of the inventory time period, tonnes C

T = number of years over a single inventory time period, yr

D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr.

c = represents the climate zones, s the soil types, and i the set of management systems that are present in a country.

SOC_{REF} = the reference carbon stock, tonnes C ha⁻¹

F_{LU} = stock change factor for land-use systems or sub-system for a particular land-use, dimensionless

F_{MG} = stock change factor for management regime, dimensionless

F_I = stock change factor for input of organic matter, dimensionless

A = land area of the stratum being estimated, ha.

p = parcel of land

As discussed above, the NFI report does not provide updates values on soil organic carbon. Therefore, the value for national soil organic carbon stocks for forest that was used in the ER Program inventory in the validated ERPD is also used for this monitoring report. This national value was obtained from the "Evaluation of the forest carbon content in soil and litter in Ethiopia"¹⁵ which was implemented by Natural Resources Finland (LUKE) and Ethiopia Environment and Forestry Research Institute (EEFRI). The national value was based on biome specific values as shown in the table below.

Table 10: Soil organic carbon in forest in Ethiopia

Soil type - Biome	SOC ref (tC/ha)	N	Standard deviation (tC/ha)	Source
Acacia Commiphora	34.245	11	17.01197	Evaluation of the forest carbon content in soil and litter in Ethiopia, Implementing agency: Natural Resources Institute Finland (LUKE) and Ethiopia Environment and Forestry Research Institute (EEFRI) Duration of the Report: August 2017 - February 2018. Beneficiaries: FAO, MEFC, EEFRI
Combretum Terminalia	41.561	37	28.25306	Idem above
Dry Afromontaine	53.080	33	34.46676	Idem above
Moist Afromontaine	83.886	17	34.65632	Idem above
Average	51.961	98	33.58339	Idem above

¹⁵ Some of the results of this study are discussed in Lehtonen A, Ťupek B, Nieminen TM, et al. Soil carbon stocks in Ethiopian forests and estimations of their future development under different forest use scenarios. Land Degrad Dev. 2020; 31: 2763–2774. <https://doi.org/10.1002/ldr.3647>

In line with the guidance note, the Soil Organic Carbon pool in Forest Land was assumed to be in equilibrium at the beginning of the Baseline Period and the average value of 51.96 t C/ha has been used as SOC_{ref} and the equilibrium value for forest.

Following the equation above and equation 2.25 of the 2006 IPCC guidelines, the equilibrium values for each non-forest subcategory was conservatively determined by using the same stock change factors applied in the validated ERPD and the formula below:

$$SOC_i = SOC_{ref} \cdot F_{LU} \cdot F_I \cdot F_{MG}$$

Where:

SOC_i = Equilibrium soil organic C stocks for mineral soils under land use type i , tonnes C ha^{-1}

Other factors as defined above

The applied stock change factors and the resulting equilibrium SOC values are shown in the table below.

Table 11: Stock change values applied for estimating equilibrium soil organic carbon content of non-forest land categories

	FLU	FI	FMG	Equilibrium SOC (tC/ha)
Annual cropland	0.48	0.92	1	22.94
Grassland	1	1	0.97	50.40

2.3 Data and parameters

2.3.1 Fixed Data and Parameters

Table 12: Fixed data and parameter

Parameter:	EF_{C_ABBG}
Description:	<i>Emission Factor for loss of above ground and below ground biomass in the conversion from forest to cropland.</i>
Subcategory for which the parameter is used:	This parameter is used for the subcategory forest land converted to crop land
Data unit:	tCO ₂ /ha

Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international) :	Calculated as the difference between the carbon stocks of forest in Oromia from table 6 and that of the Ethiopia wide value for cropland from table 7
Value applied:	$92.2 \text{ tC/ha} - 10.0 \text{ tC/ha} = 82.2 \text{ t C/ha} * 44/12 = 301.43 \text{ tCO}_2\text{eq}$
QA/QC procedures applied	<p>Above ground biomass data obtained through the National Forest Inventory. In the NFI process, Quality Assessment/Quality Control (QA/QC) procedures were implemented in order to ensure an adequate standard in the data collection and data entry procedures. Based on random sub-sampling, 10% of the SUs was re-measured by a semi-independent team (composed of EFD (former MEFCC) experts not involved in the field campaign and specifically trained for QA/QC). At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. The QA/QC team used the original data forms to check any irregularities in the records. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. The inventory teams were not aware of which SUs were re-measured. This procedure allowed the QA/QC team to identify the field teams with insufficient or nonstandard performances and contact them to improve their measurements precision in the data collection. The data was entered into a database and then subject to cleansing procedures in order to filter all the records considered potentially erroneous.</p>

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Description:	Emission Factor for loss of above ground and below ground biomass in the

	conversion from forest to grassland.
Subcategory for which the parameter is used:	This parameter is used for the subcategory forest land converted to grassland
Data unit:	tCO ₂ /ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Calculated as the difference between the carbon stocks of forest in Oromia from table 6 and that of the Ethiopia wide value for grassland from table 7
Value applied:	$92.2 \text{ tC/ha} - 3.5 \text{ tC/ha} = 88.7 \text{ t C/ha} * 44/12 = 325.12 \text{ tCO}_2\text{eq}$
QA/QC procedures applied	Above ground biomass value obtained through the National Forest Inventory. In the NFI process, Quality Assessment/Quality Control (QA/QC) procedures were implemented in order to ensure an adequate standard in the data collection and data entry procedures. Based on random sub-sampling, 10% of the SUs was re-measured by a semi-independent team (composed of EFD (former MEFCC) experts not involved in the field campaign and specifically trained for QA/QC). At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. The QA/QC team used the original data forms to check any irregularities in the records. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. The inventory teams were not aware of which SUs were re-measured. This procedure allowed the QA/QC team to identify the field teams with insufficient or nonstandard performances and contact them to improve their measurements precision in the data collection. The data was entered into a database and then subject to cleansing procedures in order to filter all the records considered potentially erroneous.

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Parameter:	EF _{shrub_AGBG}
Description:	Emission Factor for loss of above ground and below ground biomass in the conversion from forest to shrubland
Subcategory for which the parameter is	This parameter is used for the conversion of forest land to shrubland

used:									
Data unit:	tCO ₂ /ha								
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Calculated as the difference between the Oromia specific calculated carbon stocks of forest and ‘Other Wooded Land’ from table 6								
Value applied:	$92.2 \text{ tC/ha} - 7.4 \text{ tC/ha} = 84.8 \text{ t C/ha} * 44/12 = 310.86 \text{ tCO}_2\text{eq}$								
QA/QC procedures applied	Above ground biomass values obtained through the National Forest Inventory. In the NFI process, Quality Assessment/Quality Control (QA/QC) procedures were implemented in order to ensure an adequate standard in the data collection and data entry procedures. Based on random sub-sampling, 10% of the SUs were re-measured by a semi-independent team (composed of EFD (former MEFCC) experts not involved in the field campaign and specifically trained for QA/QC). At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. The QA/QC team used the original data forms to check any irregularities in the records. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. The inventory teams were not aware of which SUs were re-measured. This procedure allowed the QA/QC team to identify the field teams with insufficient or nonstandard performances and contact them to improve their measurements precision in the data collection. The data was entered into a database and then subject to cleansing procedures in order to filter all the records considered potentially erroneous.								
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		For below ground biomass, the root-shoot ratios from the 2006 IPCC guidelines (volume 4, table 4.4) were used as below.								
				Ecological zone	Value	IPCC default uncertainty estimate				
		Tropical Moist Deciduous Forest	0.24	0.22-0.33						
		Tropical Dry Forest	0.28	0.27-0.28						
		Tropical shrubland	0.4	-						
Any comment:										

Parameter:	RF _C _AGBB
Description:	Above ground and below ground biomass removal Factor for the conversion of cropland to forest land.
Subcategory for which the parameter is used:	This parameter is used to calculate the changes in above ground and below ground biomass in the conversion of cropland to forest land
Data unit:	tCO ₂ /ha/year
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	As per the ISFL guidance note , the removal factor is calculated by assuming that during the conversion from cropland to forest, carbon stocks will go from average carbon stocks in non-forest to average carbon stocks in forests during a period of 20 years.
Value applied:	15.07 (301.43 / 20)
QA/QC procedures applied	See EF _C _AGBG

Uncertainty associated with this parameter:	See EF_{C-AGBG}
Any comment:	

Parameter:	RF_{G_AGBB}
Description:	<i>Above ground and below ground biomass removal factor for the conversion of Grassland to forest land.</i>
Subcategory for which the parameter is used:	This parameter is used to calculate the changes in above ground and below ground biomass in the conversion of grassland to forest land
Data unit:	tCO ₂ /ha/year
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	As per the ISFL guidance note , the removal factor is calculated by assuming that during the conversion from grassland to forest, carbon stocks will go from average carbon stocks in non-forest to average carbon stocks in forests during a period of 20 years.
Value applied:	16.26 (325.12 / 20)
QA/QC procedures applied	<i>See EF_{G_AGBG}</i>
Uncertainty associated with this parameter:	<i>See EF_{G-AGBG}</i>
Any comment:	

Parameter:	RF_{shrub_AGBB}
Description:	Above ground and below ground biomass removal factor for the conversion of shrubland to forest land.
Subcategory for which the parameter is used:	This parameter is used to calculate the changes in above ground and below ground biomass in the conversion of shrubland to

	forest land
Data unit:	tCO ₂ /ha/year
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	As per the ISFL guidance note , the removal factor is calculated by assuming that during the conversion from grassland to forest, carbon stocks will go from average carbon stocks in non-forest to average carbon stocks in forests during a period of 20 years.
Value applied:	15.54 (310.86 / 20)
QA/QC procedures applied	See <i>EF_{shrub}_AGBG</i>
Uncertainty associated with this parameter:	See <i>EF_{shrub}-AGBG</i>
Any comment:	

Parameter:	R
Description:	Root to shoot ratio to estimate Below Ground Biomass
Subcategory for which the parameter is used:	This parameter is used for all subcategories
Data unit:	Dimensionless
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national,	IPCC default values

international):																				
Value applied:	<table border="1"> <thead> <tr> <th data-bbox="423 275 613 373">IPCC ecological zone</th> <th data-bbox="618 275 711 306">Value</th> <th data-bbox="716 275 959 306">Source</th> <th data-bbox="964 275 1438 306">Application to Ethiopia biomes</th> </tr> </thead> <tbody> <tr> <td data-bbox="423 380 613 569">Tropical Moist Deciduous Forest</td> <td data-bbox="618 380 711 411">0.24</td> <td data-bbox="716 380 959 569">2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical moist deciduous</td> <td data-bbox="964 380 1438 411">Applicable to Moist Afromontane Forest</td> </tr> <tr> <td data-bbox="423 575 613 732">Tropical Dry Forest</td> <td data-bbox="618 575 711 606">0.28</td> <td data-bbox="716 575 959 732">2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical dry</td> <td data-bbox="964 575 1438 669">Applicable to Dry Afromontane Forest, CombretumTerminalia, Acacia-Commiphora</td> </tr> <tr> <td data-bbox="423 739 613 896">Tropical shrubland</td> <td data-bbox="618 739 711 770">0.4</td> <td data-bbox="716 739 959 896">2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland</td> <td data-bbox="964 739 1438 770">Applicable to other wooded land</td> </tr> </tbody> </table>				IPCC ecological zone	Value	Source	Application to Ethiopia biomes	Tropical Moist Deciduous Forest	0.24	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical moist deciduous	Applicable to Moist Afromontane Forest	Tropical Dry Forest	0.28	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical dry	Applicable to Dry Afromontane Forest, CombretumTerminalia, Acacia-Commiphora	Tropical shrubland	0.4	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland	Applicable to other wooded land
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	Tropical shrubland	0.4	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland	Applicable to other wooded land
Any comment:				

Parameter:	ΔCF_{DOM}																		
Description:	annual change in carbon stocks in dead wood																		
Subcategory for which the parameter is used:	Conversion from and to forest																		
Data unit:	tonnes C ha ⁻¹ yr ⁻¹																		
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	<p>For deadwood, table 3-24 of the NFI report (MEFCC, 2018) provides values for carbon in deadwood for different land use/land cover types on the national level as shown below.</p> <table border="1" data-bbox="662 1079 1599 1312"> <thead> <tr> <th>FRA class</th> <th>Major LUCC</th> <th>Carbon (t ha⁻¹)</th> </tr> </thead> <tbody> <tr> <td>Forest</td> <td>Natural regenerated forest</td> <td>15.8</td> </tr> <tr> <td>Forest</td> <td>Plantation</td> <td>0.5</td> </tr> <tr> <td>Other Wooded Land</td> <td>Other wooded land</td> <td>1.9</td> </tr> <tr> <td>Other Land</td> <td>Cultivated</td> <td>2.6</td> </tr> <tr> <td>Other Land</td> <td>Natural</td> <td>0.9</td> </tr> </tbody> </table> <p>Since no region specific values for dead wood are provided in the NFI, the national values have been used for the emission and removal factors.</p> <p>The emission and removals from deadwood have been calculated according to the ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period (Version 1.0). In line with this guidance note, equation 2.23 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories has been applied to estimate annual change in carbon stocks in dead wood due to land conversion by comparing dead wood stock, under the old land-use category and under the new land-use</p>	FRA class	Major LUCC	Carbon (t ha ⁻¹)	Forest	Natural regenerated forest	15.8	Forest	Plantation	0.5	Other Wooded Land	Other wooded land	1.9	Other Land	Cultivated	2.6	Other Land	Natural	0.9
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	category. Since there are no data to distinguish between the dead wood stocks immediately after the land-use conversion and the later transition period, it is assumed that the changes in the dead wood from one value to another happen in a linear fashion over the IPCC default period of 20 years.																												
Value applied:	<p>According to the ISFL guidance note, the values for litter and dead wood pools can be assumed zero in all non-forest categories and dead organic matter in Forest Land shall be assumed to have the value of mature forests at the beginning of the Baseline Period. Since values are available from the NFI, the following emission and removal factors have been as outlines in the table below.</p> <table border="1"> <thead> <tr> <th>Baseline subcategory</th> <th></th> <th>Corresponding change from table 3-24 of the NFI report</th> <th>Change factor (t C ha⁻¹ yr⁻¹)</th> </tr> </thead> <tbody> <tr> <td>Forest cropland</td> <td>to</td> <td>Natural regenerated forest to Other land-cultivated</td> <td>-0.66</td> </tr> <tr> <td>Forest grassland</td> <td>to</td> <td>Natural regenerated forest to Other land-natural</td> <td>-0.745</td> </tr> <tr> <td>Forest shrubland</td> <td>to</td> <td>Natural regenerated forest to other wooded land</td> <td>-0.695</td> </tr> <tr> <td>Cropland forest</td> <td>to</td> <td>Other land-cultivated to plantation</td> <td>-0.105</td> </tr> <tr> <td>Grassland forest</td> <td>to</td> <td>Other land-natural to plantation</td> <td>-0.02</td> </tr> <tr> <td>Shrubland forest</td> <td>to</td> <td>Other wooded land to plantation</td> <td>-0.07</td> </tr> </tbody> </table>	Baseline subcategory		Corresponding change from table 3-24 of the NFI report	Change factor (t C ha ⁻¹ yr ⁻¹)	Forest cropland	to	Natural regenerated forest to Other land-cultivated	-0.66	Forest grassland	to	Natural regenerated forest to Other land-natural	-0.745	Forest shrubland	to	Natural regenerated forest to other wooded land	-0.695	Cropland forest	to	Other land-cultivated to plantation	-0.105	Grassland forest	to	Other land-natural to plantation	-0.02	Shrubland forest	to	Other wooded land to plantation	-0.07
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QA/QC procedures applied																													
Uncertainty associated with this parameter:	No uncertainties have been provided in the NFI report for the deadwood values																												
Any comment:																													

Parameter:	SOC_{ref}
Description:	reference soil organic C stocks for mineral soils under native forest (in 0-30 cm depth)
Subcategory for which the parameter is used:	Conversion from and to forest
Data unit:	tonnes C ha ⁻¹
Source of data or description of the	"Evaluation of the forest carbon content in soil and litter in Ethiopia" which was implemented by Natural Resources Finland (LUKE) and Ethiopia Environment and Forestry Research Institute

method for developing the data including the spatial level of the data (local, regional, national, international):	(EEFRI). https://onlinelibrary.wiley.com/doi/full/10.1002/ldr.3647 , https://onlinelibrary.wiley.com/action/downloadFigures?id=ldr3647-fig-0002&partId=&doi=10.1002%2Fldr.3647 , The national value was based on biome specific values as shown in the table below.																								
	<table border="1"> <thead> <tr> <th>Soil type - Biome</th> <th>SOC ref (tC/ha)</th> <th>N</th> <th>Standard deviation (tC/ha)</th> </tr> </thead> <tbody> <tr> <td>Acacia Commiphora</td> <td>34.245</td> <td>11</td> <td>17.01197</td> </tr> <tr> <td>Combretum Terminalia</td> <td>41.561</td> <td>37</td> <td>28.25306</td> </tr> <tr> <td>Dry Afromontaine</td> <td>53.080</td> <td>33</td> <td>34.46676</td> </tr> <tr> <td>Moist Afromontaine</td> <td>83.886</td> <td>17</td> <td>34.65632</td> </tr> <tr> <td>Average</td> <td>51.961</td> <td>98</td> <td>33.58339</td> </tr> </tbody> </table>	Soil type - Biome	SOC ref (tC/ha)	N	Standard deviation (tC/ha)	Acacia Commiphora	34.245	11	17.01197	Combretum Terminalia	41.561	37	28.25306	Dry Afromontaine	53.080	33	34.46676	Moist Afromontaine	83.886	17	34.65632	Average	51.961	98	33.58339
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Value applied:	51.96 (average value)																								
QA/QC procedures applied																									
Uncertainty associated with this parameter:	See above for standard deviation																								
Any comment:																									

Parameter:	<i>SOC_i</i>												
Description:	Equilibrium soil organic C stocks for mineral soils under land use type <i>i</i>												
Subcategory for which the parameter is used:	Conversion from and to forest												
Data unit:	tonnes C ha ⁻¹												
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Calculated from the reference SOC value for forest and applying the stock change factors applied from the validated ERPD as shown in the table below. <table border="1"> <thead> <tr> <th></th> <th>FLU</th> <th>FI</th> <th>FMG</th> </tr> </thead> <tbody> <tr> <td>Annual cropland</td> <td>0.48</td> <td>0.92</td> <td>1</td> </tr> <tr> <td>Grassland</td> <td>1</td> <td>1</td> <td>0.97</td> </tr> </tbody> </table>		FLU	FI	FMG	Annual cropland	0.48	0.92	1	Grassland	1	1	0.97
	FLU	FI	FMG										
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Value applied:	<table border="1"> <thead> <tr> <th></th> <th>Equilibrium SOC (tC/ha)</th> </tr> </thead> <tbody> <tr> <td>Annual cropland</td> <td>22.94</td> </tr> <tr> <td>Grassland</td> <td>50.40</td> </tr> </tbody> </table>		Equilibrium SOC (tC/ha)	Annual cropland	22.94	Grassland	50.40						
	Equilibrium SOC (tC/ha)												
Annual cropland	22.94												
Grassland	50.40												

QA/QC procedures applied	
Uncertainty associated with this parameter:	Calculated from SOC_{ref} . Standard deviation for SOC_{ref} provided in table above
Any comment:	

Parameter:	Area
Description:	Area of Oromia classified by its land-use and detection of land-use changes.
Subcategory for which the parameter is used:	All
Data unit:	Ha
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Calculation based on sampling analysis.
Value applied:	32,238,018
QA/QC procedures applied	SOP to conduct sample analysis and land-use and land-use change detection with Collect Earth. Capacity training with external trainers (FAO).
Uncertainty associated with this parameter:	Systematic errors from operators classifying incorrectly the land-use and land-use change.
Any comment:	

Parameter:	A
Description:	Area of sampling frame.
Subcategory for which the parameter is used:	
Data unit:	M ²
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Field measurement in sample plots.

Value applied:	
QA/QC procedures applied	Standard operating procedures (SOPs) prescribed under national forest inventory are applied (MEFCC) “Field manual”. SOPs from published handbooks, or from the IPCC GPG LULUCF 2003 will also be applied.
Uncertainty associated with this parameter:	Systematic errors from field measurements, digitalization of field measurements.
Any comment:	

Parameter:	WD
Description:	Basic Wood density of every species.
Subcategory for which the parameter is used:	Used to estimate the EF for all subcategories
Data unit:	g/cm ³
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Data for 400 species from Ethiopia specific literature values based on extraction of samples on field and delivery to laboratories for measurement. Where no Ethiopia specific values were available, values from the Global Wood Density Database were used.
Value applied:	Individual values are available in database of the Collect software. The same values have been used in Ethiopia’s FREL and can be seen in Annex II of the <i>Ethiopia</i> FREL document ¹⁶ .
QA/QC procedures applied	SOP applicable to this activity, ISO standards.
Uncertainty associated with this parameter:	No uncertainty values are provided for wood density in the NFI report
Any comment:	

Parameter:	DBH
Description:	Diameter at breast height.

¹⁶ https://redd.unfccc.int/files/ethiopia_frel_3.2_final_modified_submission.pdf

Subcategory for which the parameter is used:	used to estimate the EF for all subcategories
Data unit:	Cm
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Field measurement in sample plots.
Value applied:	Values from the NFI. See table A3.5 of the NFI document for a summary of number of trees per hectare in DBH ranges. Individual values available in database of the Collect software
QA/QC procedures applied	Standard operating procedures (SOPs) prescribed under national forest inventory are applied (MEFCC) “Field manual”. SOPs from published handbooks, or from the IPCC GPG LULUCF 2003 will also be applied.
Uncertainty associated with this parameter:	Systematic errors from field measurements, digitalization of field measurements. No uncertainty values are provided for DBH in the NFI report but uncertainties for volume are provided in table A9.6
Any comment:	

Parameter:	H
Description:	Height
Subcategory for which the parameter is used:	used to estimate the EF for all subcategories
Data unit:	M
Source of data or description of the method for developing the data including the spatial level of the data (local, regional, national, international):	Field measurement in sample plots.
Value applied:	Values from the NFI. See table A3.6 of the NFI document for a summary of number of trees per hectare in height ranges. Individual values available in database of the Collect software
QA/QC procedures applied	Standard operating procedures (SOPs) prescribed under national forest inventory are applied (MEFCC) “Field manual”. SOPs

	from published handbooks, or from the IPCC GPG LULUCF 2003 will also be applied.
Uncertainty associated with this parameter:	Systematic errors from field measurements, digitalization of field measurements. No uncertainty values are provided for Height in the NFI report but uncertainties for volume are provided in table A9.6
Any comment:	

2.3.2 Monitored Data and Parameters

The key data and parameters monitored during the 2024 reporting period focused on land use/cover change, particularly, total forest area within the project boundary, Annual changes in forest area (deforestation, afforestation/reforestation). These monitored parameters were crucial in assessing the extent of deforested and afforested areas within the emissions reduction program area. Additionally, the estimation of the forest carbon stock potential in the region was carried out by utilizing national forest inventory results to calculate greenhouse gas emissions and removals.

All land cover transitions reported in this Monitoring Report are based on the standardized definitions and thresholds outlined in the “Land Use Land Cover, Land Use Land Cover Change and Forest Disturbance Interpretation Key for Ethiopia” (November 2023). Each category including Forest Land, Cropland, Shrubland, and Grassland was interpreted using consistent criteria related to canopy cover, vegetation type, land use, and spatial extent. Interpreters were trained using this legend and applied it uniformly across all sample plots during visual interpretation. The monitored parameters (e.g., $\Delta AF-C$) represent transitions between these defined categories, ensuring traceability and alignment with national MRV protocols.

Table 13 Land Cover Change Parameters and Legend Linkages

Local Legend Category	IPCC AFOLU Category (2006 Guidelines, Vol. 4, Ch. 3)	Example Conversion Parameter
Forest	Forest Land (FL)	$\Delta AF-C = \text{Forest Land} \rightarrow \text{Cropland}$
Cropland	Cropland (CL)	$\Delta AF-C = \text{Forest Land} \rightarrow \text{Cropland}$

Grassland	Grassland (GL)	$\Delta FG-L = \text{Forest Land} \rightarrow \text{Grassland}$
Wetland	Wetlands (WL)	$\Delta FW-L = \text{Forest Land} \rightarrow \text{Wetlands}$
Settlement	Settlements (SL)	$\Delta FS-L = \text{Forest Land} \rightarrow \text{Settlements}$
Other Land	Other Land (OL)	$\Delta FO-L = \text{Forest Land} \rightarrow \text{Other Land}$

We confirm that the parameter $\Delta AF-C$ corresponds to the IPCC-defined land-use conversion category ‘Forest Land converted to Cropland (FL \rightarrow CL)’ as outlined in Volume 4, Chapter 3 of the 2006 IPCC Guidelines. Our legend implementation manual aligns with the six IPCC land-use categories out of which three of them (Forest Land, Cropland and Grassland, **Wetlands, Settlements, Other Land**), are included in this report and the linkage is documented in the table provided to ensure consistency and transparency in reporting.

Table 14: Monitored Data and Parameters

Parameter:	$\Delta AF-C$
Description:	area converted from forest to cropland category during the monitoring period
Subcategory for which the parameter is used:	Forest to Cropland
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across the project area, with each sample plot measuring 0.5 hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images like NICFI Planet, Google Earth, Sentinel, and Landsat from December 2023 to December 2024.
Frequency of monitoring/recording:	One year
Value monitored during this Reporting Period:	5,875.98
Quality Assurance/Quality Control procedures applied:	A centralized data collection team facilitated a common understanding and accurate interpretation of land use and

	<p>forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.</p> <p>The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.</p>
Uncertainty for this parameter:	<p>StdError: 4,332</p> <p>abs 90% CI: 7,126</p> <p>rel 90% CI (in %): 121.2788709</p>
Any comment:	

Parameter:	ΔA_{F-G}
Description:	area converted from forest to grassland category during the monitoring period
Subcategory for which the parameter is used:	Forest to grassland
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across the project area, with each sample plot measuring 0.5 hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images like NICFI Planet, Google Earth, Sentinel, and Landsat from December, 2023 to December, 2024.
Frequency of monitoring/recording:	One year
Value monitored during this Reporting Period:	0

Quality Assurance/Quality Control procedures applied:	A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly. The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.
Uncertainty for this parameter:	<i>N/A (change not observed)</i>
Any comment:	

Parameter:	$\Delta A_{F-shrub}$
Description:	area converted from forest to shrubland category during the monitoring period
Subcategory for which the parameter is used:	Forest to shrubland
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across the project area, with each sample plot measuring 0.5 hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images like NICFI Planet, Google Earth, Sentinel, and Landsat from December 2023 to December 2024.
Frequency of	One year

monitoring/recording:	
Value monitored during this Reporting Period:	0
Quality Assurance/Quality Control procedures applied:	<p>A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.</p> <p>The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.</p>
Uncertainty for this parameter:	<i>N/A (change not observed)</i>
Any comment:	

Parameter:	ΔA_{C-F}
Description:	area converted from cropland to forest category during the monitoring period
Subcategory for which the parameter is used:	Cropland to forest
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across the project area, with each sample plot measuring 0.5 hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images

	like NICFI Planet, Google Earth, Sentinel, and Landsat from December 2023 to December 2024.
Frequency of monitoring/recording:	One year
Value monitored during this Reporting Period:	0
Quality Assurance/Quality Control procedures applied:	<p>A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.</p> <p>The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.</p>
Uncertainty for this parameter:	<i>N/A (change not observed)</i>
Any comment:	

Parameter:	ΔA_{G-F}
Description:	area converted from grassland to forest category during the monitoring period
Subcategory for which the parameter is used:	Grassland to forest
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across the project area, with each sample plot measuring 0.5

	hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images like NICFI Planet, Google Earth, Sentinel, and Landsat from December 2023 to December 2024.
Frequency of monitoring/recording:	One year
Value monitored during this Reporting Period:	0
Quality Assurance/Quality Control procedures applied:	A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly. The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.
Uncertainty for this parameter:	<i>N/A (change not observed)</i>
Any comment:	

Parameter:	$\Delta A_{shrub-F}$
Description:	area converted from shrubland to forest category during the monitoring period
Subcategory for which the parameter is used:	Shrubland to forest
Data unit:	Hectares
Source of data and description of measurement/calculation methods and procedures applied:	Analysis of remote sensing images using stratified random sampling. The data was generated using Collect Earth Online and SEPAL platform to integrate the different satellite imagery. 3741 sample points were analyzed across

	the project area, with each sample plot measuring 0.5 hectares. Sample points were analyzed through visual interpretation of various high-resolution satellite images like NICFI Planet, Google Earth, Sentinel, and Landsat from December 2023 to December 2024.
Frequency of monitoring/recording:	One year
Value monitored during this Reporting Period:	0
Quality Assurance/Quality Control procedures applied:	<p>A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.</p> <p>The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. Consequently, a total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in ORCU. Of these sample points, 458 (92.34%) yielded results consistent with the initial interpretations, while 38 (7.66%) showed discrepancies. The discrepancies were resolved through discussions with all team members.</p>
Uncertainty for this parameter:	<i>N/A (change not observed)</i>
Any comment:	

3 Quantification of emission reductions

3.1 Emissions Baseline for the Reporting Period covered in this report

In the assessed ERPD, the Emissions Baseline was estimated for the period 2008 and 2017. The activity data for this Emissions Baseline was collected using a sample-based data collection approach to analyze changes in land use and land cover. In the assessed ERPD, land use and land use change were assessed using 3,745 samples distributed across Oromia using a 10km grid (see annex 6, section 3.2.1 of the ERPD for details). It was decided to improve this analysis of land use and land use change because of different reasons:

- The land use change matrix produced only covered 29.9 million hectares and not the full area of Oromia
- Definitions of land use classes used (see subsection on land use classes in section 2.2 above)
- In the Benefit Sharing Plan, benefit distribution is based on different indicators including performance against sub-jurisdictional, zonal level baselines. In order to develop credible zonal level baselines, more intensive sampling was required than what was done for the Oromia level baseline. 92,820 samples were analyzed to develop the 21 zonal baselines using a systematic sampling design involving a 2 x 2 km grid for Oromia Regional State. With the information derived from this intensified sampling being available, it was decided this could also be used to also update the Oromia level Emissions Baseline since it would provide a higher quality result than the original 3,745 samples (see Annex 4 for details)

In addition, updated values on biomass of different land use categories in Oromia, was available from Ethiopia's National Forest Inventory. The details of the updated baseline using the improved land use change analysis and the latest emission factors are described in Annex 4 of this report.

For the removal categories the ISFL 'Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period' was applied.

The specific results are detailed in the table provided below. Following the ISFL guidance note for subcategories and carbon pools where changes take place over a longer time period, the changes in SOC are calculated for the whole landscape taking into account land units that represent different changes. Hence SOC is represented in the table as a separate column.

Table 15: Oromia Regional State baseline emissions

Year of reporting period	Baseline emissions (tCO ₂ e)							
	Subcategory 1	Subcategory 2	Subcategory 3	Subcategory 4	Subcategory 5	Subcategory 6	Subcategory 7	Total Emissions Baseline (tCO ₂ e)
	Forest - Cropland	Forest - Grassland	Forest - shrub	Cropland - forest	Grassland - forest	Shrubland - forest	SOC	
2024	7,244,153	1,628,519	931,119	-213,497	-68,048	-159,775	1,300,693	10,663,164
Total emissions during the Reporting Period								10,663,164

3.2 Estimation of emissions by sources and removals by sinks included in the ISFL ER Program’s scope

The emission and removals have been calculated using the equations discussed in section 2. A spreadsheet with the detailed calculations is attached.

Table 16: Oromia Regional state Emissions during monitoring period (2024)

Year of reporting period	Actual Emissions (tCO ₂)							
	Emission							Total Emissions (tCO ₂ e)
	Subcategory 1	Subcategory 2	Subcategory 3	Subcategory 4	Subcategory 5	Subcategory 6	Subcategory 7	
	Forest-Cropland	Forest-Grassland	Forest-Shrubland	Cropland - forest	Grassland - forest	Shrubland - forest	SOC	
2024	1,824,145	0	0	-205,726	-64,877	-168,743	1,066,333	2,451,132

3.3 Calculation of emission reductions

The emission reductions were calculated as the difference between the baseline emissions and the actual emissions during the monitoring period. The emission reductions from removals are calculated as the difference between the expected removals under the Emissions Baseline and the actual removals.

Table 17: Calculation of emission reductions

Actual net GHG emissions from the ISFL ER Program during the Reporting Period (tCO₂-e)	2,451,132
Total net Emissions Baseline during the Reporting Period (tCO₂-e)	10,663,164
Net Emission Reductions during the Reporting Period (tCO₂-e)	8,212,032

	Year	2024
T.2	Actual net GHG emissions from the ISFL ER Program during the Reporting Period (tCO₂-e)	2,451,132
	Total net Emissions Baseline during the Reporting Period (tCO₂-e)	10,663,164
	Net Emission Reductions during the Reporting Period (tCO₂-e)	8,212,032

3.4 Results for Monitoring, Evaluation and Learning (MEL) Framework

The critical contribution of ISFL program activities to emission reductions and sustainable land management across targeted areas provides a framework for ongoing monitoring and improvement, ensuring that forest conservation and restoration efforts achieve long-term environmental and economic benefits.

This monitoring report presents areas under specific subcategories and the corresponding estimation of Emission Reductions (ERs) within the scope of the ISFL MEL Framework considering the designated reporting period and aligns with key metrics provided in the MEL Framework for measuring forest and land use dynamics with the summarized following Key results:

Area of Forest Remaining Forest:

This subcategory corresponds to T2.O1.1 and reflects the extent of forested areas maintained their status within ISFL program boundaries during the reporting period that are critical for sequestering carbon and contributing to sustainable forest management and the result shows 11,795,375 ha of Area of Forest Remaining Forest in the monitoring period (2024)

Area of Conversions from Forest to Other Land Uses: Representing T2.O1.2a,

This subcategory measures the transition of forested areas into other land use categories, which directly affects carbon emissions and underscores the need for strategies to minimize such conversions. Accordingly, the report emphasized on Area of Conversions from Forest to Other Land Uses in the monitoring Period (2024) accounted to **5,876** ha following the intensive interventions conducted through coordinated and collaborated stakeholders engagement and enhanced the degradation and deforestation measures.

Area of Other Land Uses Converted to Forest:

As per T2.O1.2b, this subcategory tracks the regeneration or afforestation efforts where non-forest land restored to forest cover through enhanced carbon sinks and reversing degradation trends. Accordingly, the report examined that no Other Land Uses Converted to Forest during the monitoring period (2024).

Emission Reductions from Forest Remaining Forest:

The emission reduction from forest remaining forest was not included in this Monitoring Report (MR) because the current MR only covers emission reductions from deforestation and removals.

Table 18: Result for Monitoring, Evaluation, Learning framework

Result	Unit	Year (2024)
Area of forest remaining forest in ISFL program areas (corresponding to T2.O1.1 on MEL Framework)	Ha	11,795,375
Area of conversions from forest to other land uses in ISFL program areas (corresponding to T2.O1.2a on MEL Framework)	Ha	5,876
Area of other land uses converted to forest in ISFL program areas (corresponding to T2.O1.2b on MEL Framework)	Ha	0
Emission reductions from forest remaining forest as compared to a reference level in ISFL program areas (corresponding to T2.O1.3 on MEL Framework)	MtCO ₂ e	NA

4 Uncertainty of the estimate of Emission Reductions

4.1 Initial identification and assessment of sources of uncertainty

Uncertainties arise in baseline setting and Measurement, Monitoring and Reporting. Uncertainty (the lack of knowledge of the true value) is due to both random and systematic errors. Uncertainties can be addressed in a number of ways. Systematic errors (bias) should be avoided by good Measurement practices. Random errors tend to cancel each other out and can be managed by sampling.

Some sources of uncertainty linked to sampling protocols (sample size, spatial representativeness of sampled areas, measurement errors) or to the extrapolation from the sample to the entire Oromia region cannot be assessed directly, as this requires specific studies and dedicated experimental designs to compare different protocols with each other. Nevertheless, the uncertainties associated with an unsuitable protocol are expected to be significant. However, we assume that the sampling protocols implemented in this study are robust, allowing a precise description of the variability of the variable under consideration and providing accurate estimates of the population mean and standard deviation from the sample. For the other sources of uncertainty associated with the input variables (Biomass, Activity Data) and parameters (carbon fraction, root/shoot ratio, etc.), the sensitivity analysis will be described in section 4.5.

Table 19: Uncertainties sources and assessment

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
<i>Activity data during the baseline period</i>		
<i>Measurements</i>	<i>All</i>	<p><i>Significant effect</i></p> <p>Measurement error significantly contributes to the overall uncertainty of activity data. Inaccurate readings of time series from Mapbox or Google Earth can lead to incorrect interpretations of land use. Factors such as cloud-covered images or environmental changes during measurements can</p>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		<p>also affect data collection and interpretation, adding to the uncertainty.</p> <p>To minimize these measurement errors, the MRV team has undergone training on how to collect and interpret land-use and land-cover changes. Additionally, the team has utilized an interpretation key specifically prepared for this purpose. They also conducted quality control and quality assurance activities to ensure the accuracy of the data.</p>
<i>Representativeness</i>	<i>All</i>	<p><i>Significant effect</i></p> <p>Representativeness error significantly affects the overall uncertainty of activity data. When data is gathered from a subset that fails to adequately represent the entire population or activity being studied, it can lead to bias or skewed results. Similarly, data collected from specific locations or time periods may not capture the variability present across other areas or times, introducing uncertainty when generalized to broader contexts. Moreover, the exclusion of certain activities or populations during the data collection process can result in underrepresentation, further distorting baseline accuracy.</p> <p>To minimize representativeness error, careful attention has been given to sampling design, data</p>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		<p>collection methods, and efforts to ensure comprehensive coverage of relevant factors.</p> <p>In the 2024 reporting period of the Oromia Forested Landscape Program (OFLP), the application of SOPs ensured consistency and reliability in activity data collection and interpretation. Landsat and Sentinel imagery were systematically acquired and pre-processed, with classifications harmonized against sample plots to minimize errors in forest/non-forest transitions. Land-use categories such as forest, cropland, grassland, and shrubland were defined in accordance with the Ethiopian Interpretation Key guideline, and change detection algorithms were applied for activity data analysis. Field verification teams followed SOP checklists to confirm suspected land-use changes, thereby ensuring accurate attribution of deforestation or restoration. To safeguard data integrity, SOPs mandated double-checking of field measurements and random re-surveys, while remote sensing outputs underwent accuracy assessments before acceptance, ultimately strengthening the credibility and transparency of the activity data collection and interpretation process.</p>
<i>Sampling</i>	<i>All</i>	<i>Significant effect</i>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		<p>Sampling error contributes to the overall uncertainty of activity data by highlighting the discrepancy between the sample data collected and the true population data it aims to represent. If the sample size is too small, it increases the likelihood that the results may not accurately reflect the full population, leading to greater uncertainty. Additionally, if the sampling method introduces bias such as favouring certain groups or conditions—this error becomes embedded in the baseline activity data.</p> <p>To reduce sampling error, careful attention has been given to designing the sampling strategy, ensuring randomness, increasing sample size, and employing statistical techniques to estimate and correct such errors. These measures help improve the reliability of the activity data baseline.</p>
<i>Extrapolation to Oromia region</i>	<i>All</i>	<p><i>Significant effect</i></p> <p>Extrapolating data to represent the area of a region introduces errors that contribute to overall uncertainty by expanding localized or sample data to encompass the entire region. Poorly surveyed areas or those lacking data altogether may cause extrapolation to rely on assumptions, thereby increasing uncertainty. Additionally, extrapolation may fail to account for temporal changes, such as seasonal fluctuations or activity</p>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		<p>trends, leading to inaccurate estimations.</p> <p>To minimize extrapolation errors, the team has designed sampling strategies that ensure adequate coverage of diverse areas, applied statistical methods to estimate uncertainty, and verified data against known regional characteristics.</p>
<i>Activity data during the monitoring period</i>		
<i>Measurements</i>	<i>All</i>	<p>Estimation of area changes is derived from a stratified random sampling approach where the likelihood of change is used to determine the strata.</p> <p>3,741 plots across the Oromia Region were classified into seven land use/land cover (LULC) classes: Forest, Cropland, Grassland, Settlement, Wetland, Shrubland, and Other Land. The assessment of the sample points was done through visual interpretation of available high-resolution images and by interpreting vegetation indices derived from medium and high-resolution images. To ensure the quality of the AD collection, various vegetation indices were used, such as the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Fraction Index (NDFI). Furthermore, historical trends in land use/cover from 2023 to 2024 were assessed and labeled for each change and unchanged land use/cover classes. QA/QC</p>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		<p>procedures are applied to ensure correct and consistent interpretation of sampling but interpretation errors can still occur.</p> <p><i>To minimize measurement errors, the MRV team first had engaged in in-depth consultations with subject-matter experts from federal office on methodologies for collecting and interpreting land-use and land-cover changes. These collaborative exchanges refined the team’s understanding and led to the application of a specifically prepared interpretation key. This systematic approach ensured consistency, reduced ambiguity, and reinforced the credibility of the data collected during this reporting period. Building on this foundation, the team drew upon the structured training and practical expertise acquired during the first reporting period. Their prior knowledge was effectively applied in the current reporting period, enabling them to carry out data collection and interpretation with greater accuracy and confidence. As a result, the uncertainty that was more pronounced in the initial stages was substantially minimized, demonstrating that the combination of expert guidance, previous training, and accumulated experience played a decisive role in strengthening the reliability of outcomes.</i></p>

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
<i>Sampling</i>	<i>All</i>	Very high Estimation of area changes is derived from a stratified random sampling approach where the likelihood of change is used to determine the strata. QA/QC procedures are applied to ensure correct and consistent interpretation of sampling but errors can still occur. Sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in Oromia and Ethiopia. Discrepancies were resolved through discussions with all team members.
<i>Extrapolation to Oromia region</i>	<i>All</i>	High Integrated in the methodology where the results of the interpretation of sample plots is used to extrapolate the results to the total area of the Oromia region
Emission Factor		
<i>Sampling</i>	<i>All</i>	High (but not evaluated in Sensitivity analysis)
<i>Allometric models</i>	<i>All</i>	Allometric equations have been used in the NFI, in particular from Chave, et al. (2014) ¹⁷ and Henry et al (2013) ¹⁸

¹⁷ Chave, J. et al. (2014). "Improved allometric models to estimate the aboveground biomass of tropical trees". In: Global Change Biology, pp. 3177–3190. ISSN: 13541013. DOI: 10.1111/gcb.12629.

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		Contribution is high (but not evaluated in Sensitivity analysis)
<i>Above ground biomass (ABG)</i>	<i>All</i>	Derived from Oromia specific values in the NFI. Variance. CI and SE provided in table A9.7 of the NFI report (MEFCC, 2018) Contribution very high (The most important factor in uncertainty based on Sensitivity analysis 4.5)
<i>Below ground biomass (BBG)</i>	<i>All</i>	Very high. Calculated from ABG using ratio below
<i>Sampling of ABG</i>	<i>All</i>	Sampling was applied to estimate ABG. The Variance. CI and SE provided for AGB incorporates the sampling approach
<i>BBG to ABG ratio (rBG_AB)</i>	<i>All</i>	Low The data of BBG provided correspond to slightly different rBG_AB coefficients for the four biomes considered (Acacia Commiphora Combretum-Terminalia Dry Afromontane Moist Afromontane). However, the standard deviations of these coefficients are not provided. These were estimated from the review by Mokany et al. 2006 (Table 6)
<i>Carbon fraction</i>	<i>All</i>	Low. Not measured but sourced from literature. The value used is 0.5 which corresponds to default value of CF in IPCC 2006: 2006 IPCC

¹⁸ Henry, M. et al. (2013). "GlobAllomeTree: international platform for tree allometric equations to support volume, biomass and carbon assessment". iForest - Biogeosciences and Forestry 6.5, pp. 326– 330.

Sources of uncertainty	Parameters and applicable subcategories affected by these sources of uncertainty	Analysis of contribution to overall uncertainty
		Guidelines for National Greenhouse Gas Inventories. The standard deviation required to estimate uncertainty on this parameter is not provided. The review by Martin et al. 2018 was used to estimate the standard deviation of carbon fraction (Table 1).
<i>Extrapolation of EF</i>	<i>All</i>	Very high EF is determined from above-ground biomass measurements in the four biomes. Extrapolation to all Oromia forests was carried out by weighting the emission factor determined per biome by the relative surface area of the biome. The relative surface area is considered without error.
Carbon removal factor		
<i>Carbon removal factor</i>	<i>All</i>	Very high The carbon removal factor is calculated by dividing the emission factor (EF) by 20. The uncertainty on this factor is therefore the same as that calculated for EF

4.2 Selection of methods and development of Standard Operating Procedures and Quality Assurance/Quality Control procedures

Activity data

Process Overview:

- Sample Generation: A total of 3,741 sample points were generated using keyman allocation.

- **Training and Awareness:** Comprehensive training sessions were conducted on the LULC nature, particularly the ‘Ethiopian LULC interpretation key’. These sessions also covered potential errors in image interpretation during activity data collection.
- **Data Distribution:** The generated sample points were equally distributed among seven interpreters.

Data Collection and Interpretation:

- **Platform Utilized:** The Collect Earth Online (CEO) platform was employed for data collection and real-time quality assurance, supported by two experts overseeing the process.
- **Satellite Integration:** High-resolution satellite images from sources such as Planet, Sentinel, Google Earth, Landsat, and NDVI values were integrated into the CEO platform, enhancing the confidence of data collectors.
- **Quality Control:** A centralized data collection team facilitated a common understanding and accurate interpretation of land use and forest area changes. Peer-to-peer support and group discussions on challenging issues were held regularly.
- **Independent Assessment:** The quality control team conducted cross-checking activities using multiple data sources and local knowledge. This team, comprising two specialists from ORCU MRV, oversaw the entire data collection process to ensure data quality. A total of 496 sample points were randomly selected for Quality Control/Quality Assurance (QC/QA). These points were reinterpreted by two experts with extensive knowledge of LULC changes in Oromia and Ethiopia. Of these sample points, 458 (92.33%) yielded results consistent with the initial interpretations, while 39 (7.67%) showed discrepancies. The discrepancies were resolved through discussions with all team members.

Standard Operating Procedures (SOPs):

- **Guidelines:** Detailed SOPs (https://drive.google.com/drive/folders/172JbZbmNefkxQqUQNkrMnfpB1crE3SJT?usp=drive_link) were followed to maintain consistency in data collection and interpretation.
- **Assessment Interpretation:** All interpreters adhered to the same guidelines, and training was provided on Ethiopian LULC interpretation to ensure uniformity.
- **Independent Assessment Percentage:** Regular independent assessments were conducted to verify the accuracy of the collected data.

By following these procedures and leveraging advanced tools, the team ensured high-quality, reliable data for the LULC change detection.

Emission factors

As discussed above, the emission factors are estimated using values from the national forest inventory.

Section 2.2 of the NFI report (MEFCC, 2018) outlines the data collection approach used in the NFI while section 2.3 of the same report outlines the Quality Assessment / Quality Control procedures. A series of best practices on the importance of data collection (including double measurement) were compiled and explained to the experts in the field in order to increase the accuracy of the measurements. Three critical tree attributes subject to errors were identified: DBH, height and scientific names.

Based on this, specific training material was prepared by EFD (former Ministry of Environment, Forest, and Climate Change) and training was provided for the national forest inventory team in order to improve the correct identification of the forest land use/cover type, by following the definition of forest and by taking into account canopy cover estimates, number of trees per hectare, and other relevant site type indicators. In addition to this, based on a random sub-sampling, 10% of the SUs were re-measured by a semi-independent team (composed of MEFCC experts not involved in the field campaign and specifically trained for QA/QC). At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. An independent botanist was assigned to evaluate, correct and improve upon the tree names assigned by the teams during the field data collection. The data entered into the database was submitted for cleansing procedures in order to filter all the records considered potentially erroneous. Several indicators have been used to identify possibly erroneous values which fall out of the expected range of results (as ratios between DBH - Height, Diameter at 30cm - DBH, DBH – Branches diameter).

4.3 Residual uncertainty of Activity Data and Emission Factors

After applying the SOPs as described in 4.2 above, Monte Carlo error propagation for estimating uncertainty in emissions reduction was used for activity data and emission factors using the uncertainties identified in section 2.3 as the basis. The Monte Carlo simulations were done in Excel using the SimVoi Add-in¹⁹. for all the Activity data and each of the parameters that together make up the Emission Factors. The table in section 4.4.1 below lists all the parameters used in the MC simulation and there residual uncertainties.

The number of simulations for the Monte Carlo was 10,0000. The simulations for activity data and emission factors were undertaken using normal cumulative distribution, at the specified probability, mean, and standard deviation (SD). Where applicable, the Standard Error (SE) was back-calculated as $SE = \text{mean} * \text{uncertainty}(90\% \text{ CI}) / 100 / 1.96$.

4.4 Uncertainty of the estimate of Emission Reductions

4.4.1 Parameters and assumptions used in the Monte Carlo method

The general methodology for calculating uncertainty is based on the Monte Carlo (MC) method. The following table provides details on the parameters and assumptions used in the MCMC.

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
Carbon fraction - Forest	0.47	0.025	0.041	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.3 .Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 4, table 4.3 for tropical and subtropical (0.44-0.49)
Carbon fraction - Woody biomass	0.50	0.025	0.041	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.3 .Uncertainty: half of

¹⁹ <https://treeplan.com/simvoi/>

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
						the range provided in 2006 IPCC guidelines, vol4, chapter 4, table 4.3 for tropical and subtropical (0.44-0.49)
Carbon fraction - Herbaceous biomass	0.47	0.025	0.041	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.3 .Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 4, table 4.3 for tropical and subtropical (0.44-0.49)
Root-shoot ratios- Tropical mountain system	0.24	0.036	0.059	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical moist deciduous.Applicati on: Applicable to Moist Afromontane forest.Uncertainty: SE for Tropical/subtropical moist forest in Mokany, Raison, and Prokushkin, 2006. Critical analysis of root :

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
						shoot ratios in terrestrial biomes. Global Change Biology (2006) 12, 84–96
Root-shoot ratios-Tropical Dry forest	0.28	0.003	0.005	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical dry.Application: Applicable to Dry Afromontane forest, Combretum-Terminalia, Acacia-Commiphora.Uncertainty: Mokany, Raison, and Prokushkin, 2006. Critical analysis of root : shoot ratios in terrestrial biomes. Global Change Biology (2006) 12, 84–96
Root-shoot ratios-Tropical shrubland	0.40	0.589	0.969	Measurement errors and model errors	Normal	Value: 2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland.Applicati on: Applicable to other wooded land.Uncertainty: SE for Tropical

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
						shrubland in Mokany, Raison, and Prokushkin, 2006. Critical analysis of root : shoot ratios in terrestrial biomes. Global Change Biology (2006) 12, 84–96
Above ground biomass in Acacia-Commiphora Forest	80.30	44.900	73.861	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Acacia-Commiphora Other wooded land	9.30	1.900	3.126	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Combretum-Terminalia Forest	46.80	10.400	17.108	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Combretum-Terminalia Other wooded land	25.00	4.300	7.074	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Dry Afromontane	69.40	29.100	47.870	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
Forest						
Above ground biomass in Dry Afromontane Other wooded land	9.00	3.500	5.758	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Moist Afromontane Forest	217.40	29.900	49.186	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Moist Afromontane Other wooded land	17.80	2.400	3.948	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Natural grassland	7.50	2.965	4.877	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Coffee plantation	214.90	2.965	4.877	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Annual crop	11.30	2.965	4.877	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground biomass in Perennial crop	102.70	2.965	4.877	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
Above ground	37.70	2.965	4.877	Overall variance	Normal	Uncertainties

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
biomass in Mixed annual and perennial crops				including sampling and measurement errors		ag_biomass (NFI report table A9.7)
Above ground biomass in Fallow	8.50	2.965	4.877	Overall variance including sampling and measurement errors	Normal	Uncertainties ag_biomass (NFI report table A9.7)
NFI area Natural grassland	7,464,741.00	298,589.64	491,179.96	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major LUCC, and LUCC)-Uncertainties area (table A2.2
NFI area Coffee plantation	1,073,035.00	72,966.38	120,029.70	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major LUCC, and LUCC)-Uncertainties area (table A2.2
NFI area Annual crop	28,283,110.00	876,776.41	1,442,297.19	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major LUCC, and LUCC)-Uncertainties area (table A2.2
NFI area Perennial crop	1,149,832.00	150,627.99	247,783.05	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major LUCC, and LUCC)-Uncertainties area (table A2.2
NFI area Mixed annual and perennial crops	393,913.00	19,301.74	31,751.36	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
						LUCC, and LUCC)- Uncertainties area (table A2.2
NFI area Fallow	2,075,917.00	91,340.35	150,254.87	Overall variance including sampling and measurement errors	Normal	NFI report Table A2.2 Area estimates by FRA, Major LUCC, and LUCC)- Uncertainties area (table A2.2
Biomass in Dead wood of Natural regenerated forest	15.80	1.000	1.645	Overall variance including sampling and measurement errors	Normal	NFI report table 3-24. Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 2, table 2.2 for tropical broadleaf deciduous (1-3)
Biomass in Dead wood of Plantation	0.50	1.000	1.645	Overall variance including sampling and measurement errors	Normal	NFI report table 3-24. Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 2, table 2.2 for tropical broadleaf deciduous (1-3)
Biomass in Dead wood of Other wooded land	1.90	1.000	1.645	Overall variance including sampling and measurement errors	Normal	NFI report table 3-24. Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 2, table 2.2 for tropical broadleaf deciduous

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
						(1-3)
Biomass in Dead wood of Cultivated land	2.60	1.000	1.645	Overall variance including sampling and measurement errors	Normal	NFI report table 3-24. Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 2, table 2.2 for tropical broadleaf deciduous (1-3)
Biomass in Dead wood of Natural	0.90	1.000	1.645	Overall variance including sampling and measurement errors	Normal	NFI report table 3-24. Uncertainty: half of the range provided in 2006 IPCC guidelines, vol4, chapter 2, table 2.2 for tropical broadleaf deciduous (1-3)
SOC-average forest	51.96	3.392	5.581	Overall variance including sampling and measurement errors	Normal	Value and Uncertainty: Evaluation of the forest carbon content in soil and litter in Ethiopia, Implementing agency: Natural Resources Institute Finland (LUKE) and Ethiopia Environment and Forestry Research Institute (EEFRI)
FLU (stock change factor for land use	0.48		0.221	Overall variance including sampling and	Normal	Value and Uncertainty: 2006

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
system cropland)				measurement errors		IPCCC guidelines, vol4, chapter 5, table 5.5 (lang term cultivated - tropical - moist/wet
FI (stock change factor for input of organic matter – cropland)	0.92		0.129	Model errors	Normal	Value and Uncertainty: 2006 IPCC guidelines, vol4, chapter 5, table 5.5 (input low - tropical - moist/wet
FLU (stock change factor for land use system - Grassland-	1.00		0.460	Model errors	Normal	Value and Uncertainty: 2006 IPCC guidelines, vol4, chapter 5, table 5.5 (lang term cultivated - tropical - moist/wet
stock change factor for input of organic matter – - Grassland-	1.00		0.140	Model errors	Normal	Value and Uncertainty: 2006 IPCC guidelines, vol4, chapter 5, table 5.5 (input low - tropical - moist/wet
LULC BSL- Cropland- Cropland	10,604,906		104,634	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Cropland-Forest land	48,457		8,628	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
LULC BSL-Cropland-Grassland	20,024		5,549	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Cropland-Other land	801		1,110	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Cropland-Settlement	79,294		11,031	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Cropland-Shrub land	15,218		4,837	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Cropland-Wetland	3,204		2,220	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest land-Cropland	234,677		18,932	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest land-Forest land	8,605,749		98,516	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest land-Grassland	48,858		8,663	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest land-Other land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest land-Settlement	10,412		4,002	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Forest	29,234		6,703	Overall variance	Normal	Calculated during

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
land-Shrub land				including sampling and measurement errors		LULUC analysis
LULC BSL-Forest land-Wetland	1,201		1,360	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Cropland	103,322		12,588	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Forest land	14,017		4,643	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Grassland	5,491,276		83,721	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Other land	1,201		1,360	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Settlement	15,218		4,837	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Shrub land	25,230		6,228	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Grassland-Wetland	801		1,110	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other land-Cropland	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other	400		785	Overall variance	Normal	Calculated during

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
land-Forest land				including sampling and measurement errors		LULUC analysis
LULC BSL-Other land-Grassland	0		0	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other land-Other land	91,708		11,861	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other land-Settlement	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other land-Shrub land	1,201		1,360	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Other land-Wetland	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-Cropland	6,808		3,236	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-Forest land	801		1,110	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-Grassland	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-Other land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-	730,862		33,150	Overall variance including sampling and	Normal	Calculated during LULUC analysis

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
Settlement				measurement errors		
LULC BSL-Settlement-Shrub land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Settlement-Wetland	8,009		3,510	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Cropland	131,355		14,187	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Forest land	34,841		7,317	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Grassland	34,040		7,233	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Other land	1,201		1,360	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Settlements	6,808		3,236	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Shrub land	4,957,446		80,337	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Shrub land-Wetland	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL-Wetland-Cropland	4,005		2,482	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
LULC BSL- Wetland-Forest land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Wetland- Grassland	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Wetland-Other land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Wetland- Settlement	2,002		1,755	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Wetland-Shrub land	400		785	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC BSL- Wetland-Wetland	868,624		36,060	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024- Grassland- Grassland	4,870,256		311,740	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024- Shrub land-Shrub land	2,055,505		210,777	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024- Cropland- Cropland	12,613,865		393,164	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024- Wetland-Wetland	547,974		126,503	Overall variance including sampling and	Normal	Calculated during LULUC analysis

Parameter included in the model	Parameter values			Error sources quantified in the model (e.g. measurement error, model error, etc.)	Probability distribution function	Source of assumptions made
	Value	SE	CI			
				measurement errors		
LULC RP 2024-Other land-Other land	78,586		47,057	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Forest land-Forest land	11,795,375		388,778	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Settlement-Settlement	278,436		82,740	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Shrub land-Grassland	8,531		12,700	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Shrub land-Cropland	9,339		14,022	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Cropland-Grassland	17,650		20,546	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Grassland-Cropland	15,346		17,831	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Grassland-Shrub land	4,160		6,843	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis
LULC RP 2024-Forest land-Cropland	5,876	0.025	7,126	Overall variance including sampling and measurement errors	Normal	Calculated during LULUC analysis

4.4.2 Quantification of the uncertainty of the estimate of Emission Reductions

The below tables quantifies the relative margin of error of the estimate of Emission Reductions at the two-tailed 90% confidence level

		Forest to cropland		Forest to grassland		Forest to shrubland		
		AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	SOC Forest to cropland, grassland and shrubland (tCO ₂ e)
A	Median	4,626,256	109,493	1,593,324	37,591	907,279	21,305	204,851
B	Upper bound 90% CI (Percentile 0.95)	8,349,076	158,018	2,482,996	53,357	1,503,484	32,336	3,332,795
C	Lower bound 90% CI (Percentile 0.05)	1,327,477	62,369	919,613	24,364	462,733	12,181	-2,669,661
D	Half Width Confidence Interval at 90% (B – C / 2)	3,510,799	47,825	781,692	14,496	520,375	10,078	3,001,228
E	Relative margin of error (D / A)	76%	44%	49%	39%	57%	47%	1465%

		Cropland to forest		Grassland to forest		Shrubland to forest		
		AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	AGB/BGB (tCO ₂ e)	Dead wood (tCO ₂ e)	SOC cropland, grassland and shrubland to forest (tCO ₂ e)
A	Median	-7,850	28	-2,779	0	8,455	-15	-2,300

B	Upper bound 90% CI (Percentile 0.95)	57,038	1,882	35,269	672	69,644	1,102	22,523
C	Lower bound 90% CI (Percentile 0.05)	-76,860	-1,498	-43,011	-630	-49,470	-1,403	-30,060
D	Half Width Confidence Interval at 90% (B – C / 2)	66,949	1,690	39,140	651	59,557	1,253	26,291
E	Relative margin of error (D / A)	-853%	6131%	-1408%	183167%	704%	-8183%	-1143%

F	Aggregate uncertainty of emission reductions	75 %
G	Uncertainty set-aside factor	12 %

4.5 Sensitivity analysis

A sensitivity analysis was performed using the Sensit add-in which is part of the SimVio package. A single-factor sensitivity analysis was performed to evaluate how a specific, single input variable impacts the ER calculations while holding all other variables constant.

The values used in the sensitivity analysis for the different variables is shown in the table below.

Table 20: Values used in the sensitivity analysis for the different parameters

Type	Parameter	Base case	OneExtreme (Lower Limit)	OtherExtreme (Upper Limit)
Defaults	Carbon fraction -Forest	0.47	0.43	0.51
	Carbon fraction -Woody biomass	0.5	0.46	0.54
	Carbon fraction -Herbaceous biomass	0.47	0.43	0.51
	Root-shoot ratios-Tropical mountain system	0.24	0.18	0.30
	Root-shoot ratios-Tropical Dry forest	0.28	0.28	0.28
	Root-shoot ratios-Tropical shrubland	0.4	-0.57	1.37
Biomass in Forest and other woodland	Acacia-Commiphora- Forest	80.3	6.44	154.16
	Acacia-Commiphora - Other wooded land	9.3	6.17	12.43
	Combretum-Terminalia - Forest	46.8	29.69	63.91
	Combretum-Terminalia - Other wooded land	25	17.93	32.07
	Dry Afromontane - Forest	69.4	21.53	117.27
	Dry Afromontane - Other wooded land	9	3.24	14.76
	Moist Afromontane - Forest	217.4	168.21	266.59
	Moist Afromontane - Other wooded land	17.8	13.85	21.75
Biomass in cropland and grassland	Natural forest coffee	699.3	694.42	704.18
	Barren land	0.2	-4.68	5.08
	Natural grassland	7.5	2.62	12.38
	Marsh	4.8	-0.08	9.68
	Coffee plantation	214.9	210.02	219.78
	Improved pastures	0	0.00	0.00
	Annual crop	11.3	6.42	16.18
	Perennial crop	102.7	97.82	107.58
	Mixed annual and perennial crops	37.7	32.82	42.58
	Fallow	8.5	3.62	13.38
	Wood lot and bamboo	11.7	6.82	16.58
	wood lot	41.3	36.42	46.18
	Build up area	21.9	17.02	26.78
Quarry / mining site	9.3	4.42	14.18	

NFI determined area of cropland and grassland	Natural forest coffee	118106	72254.89	163957.11
	Barren land	8716538	7870554.40	9562521.60
	Natural grassland	7464741	6973561.04	7955920.96
	Marsh	87127	81250.72	93003.28
	Coffee plantation	1073035	953005.30	1193064.70
	Improved pastures	0	0.00	0.00
	Annual crop	28283110	26840812.81	29725407.19
	Perennial crop	1149832	902048.95	1397615.05
	Mixed annual and perennial crops	393913	362161.64	425664.36
	Fallow	2075917	1925662.13	2226171.87
	Wood lot and bamboo	43620	40749.80	46490.20
	wood lot	92824	86716.18	98931.82
	Build up area	1193418	1079553.99	1307282.01
	Quarry / mining site	11711	2598.85	20823.15
	Dead wood Biomass	Natural regenerated forest	15.8	14.16
Plantation		0.5	-1.15	2.15
Other wooded land		1.9	0.26	3.55
Cultivated		2.6	0.96	4.25
Natural		0.9	-0.75	2.55
SOC	Average for forest	51.9608	46.38	57.54
	Annual cropland-FLU	0.48	0.26	0.70
	Annual cropland-FI	0.92	0.79	1.05
	Grassland-FLU	1	0.54	1.46
	Grassland-FI	1	0.86	1.14
BSL Transition Matrix	LULC BSL-Cropland-Cropland	10604906	10500272.00	10709540.00
	LULC BSL-Cropland-Forest land	48457	39829.00	57085.00
	LULC BSL-Cropland-Grassland	20024	14475.00	25573.00
	LULC BSL-Cropland-Other land	801	-309.00	1911.00
	LULC BSL-Cropland-Settlement	79294	68263.00	90325.00
	LULC BSL-Cropland-Shrub land	15218	10381.00	20055.00
	LULC BSL-Cropland-Wetland	3204	984.00	5424.00
	LULC BSL-Forest land-Cropland	234677	215745.00	253609.00
	LULC BSL-Forest land-Forest land	8605749	8507233.00	8704265.00
	LULC BSL-Forest land-Grassland	48858	40195.00	57521.00
	LULC BSL-Forest land-Other land	400	-385.00	1185.00
	LULC BSL-Forest land-Settlement	10412	6410.00	14414.00
	LULC BSL-Forest land-Shrub land	29234	22531.00	35937.00
	LULC BSL-Forest land-Wetland	1201	-159.00	2561.00
	LULC BSL-Grassland-Cropland	103322	90734.00	115910.00
LULC BSL-Grassland-Forest land	14017	9374.00	18660.00	

LULC BSL-Grassland-Grassland	5491276	5407555.00	5574997.00
LULC BSL-Grassland-Other land	1201	-159.00	2561.00
LULC BSL-Grassland-Settlement	15218	10381.00	20055.00
LULC BSL-Grassland-Shrub land	25230	19002.00	31458.00
LULC BSL-Grassland-Wetland	801	-309.00	1911.00
LULC BSL-Other land-Cropland	400	-385.00	1185.00
LULC BSL-Other land-Forest land	400	-385.00	1185.00
LULC BSL-Other land-Grassland	0	0.00	0.00
LULC BSL-Other land-Other land	91708	79847.00	103569.00
LULC BSL-Other land-Settlement	400	-385.00	1185.00
LULC BSL-Other land-Shrub land	1201	-159.00	2561.00
LULC BSL-Other land-Wetland	400	-385.00	1185.00
LULC BSL-Settlement-Cropland	6808	3572.00	10044.00
LULC BSL-Settlement-Forest land	801	-309.00	1911.00
LULC BSL-Settlement-Grassland	400	-385.00	1185.00
LULC BSL-Settlement-Other land	400	-385.00	1185.00
LULC BSL-Settlement-Settlement	730862	697712.00	764012.00
LULC BSL-Settlement-Shrub land	400	-385.00	1185.00
LULC BSL-Settlement-Wetland	8009	4499.00	11519.00
LULC BSL-Shrub land-Cropland	131355	117168.00	145542.00
LULC BSL-Shrub land-Forest land	34841	27524.00	42158.00
LULC BSL-Shrub land-Grassland	34040	26807.00	41273.00
LULC BSL-Shrub land-Other land	1201	-159.00	2561.00
LULC BSL-Shrub land-Settlements	6808	3572.00	10044.00
LULC BSL-Shrub land-Shrub land	4957446	4877109.00	5037783.00
LULC BSL-Shrub land-Wetland	400	-385.00	1185.00
LULC BSL-Wetland-Cropland	4005	1523.00	6487.00
LULC BSL-Wetland-Forest land	400	-385.00	1185.00
LULC BSL-Wetland-Grassland	400	-385.00	1185.00
LULC BSL-Wetland-Other land	400	-385.00	1185.00
LULC BSL-Wetland-Settlement	2002	247.00	3757.00
LULC BSL-Wetland-Shrub land	400	-385.00	1185.00
LULC BSL-Wetland-Wetland	868624	832564.00	904684.00
LULC RP 2024-Grassland-Grassland	4870255.76	4558515.70	5181995.82
LULC RP 2024-Shrub land-Shrub land	2055504.834	1844728.00	2266281.66
LULC RP 2024-Cropland-Cropland	12613865.09	12220700.73	13007029.44
LULC RP 2024-Wetland-Wetland	547973.9502	421471.15	674476.75
LULC RP 2024-Other land-Other land	78585.84065	31528.76	125642.93
LULC RP 2024-Forest land-Forest land	11795375.33	11406596.97	12184153.69
LULC RP 2024-Settlement-Settlement	278436.3591	195696.45	361176.27

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LULC RP 2024-Shrub land-Grassland	8530.737523	-4169.64	21231.11
LULC RP 2024-Shrub land-Cropland	9338.654036	-4683.29	23360.60
LULC RP 2024-Cropland-Grassland	17650.11347	-2895.96	38196.19
LULC RP 2024-Grassland-Cropland	15345.54911	-2485.49	33176.59
LULC RP 2024-Grassland-Shrub land	4160.055148	-2683.24	11003.35
LULC RP 2024-Forest land-Cropland	5875.981085	-1250.34	13002.30

The table below shows the outcomes of the sensitivity analysis. For each input variable, the impact of using the extreme values from the table above is shown, both in terms of the resulting absolute ERs and as a percentage of the range on the assumed base ERs. The table only shows the parameters for which the percentage is more than 0.1%. For all other parameters, varying the value of the parameter results in an impact on the calculated ERs of less than 0.1% on the base value.

Table 21: Values used in the sensitivity analysis for the different variables

Input Variable	Lowest ERs using extremes	Base case ERS	Highest ERs using extremes	Percentage of range against the base case ERs
Baseline land use change area Forestland-Cropland	6,011,162	8,237,090	10,463,017	35.9%
Monitored land use change area for Forestland-Cropland	6,033,874	8,237,090	10,440,306	35.2%
Biomass of Moist Afromontane Forest	6,652,610	8,237,090	9,821,569	18.2%
Carbon fraction -Forest	7,515,377	8,237,090	8,958,803	3.8%
Biomass of Acacia-Commiphora Forest	7,592,792	8,237,090	8,881,387	3.0%
Biomass of Dry Afromontane Forest	7,763,636	8,237,090	8,710,544	1.6%
Root-shoot ratios-Tropical mountain system	7,902,621	8,237,090	8,571,559	0.8%
Baseline land use change area Forest land-Grassland	7,907,980	8,237,090	8,566,199	0.8%
Baseline land use change area Forest land-Shrub land	8,023,599	8,237,090	8,450,580	0.3%
Biomass of Annual crop	8,110,471	8,237,090	8,363,708	0.1%
Annual cropland-FLU	8,144,224	8,237,090	8,329,955	0.1%

The parameters with the highest impact are the area changes, especially for the forestland to cropland transition, and the biomass values for the forest. Continued efforts will be made to reduce the uncertainty of the area changes as much as possible in the sample-based area estimates. Uncertainties in the values of the biomass for the different forest types might be further reduced pending on the outcomes of the ongoing NFI.

5 ISFL ER Program Transactions

5.1 Ability to transfer title to ERs

Ethiopia follows the federal governance system where power is devolved to the federated regional states. The federal constitution (1995) gives regional states the power to raise revenues, plan and implement their own development activities including natural resources management in their respective regional states within the federal policies and constitutional framework. Article 40 of the Constitution of the Federal Democratic Republic of Ethiopia proclaims that land and natural resources in the jurisdiction is the property of the State and the peoples of Ethiopia. Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means. The Federal Democratic Republic of Ethiopia Rural Land Administration and Use Proclamation 456/2005 allow certification of rural land to the holders in order to ensure rural land holding security and sustainable land management

The constitution of the FDR of Ethiopia guarantees Ethiopian farmers' and pastoralists have the right of gaining land free of any payment and not to be deposed from their lands. For instance, the Federal Forest Proclamation No (1065/2018) recognizes four types of forest Ownership as: Private Forest, Community Forest, Association Forest and State Forest. To facilitate the full application of proclamation and enforcement, the Council of Ministers issued the Forest Development, Protection and Utilization Regulation No 544/2024 in 2024. The regulation recognizes ownership of carbon assets (ER ownership) belongs to those legal bodies who invested their time, knowledge and resources for the development, protection and management of a given forest land. These legal bodies can be private developers (small and large), communities, associations, cooperatives and institutional developers (including religious institutions and NGOs). The regulation also enacts that, those legal bodies who are owners of carbon assets have the right to transfer the ownership titles to third parties through transaction/sell or other means.

1. In tandem with the Forest Proclamation and Forest Regulation discussed above, the EFD has also prepared a draft Forest Carbon Credit Trading Directive as guiding instrument to help implement the above legislations, among others, to provide more clarity to carbon asset (ER) ownership and the ability to transfer this asset to third party backed by appropriate legal framework(s). The directive is being finalized and will be ready for approval by the Minister of Ministry of Agriculture possibly before the end of June 2025. Similar to the Forest Regulation above, the Forest Carbon Credit Directive recognizes the existence by law of four types of forest ownership in the country: Private, community, association and state forest, and asserts, forest owners described above have ownership right on carbon (ER) asset generated within their forest jurisdiction, are legally permitted to transfer that right to a third party. The directive describes in detail arrangements on how to trade credits generated at project, subnational jurisdiction and national levels. The Scope and implementation modality of Forest Carbon Credit Directive are as follows:

1. The forest carbon credit trading initiatives may be implemented at the project or jurisdictional level.
2. Legal capacity to transact forest carbon credits for jurisdictional level
 - a. The Jurisdictional level are led by the Ethiopian Forestry Development /EFD/ in coordination with the regional government organizations authorized by regional law to develop, conserve and utilize regional forest resources.
 - b. For Jurisdictional initiatives, the emission reductions are generated based on a collective effort that is not attributable to specific actions or locations.
 - c. Forest owners and forest users are entitled to receive benefits from the sale of the forest carbon credits generated at the jurisdiction level. Such benefits will be determined and shared in accordance with BSP.
 - d. As part of its mandate described in Article 4 (4), 4 (20), and 4 (30) of the Forest Regulation 505/2022 to Determine the Power, Duties and Organization of the Ethiopian Forestry Development, and in order to generate the carbon benefits to which the forest owners and forest users are entitled, EFD may transact the forest carbon credits generated at jurisdictional level on behalf of the owners of the

forest carbon credit, and transfer ownership and title rights to such forest carbon credits on behalf of forest owners collectively.

- e. The benefits from the sale of forest carbon credit shall be shared in accordance with BSP, with full acknowledgement and respect to vulnerable groups and communities' rights.
- f. A forest carbon credit trading project initiative may be permitted within the jurisdictional initiative under specific arrangements, provided that the forest carbon credit owners notify the EFD and other relevant authorities in writing during the design phase and prior to the registration of the jurisdictional forest carbon credit trading initiative.
- g. When a forest carbon credit project is permitted within the Jurisdictional initiative under specific arrangements,
 - i. the owner of the forest carbon credit can retain the right to transfer ownership of the forest carbon credit.
 - ii. the baseline data of the project shall be aligned with the baseline data of the Jurisdictional initiative.
 - iii. the benefit from such transfer can be attributed to the owner of the forest carbon credit of such specific area.

Provisions of the Directive clarifying the right to transfer of ER titles as described above shall be confirmed by a Legal Opinion, which will be submitted by the Proponent (Program Entity) on or before end date indicated above..

The Program Stakeholders has also signed MoU with relevant regional and federal level institutions and entities as part of fulfillment of Schedule 1, condition for effectiveness (disbursement) of ERPA Phase Agreement and the Schedule 6 of ERPA Framework Agreement. The MoU was meant to aid the program manages risks that emerge in the process through reducing transactional costs and maximizing the likelihoods of effectiveness. It also provides elaborated details of corresponding rights and responsibilities as well as the obligation of parties in implementing the ER project throughout the ERPA period. This will enhance accountability among the parties and help to manage any unforeseen risks. The MoU is subject to review and amendment as needed, including during transition from 1st ERPA phase to 2nd ERPA. Furthermore, the Ministry of Planning and Development (MoPD) which the DNA for Article 6

under the Paris Agreement, is developing a comprehensive National Carbon Credit Marketing Strategy and Legislation applicable to all CRGE sector including AFOLU.

5.2 Participation under other greenhouse gas (GHG) initiatives

The OFLP ERPA has established that the 2nd ERMR of the first ERPA phase (Jan 2024 -Dec 2024) accounts ERs generated due to measures taken for avoided deforestation and new forest developments through afforestation, reforestation and ANR programs (removals).

During this RP (2024) of 1st ERPA, no known part of the ISFL ER Program, or any known part of the ISFL ER Program Accounting Area, has transferred, or is planning to transfer, any ERs to, or received or is planning to receive payment for ERs generated as a result of **avoided deforestation** from any other GHG mitigation initiative. In addition, no known parts of the ISFL ER Program Accounting Area have registered or are seeking registration under project or program level standards such as the Clean Development Mechanism (CDM), the Verified Carbon Standard (VCS), the Green Climate Fund (GCF) or others for ERs generated due to **avoided deforestation**. However, in table 38 below, a few small and micro scale ER projects are identified that are seeking registration or registered (certified) under VERRA and Gold Standards; most of these being energy efficient cook stove projects and only one as A/R project (this last one is at development stage – no credit issued yet), all operating in Oromia. Some of the cook stoves projects have already issued CERs/VERs and some of these credits are already retired, and some are transiting from CDM to VERRA or GS registration. Cook stove use is expected to alleviate the main driver of forest degradation, which is excessive use of fuel wood as main source of energy for cooking. Since forest degradation is not part of the scope of this ERPA phase, there is no double counting between the registered cookstove projects and the emission reductions reported in this monitoring report.

As indicated above, cookstoves affect the emissions from forest degradation (forest remaining forest). Since this subcategory is not included in the accounting scope for this MR, there is no double counting. In addition to this, double counting in the Oromia Forested Landscape Program (OFLP-ERP) is avoided through a combination of exclusive registration, legal safeguards, and robust monitoring systems. All emission reductions (ERs) generated under OFLP-ERP is registered solely with the Bio Carbon Fund Initiative for Sustainable Forest Landscapes (ISFL),

ensuring they are not claimed under other carbon market mechanisms. Legal ownership and transfer rights are clearly defined, with the Ethiopian government through Oromia regional authorities being the sole entity authorized to negotiate and sign Emission Reduction Purchase Agreements (ERPAs). A structured Monitoring, Reporting, and Verification (MRV) system, aligned with international standards, tracks ERs both geographically and temporally to ensure reductions are accounted for only once. The program's Benefit Sharing Plan (BSP) further reinforces transparency by outlining how ER payments are distributed across zones, woredas, and communities using performance-based criteria and legal safeguards. Participation in other greenhouse gas initiatives is explicitly restricted to prevent overlapping claims, a provision documented in the ER Program design and validated through periodic assessments.

The only known ER program in Oromia that generated ERs (VERs) both through avoided deforestation and forest development (removals) is the Bale Eco-region REDD+ Project which is registered under the VERRA Standards (ID # 1340). The Bale REDD ER Project is developed by the Oromia Government (OFWE supported by Farm Africa) and has been generating ERs since 2012 -the last accounting period being from 2019 -2021 (VERs not yet issued or transacted for this last period). It was decided by the Oromia Regional Government that the Bale REDD ER project merges with the OFLP-ERP starting January 2022 and ceases issuing VERs starting this period until the end of the ISFL ERPA period.

However, there are actions not included in the ISFL ER Program but address the drivers of land use change, deforestation, and forest degradation within the ISFL ER Program Accounting Area and that are generating ERs but are not transacting any ER, seeking any payment, transferring any generated ERs to other mitigation initiatives during the ISFL 1st ERPA period nor in the whole of the OFLP-ERP ERPA period (2022-2029). These arrangements have been extensively consulted, agreed upon and fully established during the OFLP design and the ERPA negotiations processes. The OFLP-ERP leverages on all actions in the jurisdiction that help generate ERs, including from on-going and pipeline non-ER initiatives financed by government, development partners, private sector, NGOs, communities, and the WB.

Table 22: Other projects listed/registered under the VERRA and Gold Standards

Project Name and ID	Project Type	Region	Credit tCO ₂ e		Credit period	Main characteristics	Status and carbon standard
			Issued	Retired			
Other Projects listed/registered under VERRA Standard							
1. Catalyzing community resilience through carbon finance in Ethiopia Afromontane forests –VERRA 5191	Agriculture forestry and other land uses	Oromia & Sidama Munesa and Kore woreda in Oromia)	Pipeline-listed		September 02, 2024 – May 31, 2054	the project aims to adopt Afforestation, Reforestation and Revegetation activities in Oromia and Sidama regions that cover tropical mountain ecosystems of Ethiopia. The project activity includes plantation of native tree species and highland bamboo Yushania Alpina. The project activities will cover 12,120 hectares. Various native species will be planted to improve soil fertility and productivity and sequester carbon from the environment, ultimately reducing GHG emissions	Underdevelopment- VERRA Standard
2. Distribution of fuel efficient improved cook stove - VERRA 4386	Energy efficiency improvement projects	Geographic boundary of Ethiopia	Pipeline - listed		Oct 01, 2023 – Sept 30, 2030	it aims to reduce greenhouse gas emissions by distributing 400,000 fuel-efficient improved cookstoves (ICS) to households in Ethiopia which replaces traditional cookstoves 3-stone fire, thereby reduce fuel consumption & indoor air pollution, thereby improving the health situation especially of women and children.	Under validation VERRA standard

3. Energy efficient stove program – CER conversion- VERRA 4657	Energy Efficient Stoves Project	Oromia (Adaberga, Nono wonchi, yaya gulele, boset, Jeju, Digeluna Tijo,shashemen e, Tullo)	Issued 128,214 tCO2e	Expired	Oct 17, 2013-Oct 16, 2023	this small scale PoA involves the distribution of energy efficient cooking stoves to households in The Federal Democratic Republic of Ethiopia. Most households in rural areas of The Federal Democratic Republic of Ethiopia cook over open fires ¹ , and this leads to a very significant consumption of wood, as well as a major health risk.	Units Transferred from Approved GHG Program VERRA standard (has expired)
Other Projects listed/registered under Gold Standard							
4. West Wellega Multipurpose Cookstove Distribution Project – GS ID-12134	Energy efficiency-domestic	Wellega, Gimbi, Guliso and Aira	No issuance, total ex-ante estimate is 194,285 tCO2e		2023 – 2028	West Wellega Multipurpose Cook Stove (MPCS) Distribution Project is a small-scale project activity initiated by Ethiopian Evangelical Church Mekane Yesus – Development & Social Services Commission West Wellega, Oromia region, Ethiopia. The area is highly subjected to forest degradation triggered by anthropogenic activities. To reduce the use of non-renewable biomass for household cooking, EECMY DASSC designed a project aimed to disseminate highly efficient locally produced multipurpose cook stove.	Listed -GS
5. West Guji Improved Cook Stove Distribution Project -GS ID-11187	Energy Efficiency Domestic	Bule Hora, Oromia	No issuance, total ex-ante estimate is 173,368	-	2022 — 2027	Oromia Coffee Farmers’ Cooperative Union’s West Guji improved cook stove distribution project is a small-scale project that will disseminate locally produced improved stoves to target communities.	Listed -GS

			tCO ₂ e			The technologies shall reduce the non-renewable biomass consumption required to provide thermal energy for domestic cooking requirements.	
6. Vita Green Impact Programme – Ethiopia Stove Project- GS12476	Energy Efficiency Domestic	Southern, Central, Southwestern, Sidama, Amhara and Oromia	No issuance, total ex-ante estimate is 5,226,815 tCO ₂ e	-	2023 – 2028	Applying the GS methodology for reduced emissions from cooking and heating – technologies and practices to displace centralized thermal energy consumption. Distributing improved cooking systems to reduce energy consumption.	Listed -GS
7. Jimma improved cook stove Distribution Project - GS-12498	Energy Efficiency Domestic	Jimma, Oromia Region	No issuance, total ex-ante estimate is 287,530 tCO ₂ e	-	2023 – 2028	Jima improved cook stove distribution project is a small-scale project activity that will introduce Improved Cook Stoves within Jimma Zone of Oromia Region. The ICSs shall reduce the non-renewable biomass consumption required to provide thermal energy for domestic cooking requirements	Listed-GS
8. Bunno Bedele and Ilu Ababora improved cook stove Distribution Project - GS-12499	Energy Efficiency Domestic	Bedelle -Metu, Oromia	No issuance, total ex-ante estimate is 287,530 tCO ₂ e	-	2023 – 2028	Bunno Bedele and Ilu ababora improved cook stove distribution project is a small-scale project activity that will introduce Improved Cook Stoves within Bedelle-Metu area of Oromia	Listed -GS
9. Improved Cook stoves for Environmental Conservation in Southern Ethiopia-	Energy Efficiency Domestic	Bale (Goba and Sinana), Welisso (Wonchi and Welliso) - Oromia	15198 tCO ₂ e 18,405 tCO ₂ e	15,075 tCO ₂ e 18,384 tCO ₂ e	2021 – 2026	Distribute fuel-efficient cookstoves in Oromia Region in Southern Ethiopia (COOPI -Italian NGO)	GS-Certified

GS -10989 and GS - 10988							
10. Improved Cookstoves for Environmental Conservation in Southern Ethiopia – GS-10873, GS-10872 and GS-7556	Energy Efficiency Domestic	Guji and Bale zones of Oromia (Goro Dola, Liben, Delomena and Meda Welabu)	24,966 tCO ₂ e 24,875 tCO ₂ e 28,120 tCO ₂ e	24,966 tCO ₂ e 24,875 tCO ₂ e 28,120 tCO ₂ e	2020 – 2025 2019 -2024 (for GS-7556)	Distribute fuel-efficient cookstoves in Oromia Region in Southern Ethiopia (COOPI -Italian NGO)	GS-Certified
11. Oromia Cook stove Distribution Project-GS-5463	Energy Efficiency Domestic	West Wellega, Oromia (Nole Kaba, Haru, Lalo Asabi and Homa)	99,115 tCO ₂ e	65,639 tCO ₂ e	2016-2022	Introduce Improved Cook Stoves within the project area.	GS-Certified
12. Bale Mountain Eco-region REDD+ projects ID 1340	Forestry	Bale, Oromia	3,196,344 tCO _{2eq}		January 2020-Dec. 2021	Conservation and sustainable natural forest management	GS-certified
13. East African Afforestation, Reforestation and Re-vegetation Program (Jama Urji) (ID 1443)	Jama-Urji Farmers Managed Forestry Project	West Arsi, Oromia	567,227 tCO _{2eq}		16/06/2014 15/05/2044	Biodiversity conservation and climate	GS certified

5.3 Implementation and operation of Programs and Projects Data Management System

Ethiopia has one national forest MRV system to which sub-national jurisdictions report to avoid double counting. That means that the OFLP’s Measurement, Reporting and Verification (MRV) system is an integral part of the national forest MRV system. That approach helps maintain data consistency and credibility across different levels of forest monitoring. By aligning OFLP’s MRV system with the national forest MRV, Ethiopia has ensured harmonized reporting, reduce discrepancies, and strengthen GHG emission Monitoring. A unified system also enhances transparency and facilitates better decision-making in forest management and emission reductions. (See **Error! Reference source not found.** below the institutional arrangement for national forest MRV).

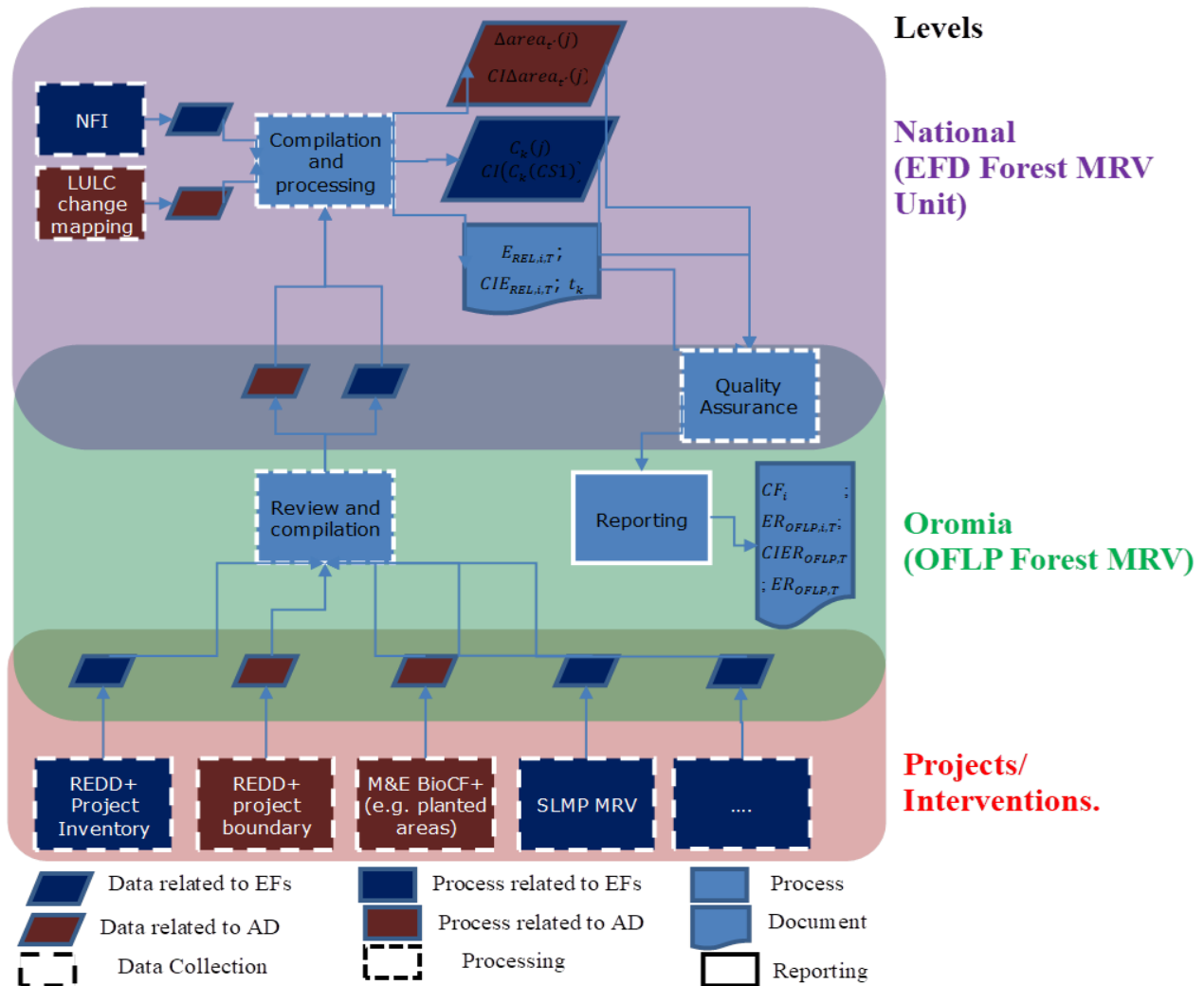


Figure 8 Programs and Project Data Management System

Data captured through the national forest MRV system is collected and analyzed at different levels. The lower levels collect important information and feed into the OFLP forest MRV system. The national level collects primary data and compiles primary and secondary data. The design of data collection, selection of data generation methodologies, analysis, preparation of maps and reporting is led by the National Forest MRV Unit in full participation of the regional forest MRV unit. Data sets of the project produced for outside reporting and those produced for benefit sharing allocation and distribution purposes are stored, retrieved and used from the data repositories (data bases) existing both in national and regional forest MRV units. Data from all sources is used to produce AD, EFs, and revised baselines for the entire program area. These data and values are used to calculate the ERs by the national forest MRV team in collaboration with the OFLP forest MRV team. OFLP shall calculate the performance and ER benefits assigned to each zone, woreda and kebele.

The national and regional MRV units have been continuously strengthened with required data storage and management facilities and manpower assisted by resources through OFLP grant financing and the Norway Government grant. The OFLP MRV Unit has organized all projects, programs and initiatives' information in the MRV lab, including on ERs generated, geographic boundaries, and information on Environmental and Social risk Management activities. Data gathering consistency was ensured for those generated from primary and secondary sources including those acquired at national and regional levels.

The initial plan to have one national MRV system under one institution at central level coordinating all key CRGE sectors including those outside of the AFOLU sectors as indicated in the ERPD did not materialize. This is because of the institutional reorganization and split of the Environment, Forest and Climate Change Commission (EFCCC) into two separate entities (the EFD and the EPA). This has brought changes in mandates in the sphere of climate change and forestry at national level. The EPA, now under the Ministry of Planning and Development (MoPD) oversees all aspects of climate change issues including the roles of a designated entity to assemble the national MRV through coordination of all sectoral reduction programs of the CRGE and designing and institutionalizing a national transaction registry system.

This task of establishing the national registry and the MRV system (for all CRGE sectors including forest) is expected to take sometimes.

5.4 Implementation and operation of ER transaction registry

The implementation and operation of the ER (Emission Reduction) transaction registry is a critical component for ensuring the integrity, transparency, and accountability of the ISFL ER Program. This registry serves as a central repository for tracking the generation, transfer, and retirement of Emission Reductions, preventing double-counting and maintaining the environmental credibility of the program. The registry's follows international best practices and relevant standards to protect the integrity of the data with secure and auditable record of all ER transactions, ensuring the accuracy and credibility of the reported emission reductions and has user-friendly interface for project proponents, government agencies, and other stakeholders to access information on ER generation and ownership.

The monitoring and reporting for the OFLP-ERP is aligned with the national forest MRV system as discussed above and is in line with the implementation of the Nationally Determined Contributions (NDC), and other commitments of the country, including the Paris Agreement. The ERCs of OFLP ER program are issued based on environmental and social integrity (according to the ISFL methodological framework and verified by a third party) and in compliance with the national Environmental and Social information system (NESIS) and the Environmental and Social Framework (ESF). To avoid the risk of double counting of ERCs coming from the Oromia jurisdictional program, all ERCs will be registered into the Carbon Assets Tracking System (CATS), a registry managed by the World Bank and ensuring traceability of each ERC generated by the program. ERC registration is only done through OFLP-ERP which is mandated to transact ERC across the region. The CATS will be used as the transaction registry system until a potential national registry system could become operational that could perform the same function. OFLP-ERP will assign a dedicated team that is responsible for managing and monitoring the registry with the collaboration of WB team ensuring smooth functioning of the system. Regular audits will be conducted to verify the accuracy and completeness of the data to identify any potential vulnerability and implement necessary security enhancements. The sustainability of the ER transaction registry is important for maintaining the credibility of the ERCs and promoting the effective implementation of the registry.

5.5 ERs transferred to other entities or other schemes

No ERs from the ISFL Program are sold, assigned or otherwise used by any other entity for sale, public relations, compliance or any other purpose including as ERs set-aside to meet Reversal management requirements under other GHG accounting schemes to date. But Emission Reductions (ERs) generated by the ISFL ER Program, and subsequently transferred to other entities or schemes, are accurately tracked and documented within the ER transaction registry. This process follows to strict protocols designed to maintain transparency and prevent any double-counting of credits. When ERs are transferred, the registry records the quantity of ERs, the identity of the receiving entity or scheme, the date of the transfer, and the specific purpose for which the ERs are being utilized. Clear legal agreements and contractual arrangements govern the transfer process, ensuring that, the receiving entity is fully aware of the terms and conditions associated with the ERs, including any restrictions on their use. The registry also maintains a comprehensive audit trail of all transfers, allowing for traceability and accountability throughout the entire lifecycle of the ERs, regardless of their final destination. The environmental and social safeguards integrity of the ERC and promotes confidence in the credibility of the transferred emission reductions.

6 Reversals

6.1 Assessment of the level of risk of Reversals

The assessment of reversal risk concentrated on two primary indicators that highlight the potential for reversal: the insufficient long-term effectiveness in mitigating the fundamental causes of AFOLU (Agriculture, Forestry, and Other Land Use) emissions and removals, as well as the degree of exposure and vulnerability to natural disturbances. To evaluate these reversal risk indicators, a thorough analysis was conducted, determining their relevance to the identified risk factors based on the ISFL percentage of reversal risk. This comprehensive approach allowed for a nuanced understanding of how these factors interplay, ultimately influencing the overall effectiveness of strategies aimed at reducing emissions and enhancing carbon sequestration in the AFOLU sector. The reversal risk assessment findings indicated that various interventions have significantly contributed to lowering risk indicators across all subcategories. The key measures included the reduction of small-scale agricultural expansion through the promotion of intensification practices, which optimize land use without further encroaching on forested areas.

Additionally, efforts to combat illegal logging were encouraged by stringent law enforcement and the implementation of effective policy measures. Strengthening institutional arrangements and enhancing coordination among stakeholders played a crucial role in fostering a collaborative approach to forest management. Furthermore, improvements in extension services and the provision of quality inputs have empowered forest-dependent communities, enabling them to pursue sustainable livelihood interventions. Collectively, these strategies have proven effective in mitigating risks and promoting environmental sustainability that reduced the baseline reversal risk rated as high for subcategories and medium for subcategories (15%) were considered low (5%) for all eligible subcategories in the monitoring period. The assessment report concluded that the lack of long-term effectiveness is addressed the main drivers of AFOLU emissions and removals.

These strategies have demonstrated strong effectiveness in mitigating risks and promoting environmental sustainability. As a result, the baseline reversal risks initially rated as high (15%) for certain subcategories and **medium (15%)** for others were reduced to low (5%) across all eligible subcategories during the monitoring report period I. The assessment report for the second ERP phase concluded that this improvement directly addressed the main drivers of AFOLU (Agriculture, Forestry, and Other Land Use) emissions and removals, ensuring that the interventions were not only corrective but also preventive in nature. Importantly, the report emphasized that the risk level is expected to remain low throughout ERPA monitoring , reflecting the durability of institutional reforms, strengthened community participation, and the integration of climate-smart practices. This outcome highlights the program's capacity to embed resilience and sustainability into Oromia's forest governance framework, thereby safeguarding emission reductions and reinforcing long-term environmental integrity.

On the other hand, the reversal risk assessment conducted in Oromia focused on indicators arising from natural factors that act as direct drivers of deforestation and forest degradation. These included wild forest fires, climate change impacts, recurrent droughts, pest infestations, plant diseases, and floods, **all of** which increase exposure and vulnerability to natural disturbances. At the baseline stage, these risks **were rated high (15%)**, reflecting their significant potential to undermine emission reduction outcomes. However, during the first ERP phase, monitoring confirmed that these risks had been reduced to **low levels**, and subsequent assessments in the second ERP phase revealed that they **remained low**, demonstrating the effectiveness of the mitigation strategies implemented. This sustained reduction highlights the resilience of Oromia's forest governance framework and the durability of interventions such as fire management systems, climate-smart agriculture, pest and disease control, and watershed management, which collectively safeguard emission reductions and ensure long-term environmental sustainability.

Table 23: Assessment of the level of risk of Reversals

.Risk Factor	Risk indicators	Level of risk	Associated reversal risk set-aside percentage
<p>A. Lack of long-term effectiveness in addressing the key drivers of AFOLU emissions and removals</p>	<p>Based on the OFLP_ERP period reference reversal risk assessment, several key factors have been identified as potential drivers of reversal risks within the program area. These include pressures from both large and small-scale agricultural expansion, challenges related to illegal logging linked to limited institutional coordination and capacity, and weak enforcement of forest governance frameworks. Additionally, reliance on conventional agricultural practices such as open grazing, limited adoption of intensified and modern agricultural inputs, and the continuing population growth pressure contribute to heightened vulnerability. These indicators underscore the need for strengthened institutional arrangements, enhanced law enforcement, and the promotion of sustainable land-use practices to mitigate risks and safeguard emission reduction outcomes.</p> <p>The OFLP-ERP has prioritized those risk factors and has been implementing different mitigation strategies:</p> <ul style="list-style-type: none"> ✓ ✓ The Oromia Forested Landscape Program-Emission reduction project (OFLP-ERP) effectively coordinates and supports a wide range of forest development, natural forest management, area closures and rehabilitation, and development initiatives that are designed to deliver sustainable outcomes well beyond the ERPA period. These include 1564 Participatory Forest Management (PFM) cooperatives were established on 2.6ha of Natural forest that empower local communities to take ownership of forest resources, thereby reducing deforestation and 	<p>Reversal Risk is considered Low for all eligible subcategories</p>	<p>5%</p>

	<p>improving livelihoods.</p> <ul style="list-style-type: none"> ✓ OFLP-ERP implementation activities that establish robust monitoring, reporting, and verification systems to ensure credible emission reductions; ✓ Agroforestry and climate-smart agriculture programs that integrate trees into farming systems and promote sustainable land use. During the reporting period, the government implemented extensive physical and biological soil conservation measures. A total of 2.5 kilometers of bunds were constructed, alongside 5.6 million cubic meters of check dams. In addition, 1.174 hectares of degraded land were enclosed for rehabilitation. ✓ OFLP-ERP facilitates forest fire management and restoration projects, introducing prevention and rapid response mechanisms while supporting reforestation in degraded landscapes. The program and underlying projects also advances alternative livelihood initiatives such as beekeeping, ecotourism, and sustainable forest product enterprises, which reduce dependency on unsustainable forest exploitation. The REDD+ projects and none REDD+ projects, contribute 274 Million birr for 50,450(15920F) for forest based cooperatives in the monitoring period for livelihood improvements of forest dependent communities. ✓ Institutional strengthening and capacity building are central to OFLP-ERP work, enhancing coordination among government agencies, local administrations, and community forest associations. During the reporting period 4,989 officials and experts capacitated on landscape forest management and restoration. ✓ The first phase first round pipelined benefit-sharing (BSP) distribution initiates forest dependent communities and ensures equitable distribution of carbon and non-carbon benefits, building trust and long-term commitment to conservation. These coordinated efforts contribute to emission reductions that extend beyond ERPA phase timelines, embedding resilience, community empowerment, and institutional legacy into Oromia’s forest governance system. 		
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	<ul style="list-style-type: none"> ✓ The County’s Climate Smart Agriculture (CSA) strategy places particular emphasis on the livestock sector, recognizing its central role in both rural livelihoods and environmental sustainability. Within this framework, initiatives are designed to enhance productivity while reducing greenhouse gas emissions. Key measures include the promotion of improved livestock feeding practices to reduce methane emissions, the introduction of integrated rangeland management systems to prevent overgrazing and restore degraded lands, and the adoption of climate-resilient breeds that are better adapted to local conditions. The strategy also encourages manure management and biogas production, turning waste into renewable energy while minimizing environmental impacts. In addition, capacity-building programs for pastoralists and smallholder farmers strengthen knowledge on sustainable herd management, veterinary services, and market access. These initiatives contribute to climate resilience, improved food security, and reduced pressure on forests, aligning the livestock sector with broader CSA objectives and long-term sustainability goals. ✓ Institutional coordination for rural corridor development is achieved through frameworks such as OFLP-ERP and the Homegrown Economic Reform Agenda (HGER), which bring together regional bureaus of agriculture, environment and livestock to align local priorities with national strategies. ✓ The OFLP-ERP the Oromia Environmental Protection Authority (OEPA), the Bureau of Agriculture, and local administrations collaborate on participatory forest management, agroforestry, and sustainable land use, ensuring that rural communities benefit directly from emission reduction and livelihood programs. ✓ The evidence from OFLP-ERP implementation reveals 11.4 million hectares of forest, and engages over three million people aware on climate change impact management and forest sectors is the most pillar managed with shared responsibility. 		
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	<ul style="list-style-type: none"> ✓ The HGER provides a national framework for structural transformation, revitalizing productivity and strengthening sectoral linkages across agriculture through sectoral reforms so that rural priorities are embedded in Ethiopia’s broader CRGE agenda ✓ Benefit Sharing Plan (BSP) and BSOM, which increases community trust and community commitment. <p>Though these efforts are highly contributed to reduce the risks of eligible subcategories form high and medium to low risks for all categories.</p>		
<p>B. Exposure and vulnerability to natural disturbances</p>	<p>Based on the reference level indicators, the major risk factors identified related to Exposure and vulnerability to natural disturbances were: human induced and natural fires are direct drivers of deforestation and other natural drivers of deforestation such as climate change, droughts, pests and diseases, and floods were the common risk factors identified and rated as low (5%) during the frist reporting period risk assessment.</p> <p>In order to curb the incidence of these risk factors the following intercessions were done</p> <ul style="list-style-type: none"> ✓ The successful implementation of the Emergency Response Program (ERP) has been closely tied to the establishment of a well-defined and empowered organizational framework. The OFLP_ERP ensured that institutional arrangements are clear and adequately resourced; coordination among regional bureaus such as agriculture, environment, and administrative bodies becomes more effective. The administrative bodie agreed to lead the strategic governance and OEPA has been mandated to lead ERP coordination, supported by local governments and community forest associations. This framework ensures that the program possesses the legal authority, technical capacity, and financial resources necessary to facilitate operations, enforce forest governance, and oversee benefit-sharing mechanisms. 	<p>Reversal Risk is considered Low for all eligible subcategories</p>	<p>5%</p>

	<ul style="list-style-type: none"> ✓ The presence of Environmental and Social Risk Management (ESRM) tools plays a crucial role in directing and ensuring the effective implementation of strategies aimed at mitigating environmental and social risks beyond the duration of the Operational OFLP-ERP period. These instruments are essential for assessing the appropriateness of various programs and projects at the landscape level, ensuring that they align with established environmental and social standards. The Environmental and Social Commitment Plan (ESCP) of the program and binding international agreements will serve as a guiding framework for these initiatives, promoting sustainable practices and compliance with risk management protocols. ✓ In Oromia, the signing of agreements between 1,486 forest-based cooperatives and respective government structures represents a critical institutional milestone that ensures the continuation of Participatory Forest Management (PFM) well beyond the ER Program period. This formalized partnership provides cooperatives with legal recognition, operational authority, and access to technical and financial support, while government institutions retain oversight and coordination roles. Evidence from OFLP-ERP implementation confirmed that these agreements have strengthened community ownership of forest resources, improved law enforcement against illegal logging, and enhanced benefit-sharing mechanisms. By embedding PFM into cooperative structures, the program secures long-term sustainability of emission reductions, promotes livelihood diversification, and builds resilience against deforestation drivers. The cooperative-government framework thus guarantees that forest management activities are not dependent solely on ERPA timelines but are institutionalized within Oromia’s broader governance system, ensuring continuity, accountability, and community empowerment in forest conservation. ✓ In Oromia, the signing of agreements between 1,486 forest-based cooperatives and respective government structures represents a critical institutional milestone that ensures the continuation 		
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	<p>management (AGP,SLMP,CALM)</p> <p>✓ In Oromia, land tenure certification has emerged as a critical instrument for strengthening forest governance and reducing reversal risks. By formally securing land rights for private farmers, the program restricts illegal encroachment and expansion of agricultural land into designated forest areas one of the major drivers of deforestation and natural disturbances. Evidence from Oromia land administration confirms that certified tenure not only discourages unsanctioned interventions but also incentivizes farmers to adopt sustainable practices, since they gain long-term security over their holdings. In the context of the OFLP-ERP and CALM, land tenure certification is directly linked to improved compliance with forest boundaries, reduced conflict over land use, and enhanced accountability at the community level. This strategic measure therefore played a dual role in safeguarding forest ecosystems against degradation while simultaneously empowering farmers with legal recognition, enabling them to invest in climate-smart agriculture and sustainable livelihoods.</p> <p>Through all these efforts have reduced the risk factors for all subcategories and rated as low.</p>		
	<p>Actual Reversal Risk Set-Aside Percentage = Result A + Result B</p>		<p>10%</p>

6.2 Occurrence of major events or changes in ER Program circumstances that might have led to the Reversals during the Reporting Period compared to the previous Reporting Period(s)

Even though this is the second monitoring report of first ERPA phase, there have been no major events or changes in ER Program circumstances that might have led to reversals during the reporting period compared to the previous one. Instead, the trend indicates a decrease in deforestation during this monitoring period compared to the previous monitoring period.

6.3 Quantification of Reversals during the Reporting Period

A.	Total net Emissions Baseline during the Reporting Period (tCO₂-e)	<i>from section 3.3.1</i>		10,663,164	
B.	Sum of net Emissions Baselines for all previous Reporting Periods in the ERPA (tCO₂-e).	<i>from previous ISFL ER Monitoring Reports</i>		21,234,730	+
C.	Cumulative Emissions Baseline for all Reporting Periods [A + B]			31,897,894	
D.	Estimation of net GHG emissions from the ISFL ER Program during this Reporting Period (tCO₂-e)	<i>from section 3.3.2</i>	2,451,132		
E.	Estimation of net GHG emissions for all previous	<i>from previous ER</i>	6,240,883		

	Reporting Periods in the ERPA (tCO₂-e)	<i>Monitoring Reports</i>			
F.	Cumulative net GHG emissions including the current reporting period (as an aggregate accumulated since beginning of the ERPA) [D + E]			8,692,015	-
G.	Cumulative quantity of Emission Reductions estimated including the current reporting period (as an aggregate of ERs accumulated since beginning of the ERPA) [C – F]			23,205,879	
H.	Cumulative quantity of Emission Reductions estimated for prior reporting periods (as an aggregate of Emission Reductions accumulated since beginning of the ERPA)	<i>from previous ER Monitoring Reports</i>		14,993,847	-
I.	[G – H], negative number indicates Reversals			8,212,032	

If I. above is negative and reversals have occurred complete the following:				
J.	Amount of Emission Reductions that have been previously transferred to the ISFL, as Contract ERs and Additional ERs			
H.	Quantity of Emission Reductions to be cancelled from the Reversal Buffer account [J / H × (H – G)]			

7 Emission Reductions available for transfer to the ISFL

Quantify the Emission Reductions available for transfer to the ISFL by completing the white cells in the table below.

						2024	
A.	Emission Reductions during the monitoring period (tCO₂-e)	<i>from section 3.3.3</i>				8,212,032	
B.	If applicable, number of Emission Reductions calculated using Activity Data Proxies and methods (use zero if not applicable) [Corresponds to ISFL ER Program Requirement 4.6.5]					0	
C.	Number of Emission Reductions estimated using measurement approaches (A-B)					8,212,032	

D.	Percentage of ERs (A) for which the ability to transfer Title to ERs is clear or uncontested	from section 5.1				100%	
E.	ERs for which the ability to transfer Title to ERs is unclear or contested because they are sold, assigned or otherwise used by any other entity for sale, public relations, compliance or any other purpose	from section 5.2				0%	
F	Total ERs [(B+C)*D-E]					8,212,032	
G.	Conservativeness Factor to reflect the level of Uncertainty from non-proxy based approaches associated with the estimation of ERs during the Term of the ERPA	from section 4.4.2				12%	
H.	Quantity of ERs to be allocated to the Uncertainty Buffer $(0.15*B/A*F)+(G*C/A*F)$					985,443	
I.	Total Reversal Risk set-aside percentage applied to the ISFL ER Program during this Reporting Period	from section 6.3				10%	
J.	Quantity of ERs to be allocated to the Reversal Buffer (F-H)*I					722,658	
K.	Number of ISFL ERs (F- H - J)					6,503,931	

8. Annexes

Annex 1: Information on the implementation of the Safeguards

Annex 2: Information on the implementation of the Benefit Sharing Plan

Annex 3: Summary of Program Results, including non-carbon Benefits

Annex 4: Updates to the Emissions Baseline

1. Summary of updates

In the assessed ERPD, the Emissions Baseline was estimated for the period 2008 and 2017. The activity data for this Emissions Baseline was collected using a sample-based data collection approach to analyze changes in land use and land cover. Land use and land use change were assessed using 3,745 samples distributed across Oromia using a 10km grid (see annex 6, section 3.2.1 of the ERPD for details). It was decided to improve this analysis of land use and land use change because of different reasons:

- The land use change matrix produced only covered 29.9 million ha and not the full area of Oromia
- Definitions of land use classes used (see subsection on land use classes in section 2.2 above)
- It was felt more intense sampling was required, also in the Benefit Sharing Plan, benefit distribution is based on different indicators including performance against sub-jurisdictional, to be able to develop zonal level baselines. In order to develop credible zonal level baselines, more intensive sampling was required than what was done for the Oromia level baseline. 92,820 samples were analyzed to develop the 21 zonal baselines using a systematic sampling design involving a 2 x 2 km grid for Oromia Regional State. With the information derived from this intensified sampling being available, it was decided this could also be used to also update the Oromia level Emissions Baseline since it would provide a higher quality result than the original 3,745 samples (see Annex 4 for details) needed as part of the Benefit Sharing plan

In addition, updated values on biomass of different land use categories in Oromia, was available from Ethiopia's National Forest Inventory. For the categories involving conversions from other land uses to forest and for the pools 'dead wood' and 'soil organic carbon', the ISFL 'Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period' was fully applied in this updated baseline.

2. ISFL ERPA Phase

This updated baseline is valid for the first phase of the ERPA which covers the period 2022-2024.

3. Updates to the Program Emissions Baseline

i. Approach for estimating Emissions Baseline

Land use definitions

Ethiopia has adopted a new forest definition in February 2015 that forest defined as a ‘Land spanning at least 0.5 ha covered by trees (including bamboo) (with a minimum width of 20 m or not more than two-thirds of its length) attaining a height of at least 2 m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course. This definition reduced the tree height criteria from 5m in the previous definition to 2m. The main reason for this change was to capture natural forest vegetation types like the dry-land forests which host woody species that typically reach a height of around 2-3m.

The new definition was used in the land use and land use change analysis that was part of the ERPD of the Oromia Forested Landscape Program. The resulting emissions baseline considered the following categories:

- Forest to cropland
- Forest to grassland
- Cropland to forest
- Grassland to forest

In these categories, grassland included 2 types of vegetation namely (1) ‘grassland’ which includes both rangelands and pastureland and (2) ‘shrubland’ which includes ecosystems with vegetation that falls below the threshold used in the forest land category and are categorized under the grassland, the threshold used in the grassland category. For this updated baseline, it was decided to have a separate subcategory for shrubland, allowing for a more accurate use of emission factors. This also responds to one of the observations made during the validation of the ERPD.

This means that the improved baseline and this monitoring report now consider the following subcategories:

- Forest to cropland
- Forest to grassland
- Forest to shrubland
- Cropland to forest
- Grassland to forest
- Shrubland to forest

For this the following definitions were used:

- **Forest land:** Land spanning at least 0.5 ha covered by trees (including bamboo) (with a minimum width of 20 m) attaining a height of at least 2m and a canopy cover of at least 20% or trees with the potential to reach these thresholds in situ in due course and excluding land that is predominantly under agriculture or urban land use.
- **Cropland:** This category includes arable and tillage land, and agro-forestry systems. Includes land with tree canopy cover < 5% with shrubs/bushes < 10% or with predominant agriculture/urban land use or with trees <0.5ha. It includes annual crop land, perennial crop land and mixed annual and perennial crop land with tree canopy cover from 0% to 100%.
- **Grassland:** This category includes rangelands and pastureland that is not considered as cropland. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvopastoral systems, subdivided into managed and unmanaged. Includes land covered by natural growth of gramineae and herbaceous vegetation, with some scattered trees (tree canopy cover from 5% to less than 20%).
- **Shrub land:** This category includes systems with vegetation that fall below the threshold used in the forest land category (i.e., tree canopy cover from 5% to less than 20% or shrubs/bushes canopy cover $\geq 10\%$) and is not expected to exceed, without human intervention, the threshold used in the forest land category. (Source: Land Use Land Cover, Land Use Land Cover Change and Forest Disturbance Interpretation Key for Ethiopia, November /2023, Addis Ababa, Ethiopia)

Data collection approach

Activity data

The methodology used is a systematic sampling approach to target potential areas of change and assess the land use and land use changes of the samples.

Sampling design

According to IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC GPG LULUCF) (Chapter 5.3.4) areas and changes in areas can be estimated using sampling (sample-based activity data (AD) estimation) i.e., estimation via proportions. This approach requires that the total area of the survey region is known, and that the sample survey provides only the proportions of different land-use classes. IPCC GPG LULUCF (Chapter 5.3.3.2) also states that ‘it is efficient to use systematic sampling, since in most cases this will increase the precision of the estimates. Systematic sampling also simplifies the fieldwork’. Therefore, systematic sampling design was adopted for this survey (Figure 1). A 2 x 2 km grid for Oromia Regional State.

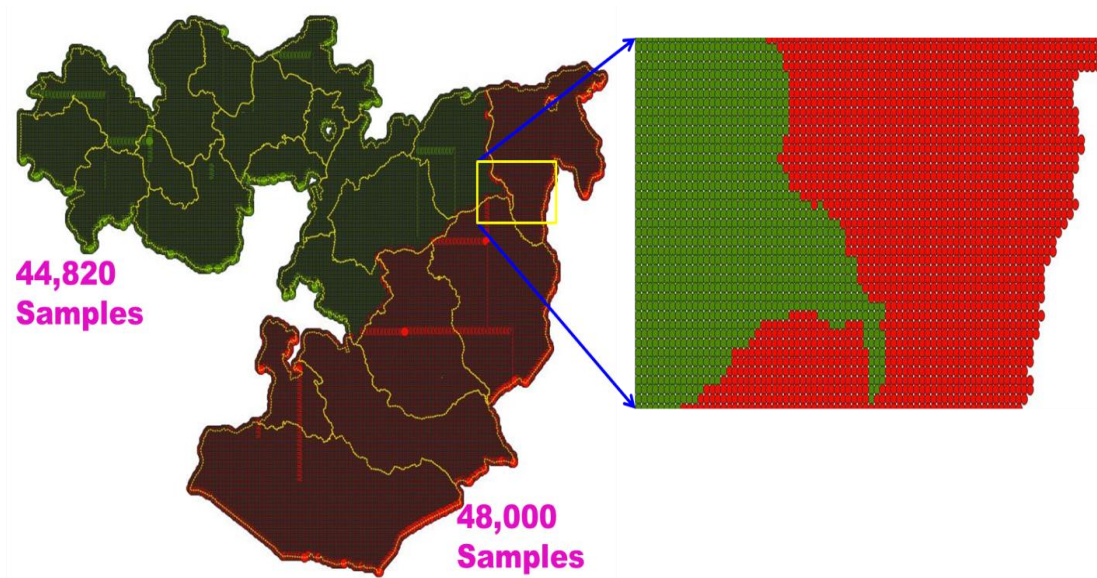


Figure 1: A 2 x 2 km grid sampling for Oromia Regional State and number of sample points for the two CEO projects.

Sample based activity data (AD) estimation.

After generating sample plots at 2x2 km systematic grid across Oromia, those reference sample plots were assessed using Collect Earth Online (CEO). CEO is a tool for collecting reference data from very high, high and medium resolution satellite imageries. It was developed by Food and Agriculture Organization of the United Nations (FAO) under the Open Foris Initiative. CEO is a free and open-source image viewing and interpretation tool, suitable for projects requiring information about land cover and/or land use. CEO enables simultaneous visual interpretations of satellite imagery, providing global coverage from MapBox and Bing Maps, a variety of satellite data sources from Google Earth Engine.

Using CEO a systematic random sample of 92,820 plots in 21 Zones across Oromia Region was analyzed to determine seven LULC classes (Forest, Cropland, Grassland, Settlement, Wetland, shrub land and other land) at point level. Historical trends in land use for the years 2008–2017 have been assessed and labeled for each change and unchanged classes. Online imageries (Mapbox, Planet, spot, Landsat imageries photo) indexed to CEO platform have been used to assess land use types.

The wall-to-wall mapping was needed for visualizing where each land use land cover (LULC) is spatially located and to increase the understanding of readers of the locations of forests. In order to classify the LULC for the year 2017 for Oromia and each zone (21 zones), high spatial resolution Planet NICFI level-1 imagery was acquired for the years 2017 covering the boundary of Oromia regional state. Planet NICFI level 1 imagery is a product of Norway's International Climate and Forests Initiative (NICFI) satellite program. It has a spatial resolution of 4.77 m. Therefore, there was a chance to capture most trees and smaller patches as small as about 25 m² in size or with a length/width of 4.77 m. Very high resolution (VHR) imagery from Google Earth was also used as auxiliary data for better visualization.

A total of 1098 Planet NICFI level 1 quads for the year 2017 (Figure 2) were downloaded and mosaicked for regional level using System for Earth Observation Data Access, Processing, & Analysis for Land Monitoring (SEPAL) considering a relatively low cloud cover period of the year, the month of March (Figure 2). For example, Planet NICFI level 1 image mosaics (false colour composite) ready for analysis for Oromia. The same procedure was applied for each Zone in order to assess AFOLU status of each Zones. SEPAL is a web-based cloud computing

platform designed by the United Nation’s Food and Agriculture Organization (FAO) to support the remote sensing and satellite-based forest monitoring efforts of developing countries (Figure 2).

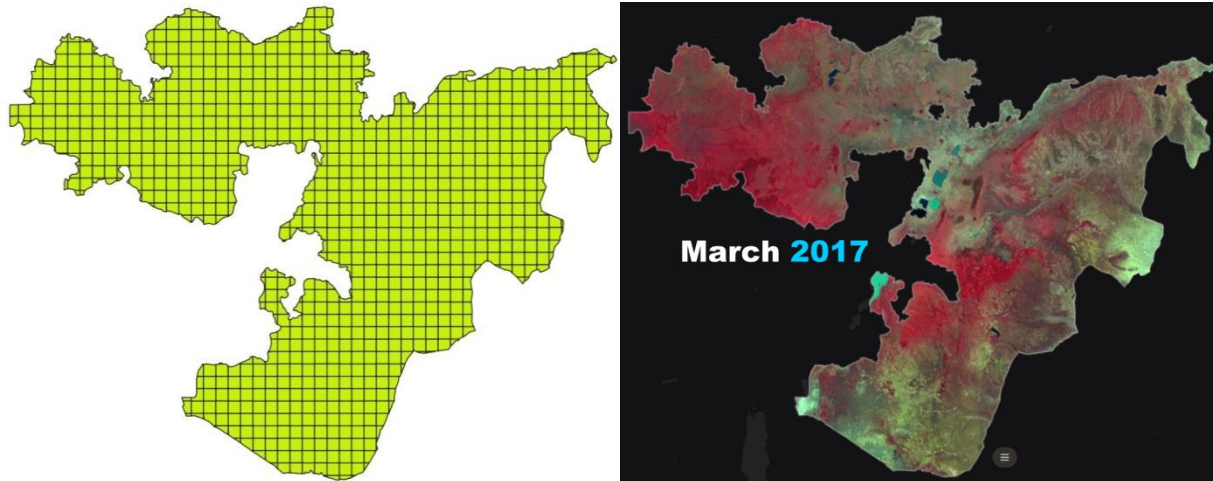


Figure 2 Quads of Planet NICFI covering the regional boundary of Oromia (left) and mosaic of NICFI Planet on SEPAL platform (right)

CEO collected 92,820 sample points collected from sample-based area estimation using visual interpretation of VHR imagery from Google Earth using SEPAL were used as training points for random forest classification algorithm during classification (Figure 3).

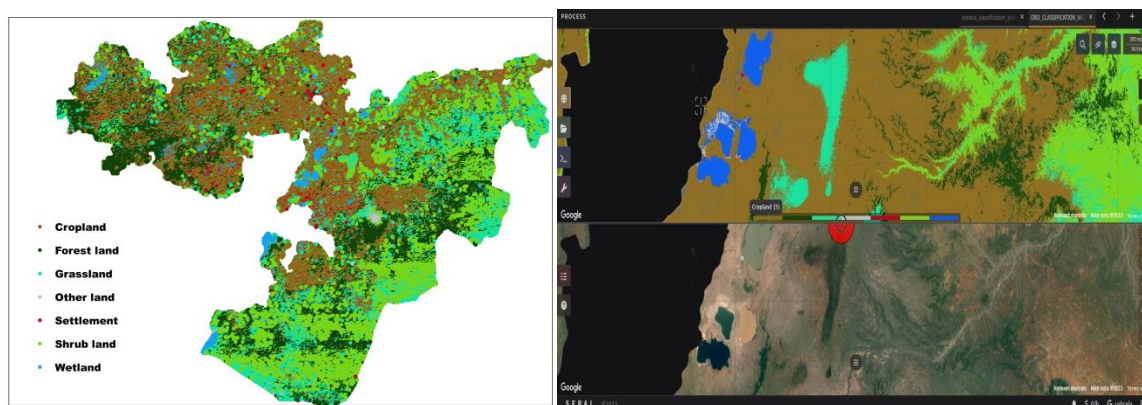


Figure 3 Training points per LULC (Left) and SEPAL interface showing the classification processes of LULCs (right).

The mapping process includes imagery data acquisition, training data collection, pre-processing (image stacking, clipping, enhancement and mosaicking), image classification through SEPAL and post-processing. Random forest machine learning algorithm was applied for classification.

The approach chosen to classify LULC was a supervised classification. In this a supervised classification of imagery the user identifies representative spectral samples for each of the classes in the digital image. The representative spectral samples are used as a dictionary and the classification algorithm uses this dictionary to classify all objects/pixels depending on what their spectral signature resembles most in the dictionary. The process assessed one Planet mosaic for the year 2017 to classify LULC. A target day is fixed in order to get the maximum vegetation cover and least cloud cover as possible. All the data collection, correction and composition are implemented within Google Earth Engine (GEE) API (Application Programming Interface) integrated with SEPAL. Downloading was performed using RStudio integrated with SEPAL. As supervised classification is dependent on the quality of samples, about 92,820 training points were used for the seven classes. Sample training data collection for the LULC classes was demonstrated below in SEPAL (Figure 4).

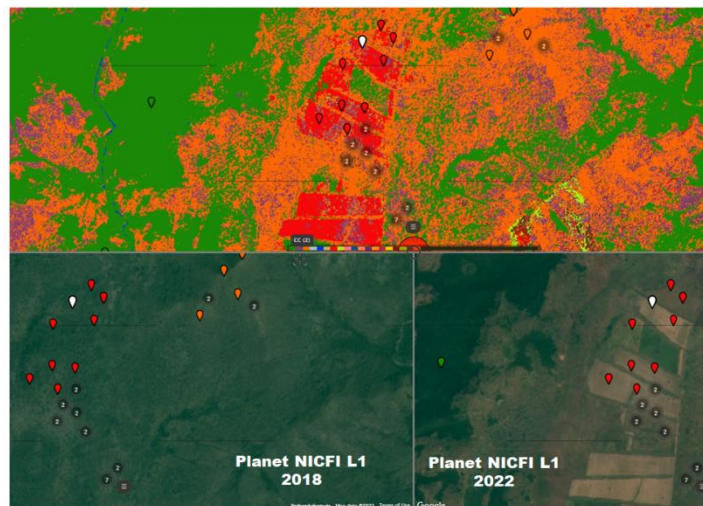


Figure 4 Additional Training data collection for the LULC classes in SEPA

The six IPCC land-use categories including shrub land and their transitions (subcategories) from IPCC 2006 Guidelines have been used for AFOLU sector activity data generation. Each land-use category is further subdivided into land remaining in that category and land converted from one category to another (e.g., forest land converted to cropland). Related to forest, the assessment tried to to harmonize and incorporate the national forest definition, which is an area of at least 0.5 hectares, with tree canopy cover of at least 20% and trees of at least 2m, in situ, including bamboo and tree plantations.

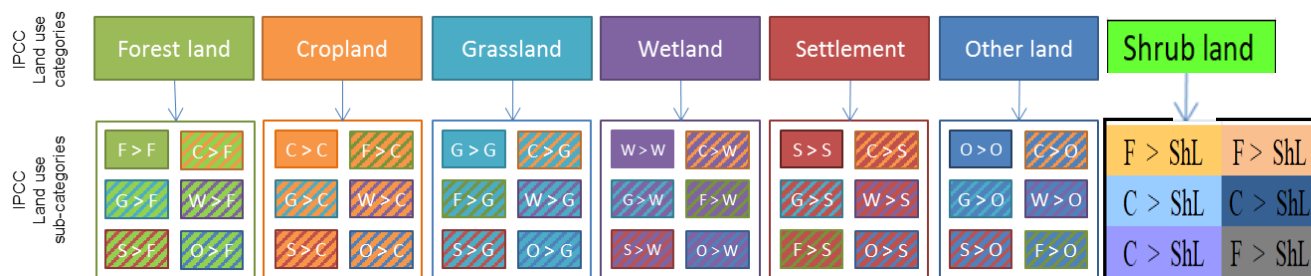


Figure 5: IPCC land use categories and change categories.

A three days training was provided before data collection to have common understanding on each LULC labeling including collecting sample points and sharing information why specific LULC class is assigned to specific class. Training was provided to all data collectors and analysts regarding the data collection process, interpretation and how to differentiate between each land use class categories and subcategories, use of Collect Earth online and online imagery interpretation modalities and procedures use of interpretation key while assigning sample plots to each land cover classes. In order keep consistency of data collection, training also covered how regional level reference level data was collected and produced for the same years at regional level for Emission Reduction Program Document development. It provided a common understanding between all data collectors and analysts on interpretation keys used during data collection and analysis, minimizing risk of inconsistent definition of land use classes and subcategories between analysts. Before data collection, about 250 other sample points were provided to all and their labeling result was compared and cross checked for common understanding. In addition, one key person was assigned to randomly control the label of LULC classes by other data collectors online and offline. Before data analysis, about 2900 sample

points related to forest were extracted and re-data collection was done assigning randomly to different data collectors to check the accuracy and consistency.

For this specific regional and zonal land use land cover change assessment way of interpreting and labeling to specific land use was provided to data collectors adopting interpretation key described by FAO 2021. Specifically, each LULC class was characterized based on their interpretation key among which some are; i) tone or color variation during use of True Color Composite (TCC) and false color Composite (FCC) (E.g. light green or light red colors indicate objects healthy condition), ii) texture variation based on each LULC classes smoothness and roughness (E.g. Smoothness for plantation and roughness for natural forest), iii) shape - which includes form, structure or outline of individual land cover classes (E.g. rectangular shape can be Plantation forest and irregular shape for natural forest, small or large rectangular shape for farm lands), iv) location – which indicate arrangement of land cover class respected to one another, v) Shadow - visible shadow of trees/objects like building, vi) Pattern – spatial arrangement of objects (E.g. Rectangular pattern – most probably plantation if forest class), vii) size – size of objects like small and large sized rectangular farm parcels, viii) Association – relationship between other recognizable objects (E.g. what can be mostly exist around water body or riverine) are main interpretation keys used during data collection for class labeling including visual assessment of each objects and expert judgments discussed.

For this specific task, a Collect Earth Online (CEO) institution called ‘REDD+ OROMIA’ was created (Figure 7). The 92,820 reference samples were collected from visual interpretation using Very High Resolution (VHR) imagery from Google Earth. Two CEO projects were created under the CEO institution called ‘REDD+ OROMIA’, one for 44,820 samples and the other for 48,000 samples. This is because CEO cannot allow sample size more than 50,000 per one CEO project. Survey design was created for each CEO project.



Figure 6: Collect Earth Online institution (left) and CEO data collection interface (Right)

Each sample plot was assessed using visual interpretation of available high-resolution images, as well as aided by interpreting vegetation indices derived from available low, medium and high-resolution images. Collect Earth online automatically generates time series of the NDVI, from each Landsat and Moderate Resolution Imaging Spectror Radiometer (MODIS) images available from 2007 onwards. First, the data collector should visually review all high-resolution historical imagery available. If there is historical high-resolution imagery available, use this imagery to determine the land use category and land uses sub-division and year of change. If only one date of high-resolution imagery is available or if it is difficult to determine the sub-category or year of change, view the Landsat and Sentinel data imagery and Vegetation indices time series trend available in Google Earth Engine, and then determine the category, subcategory and year of change (if available).

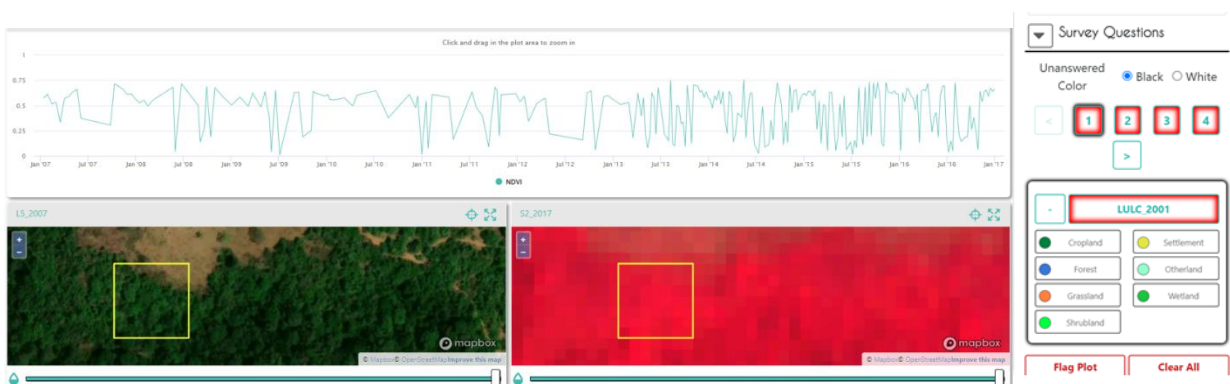




Figure 7: Collect Earth interface for data collection and Google Earth Engine platform for enabling time series imagery for sample plots using Landsat, MODIS and other available imageries.

The Collect Earth online interface used for collecting information about the AFOLU classes is shown in figure 7. There are 5 parameters to fill in this interface: land use category, land use category accuracy, land use sub-category, land use sub-category accuracy and year of change. The land use accuracy refers to the confidence of the classification. Is the interpreter sure of the land covering class they assigned? Yes, if they are confident about their classification and no if there is doubt about the classification. The same principle applies for the land use sub-category accuracy. The reference period for the analysis was already defined to ease the time trend of the sample plots, i.e., 2007-2017. As shown on figure, two vegetation indices namely Normalized Vegetation Index (NDVI) and Normalized Difference Fraction Index (NDFI) were used to assess vegetation status of each sample plot in addition to assessing high resolution imageries visually since 2007. NDFI was used a new spectral index for enhanced detection of forest canopy damage caused by selective logging and/or forest fire (forest degradation) and deforestation. On the first NDVI plot from 2007 to 2017 the density of greenness was low before 2013 and get very green after and its respective NDFI showed canopy damage due to forest degradation within the same period.

Out of the 29,589 samples (32%) extracted for the forest class and randomly re-interpreted and labeled by data collectors for QA/QC, 3,882 sample (13%) were found to be misinterpreted as forest land but they were non-forest (Figure 11). These samples were corrected and replaced the old version for final analysis.

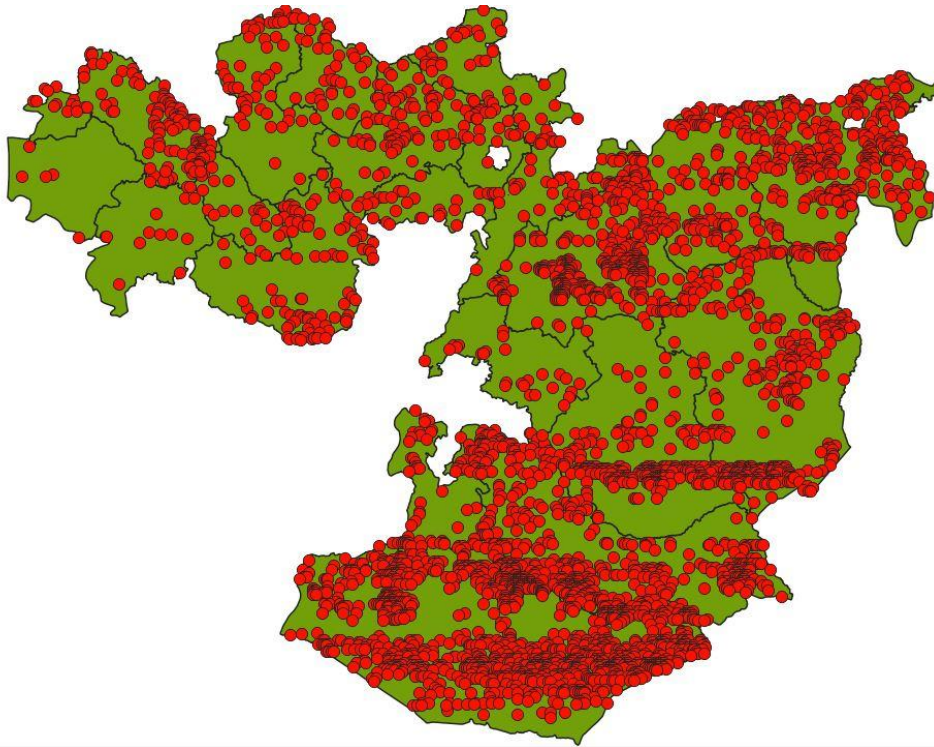


Figure 8 Misinterpreted sample points and corrected after quality assessment.

All collected data was processed and analysed using Microsoft Excel (Functions like ‘IF’, ‘Pivot’, ‘VLOOKUP’, ‘LEFT’, etc). Moreover, visualization was performed using R-Statistical software version 3.5.3 (R Development Core Team, 2020) with RStudio version 1.1.456 (RStudio team, 2022). The geospatial analysis was carried out using QGIS and Arc GIS software.

The sample-based area estimation analysis protocol involves transplantation of sample based information collected using CEO from diverse types of data, including very high-resolution imagery in to proportional area estimates. Most of the calculations are based on the transition of one land use land cover class in to other land cover classes. The analysis of the samples to calculate stratified area estimates was used on Excel sheet, where proportion matrix and estimating area of each land use land cover has been analysed. Sample based area estimation give an indication of the occurrence of land use/land use change classes and the number of samples needed to adequately capture those classes. This approach requires that the total area of the survey region is known, and that the sample survey provides only the proportions of different land-use classes. The proportions of different land uses have been estimated for the entire study

area of the region. The proportions were then converted to areas and the standard errors of the estimates have been calculated. In a similar fashion, changes were estimated by comparing the interpretations between the years at the point level. The results should be reported in hectares with confidence intervals for each class.

To quantification the area changes methodology suggested by Puyravaud (2003) and also applied by Souza et al. (2013) was used to calculate the annual percentage rate of forest cover lost. Then the percentage rate of forest loss normalized (r) between the two monitoring periods was used to calculate annual deforestation rate (in ha/year) for a given reference period following equation: $D_t = A_{t-1} * (1 - e^{-r(t-t_1)})$, where A_{t-1} and A_{t-2} are the forest areas mapped in times t_1 and t_2 , expressed in years, beginning with an initial year. The result, $r(t, t-1)$, represents the percentage rate of forest loss normalized for the period between $t_1 - t_2$ (2007-2017) and expressed in years.

3.2.2 Emission and removal factors

The values of the emission factors have been updated using the final report with the results of the National Forest Inventory (NFI) that was conducted between 2014 and 2016 (MEFCC, 2018)²⁰. In the validated ERPD, four carbon pools were considered: aboveground and belowground biomass, deadwood and soil organic carbon. It was shown in the ERPD that litter could be excluded from the accounting since the contribution of the litter carbon pool is insignificant. The NFI report covers three of the four carbon pools: aboveground biomass, belowground biomass and deadwood. For soil organic carbon, the same values were used as those used in the ERPD.

²⁰ Ministry of Environment, Forest and Climate Change (MEFCC). 2018. Ethiopia's National Forest Inventory, Final Report. Ministry of Environment, Forest and Climate Change, Addis Ababa, Ethiopia

The NFI was conducted using a stratified systematic cluster sampling approach. Using available geospatial layers of Ethiopia and large-scale ecological studies the whole country was classified into five strata. Based on these strata, a total of 627 sampling units were created, of which 221 were located in Oromia. Every sampling unit had an area of 1 km² and was composed of 4 plots (with cumulative plot area of 2 ha). The details of the sample unit and plot design can be found in section 2.1 of the NFI report (MEFCC, 2018). Out of the 627 planned sampling units, 539 were found to be accessible. The remaining 88 SUs were inaccessible due to different factors including excessive remoteness, topography and temporary security problems. Within the accessible sample units, a total of 2,077 accessible sample plots were visited in which about 49,829 trees and 2,029 stumps were recorded and analyzed.

For all the trees and stumps measured, the following variables were collected:

- Position in the plot; greater or equal to DBH 20 cm in forest) ;
- Tree/stump;
- Species name (scientific names and vernacular names);
- Diameter at 0.3 m level;
- DBH and top height (for trees and stumps greater or equal DBH 10 cm in outside forest and
- Bole height;
- Stem quality;
- Tree Health;
- Causative agents;
- Decomposition status.

In 2015 the stratification scheme was changed because Ethiopia decided to adopt a classification that better describes the vegetation characteristics of the country. With this change, the following biomes were adopted as basis for the NFI:

- Acacia-Commiphora
- Combretum-Terminalia
- Dry Afromontane
- Moist Afromontane

This change resulted in the adoption of more specific analysis methods. All the NFI results are thus presented by biome, and not by original NFI strata. Since the biome stratification was introduced when the NFI was already in progress, a post-stratification methodology was applied

in order to correctly estimate the results by the biomes. The number of SUs by biomes and strata is presented in table 2-5 of the NFI report (MEFCC, 2018) and reproduced below.

Table 1 Distribution of the sampling units per biome and strata (Table 2-5 from the NFI report)

	<i>Acacia-Commiphora</i>	<i>Combretum-Terminalia</i>	Dry Afromontane	Moist Afromontane	Others	Total
Stratum I	5	13	18	59	-	95
Stratum II	107	-	-	-	-	107
Stratum III	1	93		6	1	101
Stratum IV	36	38	114	29	1	218
Stratum V	15	2	-	-	1	18
Total	16 4	14 6	13 2	94	3	539

As part of the NFI, extensive training events were organized in order to secure that the field crews correctly collected the field data. Quality Assessment/Quality Control (QA/QC) procedures were implemented in order to ensure an adequate standard in the data collection and data entry procedures. Based on a random sub-sampling, 10% of the SUs were re-measured by a semi-independent team composed of experts not involved in the field campaign and specifically trained for QA/QC. At least one randomly selected plot per SU was re-measured entirely and the results were compared with the original values. The QA/QC team used the original data forms to check any irregularities in the records. An error tolerance (10% difference in results between the measured and re-measured sampling units) was introduced and applied in order to reject or accept the collected data. The data was entered into a database and then subject to cleansing procedures in order to filter all the records considered potentially erroneous.

A robust statistical procedure was applied to analyze the data based on the biomes. The method used was based on the one described by Sarndal et al. (1992)²¹. The details and equations are described in section 2.7 of the NFI report (MEFCC, 2018).

The data analysis of the field data results has been done using R language scripts and R scripts in OpenForis Calc²². In the data analysis, the following assumptions and equations have been used:

²¹ Sarndal, C-E., Swensson, B. and Wretman, J. (1992). "Model assisted survey sampling".

- Because field conditions do not always allow field crews to successfully determine tree height, a tree height model has been applied for trees whose heights are not measured in the field. Three different models were tested for the Ethiopia NFI dataset. Curtis' model (1967) was ultimately selected as the better fit which uses the follow equation:

$$h = 1.3 + a * \left(\frac{dbh}{1 + dbh} \right)^b$$

h = estimated top height [m];
 dbh = diameter at the breast height (DBH)[cm];
 a, b = parameters.

- In the absence of applicable biomass models for every Ethiopian ecosystem/biome consistent with international requirements, the pantropical model of Chave et al. (2014) was used:

$$AGB = 0.673 (WD \cdot dbh^2 \cdot h)^{0.976}$$

Where:

AGB = Above ground biomass [kg];

WD = Dry wood density [t m⁻³];

The default value for the WD is 0.615 t · m⁻³.

- Wood density data of over 400 tree species found in Ethiopia has been analyzed. For the NFI analysis, the ones with the highest quality have been selected and applied (see section labelled as '2.2 wood densities' on page 35 of the NFI report for details). Low quality values and tree species inventoried in Ethiopia and missing in the country databases, have been taken from the Global Wood Density Database (GWDDDB)²³. The result was that out of 360 species identified during the NFI cycle, wood densities of 341

²² Calc is a legacy tool that is part of the OpenForis tool kit. More information and access to the source code can be found at <https://openforis.org/solutions/legacy/>

²³ Zanne, A.E. et al. (2009). "Global wood density database". DRYAD. URL: <http://hdl.handle.net/10255/dryad.235>.

species have been selected using a validated value. The same values have been used in Ethiopia’s FREL as can be seen in Annex II of the Ethiopia FREL document.²⁴

- For the fallen deadwood volume, De Vries formula was used. Details on the application of this formula can be found in the section labelled ‘2.1 Deadwood’ on page 35 of the NFI report.

The National Forest Inventory Report provides more details of the approach used in the NFI. Although Ethiopia has planned to revise the carbon stock by conducting national forest inventory every five year, currently the previous assessment report announced in 2018 was not changed. This is because the country did not undertake the national forest inventory as planned due to some challenging factors. A new NFI is currently being conducted and the results of this new NFI will be incorporated in phase 2 of the ERPA when the baseline is expanded with additional subcategories.

The below-ground biomass (BGB) was estimated using the above-ground biomass values from the National Forest Inventory Report and root-shoot ratios from the Intergovernmental Panel on Climate Change (IPCC) (2006) by the ecological zones. The following root-shoot ratios have been applied.

Table 2: Root-shoot ratios applied for calculating below ground biomass

IPCC ecological zone	Value	Source	Application to Ethiopia biomes
Tropical Moist Deciduous Forest	0.24	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical moist deciduous	Applicable to Moist Afromontane Forest
Tropical Dry Forest	0.28	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical dry	Applicable to Dry Afromontane Forest, Combretum-Terminalia, Acacia-Commiphora

²⁴ https://redd.unfccc.int/files/ethiopia_frel_3.2_final_modified_submission.pdf

Tropical shrubland	0.4	2006 IPCC guidelines, vol4, chapter 4, table 4.4, default value for tropical shrubland	Applicable to other wooded land
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To estimate the carbon from the biomass, the following carbon fraction values have been applied from the Intergovernmental Panel on Climate Change (IPCC) (2006).

Table 3: Carbon fractions applied for calculating carbon from biomass

Vegetation type	Carbon fraction	Source
Forest	0.47	2006 IPCC guidelines, vol4, chapter 4, table 4.3
Woody biomass	0.5	2006 IPCC guidelines, Vol 4, chapter 6, suggested default value in step 5 on page 6.29
Herbaceous biomass	0.47	2006 IPCC guidelines, Vol 4, chapter 6, suggested default value in step 5 on page 6.29

Calculations of emissions and removals

Above and below ground biomass

For the three subcategories involving changes from forest to other land uses, the emissions from changes in the above ground and below ground biomass have been calculated as

$$\Delta C_{conversion,i} = EF_{i_ABBG} \cdot \Delta A_i$$

Where:

$\Delta C_{conversion, i}$ = change in carbon stocks on land converted from forest to land category i , tonnes CO₂

EF_{i_ABBG} = Emission factor for changes in above ground and below ground biomass in the conversion of forest to land use i , tonnes CO₂ ha⁻¹

ΔA_i = area converted from forest to land category i

The values of EF_{i_ABBG} are calculated as the difference between the carbon values of the above ground and below ground biomass before and after the change.

$$EF_{i_AGBG} = (C_n - C_o) \cdot \frac{44}{12}$$

Where:

EF_{i_ABBG} = Emission factor for changes in above ground and below ground biomass in the conversion of forest to land use i

C_n = above ground and below ground carbon stock under the new land-use category, tonnes C ha⁻¹

C_o = above ground and below ground carbon stock under the old land-use category, tonnes C ha⁻¹

44/12 = factor to convert carbon units to CO₂

As described above, the NFI provided the basis for the above ground biomass values used in the calculation of the emission and removal factors. The NFI report (MEFCC, 2018) provides a summary of the information from the NFI per biome, major land use/land cover type and regions.

For the calculation of the biomass and carbon values for the forest and shrubland categories, the values for ‘forest’ and ‘Other wooded land’ respectively were used from the NFI report. Since table A2.3 of the NFI report provides area estimates by regions, biomes and FRA classes, it was possible to calculate an Oromia specific, weighted biomass/carbon value for forest and shrubland using these areas.

For this, Table A9.7 provides values for above ground biomass per Region, Biome and FRA class. Using the IPCC root-shoot ratios from table 2, the below-ground biomass of the different FRA classes can be estimated as follows:

$$C_{cl_BG} = C_{i_AG} \cdot R$$

Where:

C_{cl_BG} = below ground carbon stock of FRA class cl , tonnes C ha⁻¹

C_{cl_AG} = above ground carbon stock of FRA class cl , tonnes C ha⁻¹

R = Root to shoot ratio, dimensionless

The table below provides an overview of the different Oromia specific values and provides reference to the source tables in the NFI report.

Table 4: Forest and shrubland Area and above ground/ below ground biomass values per biome and FRA Class for Oromia (including the relevant source tables from the NFI report (MEFCC, 2018))

Biome	FRA class	Area (ha)	ag_biomass (t /ha)	root-shoot	bg_biomass (t /ha)	Total biomass (t /ha)
Acacia-Commiphora	Forest	431,237	80.3	0.28	22.48	102.78
	Shrubland /Other wooded land	11,149,959	9.3	0.40	3.72	13.02
Combretum-Terminalia	Forest	205,087	46.8	0.28	13.10	59.90
	Shrubland/ Other wooded land	645,693	25.0	0.40	10.00	35.00
Dry Afromontane	Forest	488,946	69.4	0.28	19.43	88.83
	Shrubland / Other wooded land	7,029,220	9.0	0.40	3.60	12.60
Moist Afromontane	Forest	1,643,917	217.4	0.24	52.17	269.57
	Shrubland Other wooded land	2,747,305	17.8	0.40	7.12	24.92
Sources		NFI report table	NFI report table			

		A.2.3	A9.7			
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From the values above and using the carbon fractions from table 3, a weighted region specific value region for tree biomass and carbon was calculated as shown below.

Table 5 Tree biomass and carbon for forest and shrubland in Oromia

<i>FRA Class</i>	<i>Biomes</i>	<i>Area (ha)</i>	<i>biomass (t /ha)</i>	<i>Carbon fraction</i>	<i>carbon (t /ha)</i>	<i>total carbon (Total)</i>	<i>Weighted carbon t/ha</i>
<i>Forest</i>	<i>Acacia-Commiphora</i>	431,237	102.78	0.47	48.31	20,832,404	
	<i>Combretum-Terminalia</i>	205,087	59.90	0.47	28.15	5,774,200	
	<i>Dry Afromontane</i>	488,946	88.83	0.47	41.75	20,414,004	
	<i>Moist Afromontane</i>	1,643,917	269.58	0.47	126.70	208,285,468	
<i>Weighted value forest</i>		2,769,187				255,306,075	92.2
<i>Other Wooded Land</i>	<i>Acacia-Commiphora</i>	11,149,959	13.02	0.50	6.51	72,586,233	
	<i>Combretum-Terminalia</i>	645,693	35.00	0.50	17.50	11,299,628	
	<i>Dry Afromontane</i>	694,253	12.60	0.50	6.30	4,373,794	
	<i>Moist Afromontane</i>	867,005	24.92	0.50	12.46	10,802,882	
<i>Weighted value Other Wooded Land</i>		13,356,910				99,062,537	7.4

The National Forest Inventory Report (MEFCC, 2018) does not provide specific values for cropland and grassland. Table A1.1 of this report provides a description of the land use/land cover categories used. In this table, different vegetation types related to cropland and grassland are all included under the FRA class ‘Other land’. Since the National Forest Inventory Report

still provides the most comprehensive data set available, biomass and carbon values for cropland and grassland have been estimated using the data provided in this report.

Under the definitions of cropland and grassland used in Ethiopia, the following land uses from table A1.1 of the National Forest Inventory Report (MEFCC, 2018) would be included under the IPCC categories of Cropland and Grassland respectively:

Cropland	Annual crops
	Perennial crops
	Mixed annual and perennial crops
	Coffee plantations
	Fallow land
Grassland	Natural grassland

Table A2.2 of the National Forest Inventory Report provides Ethiopia wide area estimates for each of these land use classes. Table A8.1 of the same report provides (tree) biomass for the same. Using these data, an Ethiopia level weighted biomass and carbon value was calculated for Cropland and Grassland respectively using the root-shoot ratios and carbon fraction from Table 32 and Table 43 above. Since there are no Oromia specific area and biomass values available in the report, it was not possible to calculate an Oromia specific value.

The result of these calculations is shown in the table below.

Table 6 Biomass and carbon for cropland and grassland in Ethiopia

IPCC Class	NFI LUCC	Area (ha) (from NFI report, table A.2.2)	Biomass (t ha ⁻¹) (from NFI report, table A8.1)	Total biomass	Carbon fraction	Total carbon	Total carbon /ha	Weighted carbon (t C/ ha)
Cropland	Coffee plantation	1,073,035.0	214.9	230,595,221.5	0.5	108,379,754.1	101.0	
	Annual crop	28,283,110.0	11.3	319,599,143.0	0.5	150,211,597.2	5.3	
	Perennial crop	1,149,832.0	102.7	118,087,746.4	0.5	55,501,240.8	48.3	

	Mixed annual and perennial crops	393,913.0	37.7	14,850,520.1	0.5	6,979,744.4	17.7	
	Fallow	2,075,917.0	8.5	17,645,294.5	0.5	8,293,288.4	4.0	
Weighted value cropland		32,975,807.0		700,777,925.5		329,365,625.0		10.0
Grassland	Natural grassland	7,464,741.0	7.5	55,985,557.5	0.5	26,313,212.0	3.5	
Weighted value grassland		7,464,741.0		55,985,557.5		26,313,212.0		3.5

For the calculation of the emission factors used for conversions of forest to cropland and grassland, the difference between the carbon stocks of forest in table 5 and that of the Ethiopia wide value for cropland and grassland from table 6 was used. For the conversion of forest to shrubland, the difference between the carbon stock of forest and that of ‘other wooded land’ in table 5 was used.

For the subcategories involving removals, the removals are calculated using the approach outlined in the ISFL ‘Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period. The guidance note suggests that for change in biomass carbon stocks (above-ground biomass and below-ground biomass) it can be assumed that during the conversion from non-forest to forest, carbon stocks will go from average carbon stocks in non-forest to average carbon stocks in forests during a default period of 20 years. Therefore, the removal factors used were calculated as the emission factors (as described above) divided by 20.

Dead wood

The emission and removals from deadwood have been calculated according to the ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period (Version 1.0). In line with this guidance note, equation 2.23 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories has been used as the basis to estimate annual change in carbon stocks in dead wood due to land conversion.

<p>EQUATION 2.23</p> <p>ANNUAL CHANGE IN CARBON STOCKS IN DEAD WOOD AND LITTER DUE TO LAND CONVERSION</p> $\Delta C_{DOM} = \frac{(C_n - C_o) \cdot A_{on}}{T_{on}}$
--

Where:

ΔC_{DOM} = annual change in carbon stocks in dead wood or litter, tonnes C yr⁻¹

C_o = dead wood/litter stock, under the old land-use category, tonnes C ha⁻¹

C_n = dead wood/litter stock, under the new land-use category, tonnes C ha⁻¹

A_{on} = area undergoing conversion from old to new land-use category, ha

T_{on} = time period of the transition from old to new land-use category, yr. The Tier 1 default is 20 years for carbon stock increases and 1 year for carbon losses.

In line with the ISFL guidance note, it has been assumed that the average annual rate of conversion during the Baseline Period would have applied during the ISFL ERPA Phase. Instead of applying IPCC equation 2.23 directly, a change factor has been calculated (ΔCF_{DOM}) which is used in combination with the projected baseline area change.

$$\Delta CF_{DOM} = \frac{(C_n - C_o)}{T_{on}}$$

Where:

ΔCF_{DOM} = annual change in carbon stocks in dead wood, tonnes C ha⁻¹ yr⁻¹

With the other factor as defined for IPCC equation 2.23 above

Since there are no data to distinguish between the dead wood stocks immediately after the land-use conversion and the later transition period, it is assumed that the changes in the dead wood from one value to another happen in a linear fashion over the IPCC default period of 20 years.

Table 3-24 of the NFI report provides values for carbon in deadwood for different land use/land cover types on the national level as shown below.

Table 7: Carbon in deadwood by Major LUCC types (Table 3-24 of the NFI report (MEFCC, 2018))

FRA class	Major LUCC	Carbon (t ha ⁻¹)
Forest	Natural regenerated forest	15.8
Forest	Plantation	0.5
Other Wooded Land	Other wooded land	1.9
Other Land	Cultivated	2.6
Other Land	Natural	0.9

Since no region-specific values for dead wood are provided in the NFI, the national values have been used for the emission and removal factors.

According to the ISFL guidance note, the values for litter and dead wood pools can be assumed zero in all non-forest categories and dead organic matter in Forest Land shall be assumed to have the value of mature forests at the beginning of the Baseline Period. Since values are available from the NFI, the following emission and removal factors have been as outlines in the table below.

Table 8: Dead wood change factors applied

Baseline subcategory	Corresponding change from LUCC clases in figure 7 above	Change factor (t C ha ⁻¹ yr ⁻¹)
Forest to cropland	Natural regenerated forest to Other land-cultivated	-0.66
Forest to grassland	Natural regenerated forest to Other land-natural	-0.745
Forest to shrubland	Natural regenerated forest to other wooded land	-0.695
Cropland to forest	Other land-cultivated to plantation	-0.105
Grassland to forest	Other land-natural to plantation	-0.02
Shrubland to forest	Other wooded land to plantation	-0.07

Soil organic carbon

Changes in the Soil Organic Carbon pool in mineral soils associated with conversion from and to forest were calculated according to the ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period (Version 1.0). In line with this guidance note, formulation B from box 2.1 in the 2006 IPCC Guidelines, Volume 4, Chapter 2 was used as below.

Formulation B (Approaches 2 and 3 for Activity Data Collection)

$$\Delta C_{Mineral} = \frac{\sum_{c,s,p} \left[\left\{ \begin{array}{l} \left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \right)_0 - \\ \left(SOC_{REF_{c,s,p}} \cdot F_{LU_{c,s,p}} \cdot F_{MG_{c,s,p}} \cdot F_{I_{c,s,p}} \right)_{(0-T)} \end{array} \right\} \cdot A_{c,s,p} \right]}{D}$$

Where:

$\Delta C_{Mineral}$ = annual change in carbon stocks in mineral soils, tonnes C yr⁻¹

SOC_0 = soil organic carbon stock in the last year of an inventory time period, tonnes C

$SOC_{(0-T)}$ = soil organic carbon stock at the beginning of the inventory time period, tonnes C

T = number of years over a single inventory time period, yr

D = Time dependence of stock change factors which is the default time period for transition between equilibrium SOC values, yr.

c = represents the climate zones, s the soil types, and i the set of management systems that are present in a country.

SOC_{REF} = the reference carbon stock, tonnes C ha⁻¹

F_{LU} = stock change factor for land-use systems or sub-system for a particular land-use, dimensionless

F_{MG} = stock change factor for management regime, dimensionless

F_I = stock change factor for input of organic matter, dimensionless

A = land area of the stratum being estimated, ha.

p = parcel of land

As discussed above, the NFI report does not provide updates values on soil organic carbon. Therefore, the value for national soil organic carbon stocks for forest that was used in the ER Program inventory in the validated ERPD is also used for this monitoring report. This national value was obtained from the "Evaluation of the forest carbon content in soil and litter in Ethiopia"²⁵ which was implemented by Natural Resources Finland (LUKE) and Ethiopia Environment and Forestry Research Institute (EEFRI). The national value was based on biome specific values as shown in the table below.

Table 9: Soil organic carbon in forest in Ethiopia

Soil type - Biome	SOC ref (tC/ha)	N	Standard deviation (tC/ha)	Source
Acacia Commiphora	34.245	11	17.01197	Evaluation of the forest carbon content in soil and litter in Ethiopia, Implementing agency: Natural Resources Institute Finland (LUKE) and Ethiopia Environment and Forestry Research Institute (EEFRI) Duration of the Report: August 2017 - February 2018. Beneficiaries: FAO, MEFCC, EEFRI
Combretum Terminalia	41.561	37	28.25306	Idem above
Dry Afromontaine	53.080	33	34.46676	Idem above
Moist Afromontaine	83.886	17	34.65632	Idem above
Average	51.961	98	33.58339	Idem above

²⁵ Some of the results of this study are discussed in Lehtonen A, Ťupek B, Nieminen TM, et al. Soil carbon stocks in Ethiopian forests and estimations of their future development under different forest use scenarios. Land Degrad Dev. 2020; 31: 2763–2774. <https://doi.org/10.1002/ldr.3647>

In line with the guidance note, the Soil Organic Carbon pool in Forest Land was assumed to be in equilibrium at the beginning of the Baseline Period and the average value of 51.96 t C/ha has been used as SOC_{ref} and the equilibrium value for forest.

Following the equation above and equation 2.25 of the 2006 IPCC guidelines, the equilibrium values for each non-forest subcategory was conservatively determined by using the same stock change factors applied in the validated ERPD and the formula below:

$$SOC_i = SOC_{ref} \cdot F_{LU} \cdot F_I \cdot F_{MG}$$

Where:

SOC_i = Equilibrium soil organic C stocks for mineral soils under land use type i , tonnes C ha^{-1}

Other factors as defined above

The applied stock change factors and the resulting equilibrium SOC values are shown in the table below.

Table 10: Stock change values applied for estimating equilibrium soil organic carbon content of non-forest land categories

	FLU	FI	FMG	Equilibrium SOC (tC/ha)
Annual cropland	0.48	0.92	1	22.94
Grassland	1	1	0.97	50.40

3.4 Results of the land use change analysis

Table 11 Oromia National Regional State transition matrix of Land Use Land Cover Changes between base year 2007 and year 2017 in hectares

Row Labels	2007 LULC							Total
	Cropland	Forest land	Grassland	O/ land	Settlement	Shrub land	Wetland	
Cropland	10,604,906	234,677	103,322	400	6,808	131,355	4,005	11,085,473
Forest land	48,457	8,605,749	14,017	400	801	34,841	400	8,704,665
Grassland	20,024	48,858	5,491,276	-	400	34,040	400	5,594,998

Other land	801	400	1,201	91,708	400	1,201	400	96,113
Settlement	79,294	10,412	15,218	400	730,862	6,808	2,002	844,996
Shrub land	15,218	29,234	25,230	1,201	400	4,957,446	400	5,029,131
Wetland	3,204	1,201	801	400	8,009	400	868,624	882,641
Grand Total	10,771,903	8,930,532	5,651,064	94,511	747,682	5,166,092	876,233	32,238,018

The transition matrix indicated above showed that from 8,930,532 ha estimated as forest cover class in 2007, about 8,889 ha was converted to other land cover classes between the two-monitoring period, where 234, 677 ha, 48,858 ha, 400 ha, 10,000 ha, 29,234 ha and 1,201 ha has been converted in to cropland, Grassland, other land, settlement, shrub land and wetland respectively. Detailed information about each class and change class activity data is presented in table 11.

Uncertainty Estimates

The table below showed the uncertainty of land use land cover area estimation with 95% confidence interval. Statistical error value was calculated both for land remaining land classes and land use change categories.

Table 12 Area estimates for the change and stable LULC classes with 95% confidence Interval uncertainty estimates.

No	LULC subcategory	Area (ha)	CI (ha)	No	LULC subcategory	Area (ha)	CI (ha)
1	Cropland-Cropland	10,604,906	104,634	25	Other land-Settlement	400	785
2	Cropland-Forest land	48,457	8,628	26	Other land-Shrub land	1,201	1,360
3	Cropland-Grassland	20,024	5,549	27	Other land-Wetland	400	785
4	Cropland-Other land	801	1,110	28	Settlement-Cropland	6,808	3,236
5	Cropland-Settlement	79,294	11,031	29	Settlement-Forest land	801	1,110
6	Cropland-Shrub land	15,218	4,837	30	Settlement-Grassland	400	785

7	Cropland-Wetland	3,204	2,220	31	Settlement-Other land	400	785
8	Forest land-Cropland	234,677	18,932	32	Settlement-Settlement	730,862	33,150
9	Forest land-Forest land	8,605,749	98,516	33	Settlement-Shrub land	400	785
10	Forest land-Grassland	48,858	8,663	34	Settlement-Wetland	8,009	3,510
11	Forest land-Other land	400	785	35	Shrub land-Cropland	131,355	14,187
12	Forest land-Settlement	10,412	4,002	36	Shrub land-Forest land	34,841	7,317
13	Forest land-Shrub land	29,234	6,703	37	Shrub land-Grassland	34,040	7,233
14	Forest land-Wetland	1,201	1,360	38	Shrub land-Other land	1,201	1,360
15	Grassland-Cropland	103,322	12,588	39	Shrub land-Settlement	6,808	3,236
16	Grassland-Forest land	14,017	4,643	40	Shrub land-Shrub land	4,957,446	80,337
17	Grassland-Grassland	5,491,276	83,721	41	Shrub land-Wetland	400	785
18	Grassland-Other land	1,201	1,360	42	Wetland-Cropland	4,005	2,482
19	Grassland-Settlement	15,218	4,837	43	Wetland-Forest land	400	785
20	Grassland-Shrub land	25,230	6,228	44	Wetland-Grassland	400	785
21	Grassland-Wetland	801	1,110	45	Wetland-Other land	400	785
22	Other land-Cropland	400	785	46	Wetland-Settlement	2,002	1,755
23	Other land-Forest	400	785	47	Wetland-Shrub	400	785

	land				land		
24	Other land-Other	91,708	11,861	48	Wetland-Wetland	868,624	36,060
	land						
Total						32,238,018	

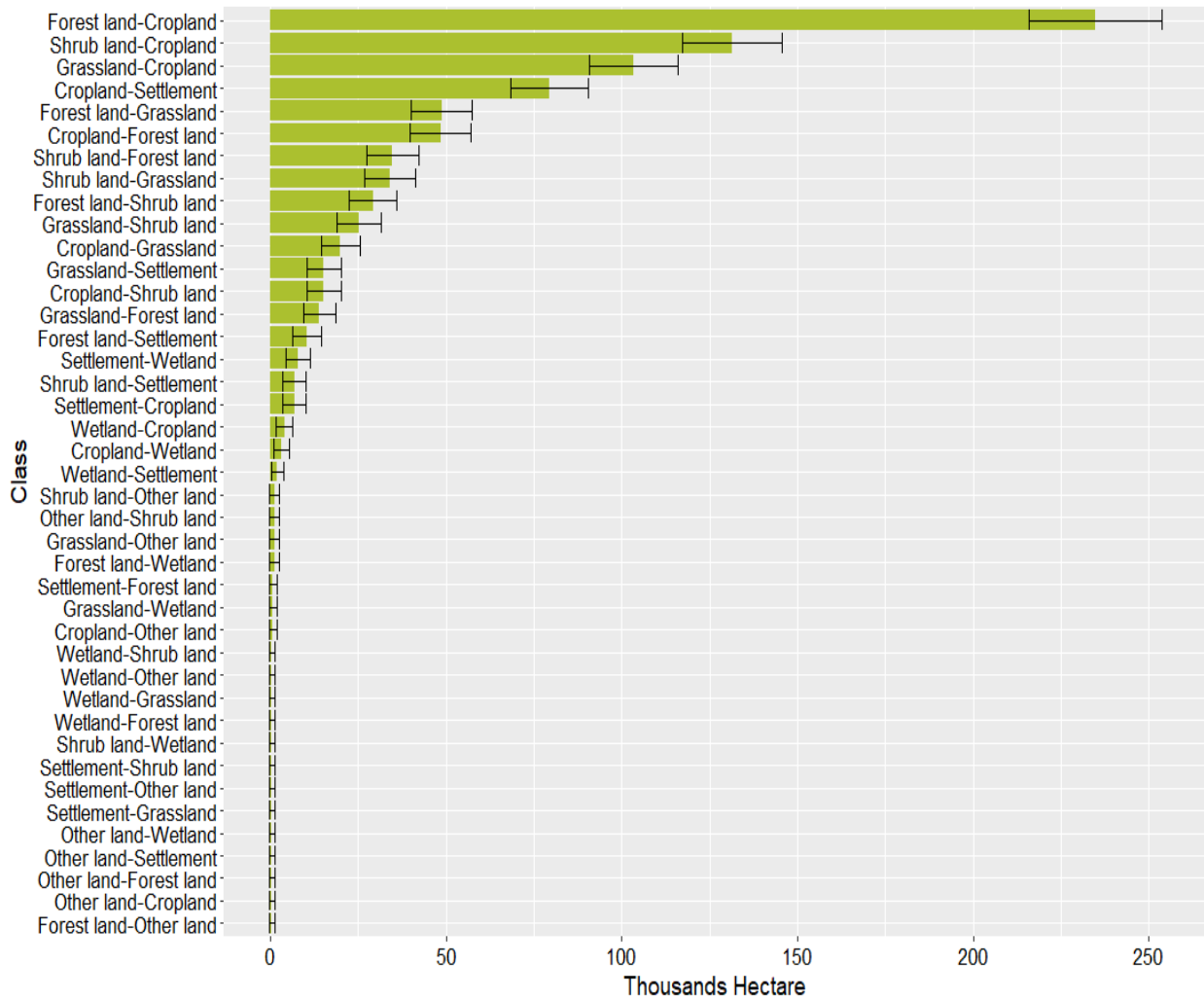


Figure 9 Area estimates for the 41 LULC change and stable classes with uncertainty.

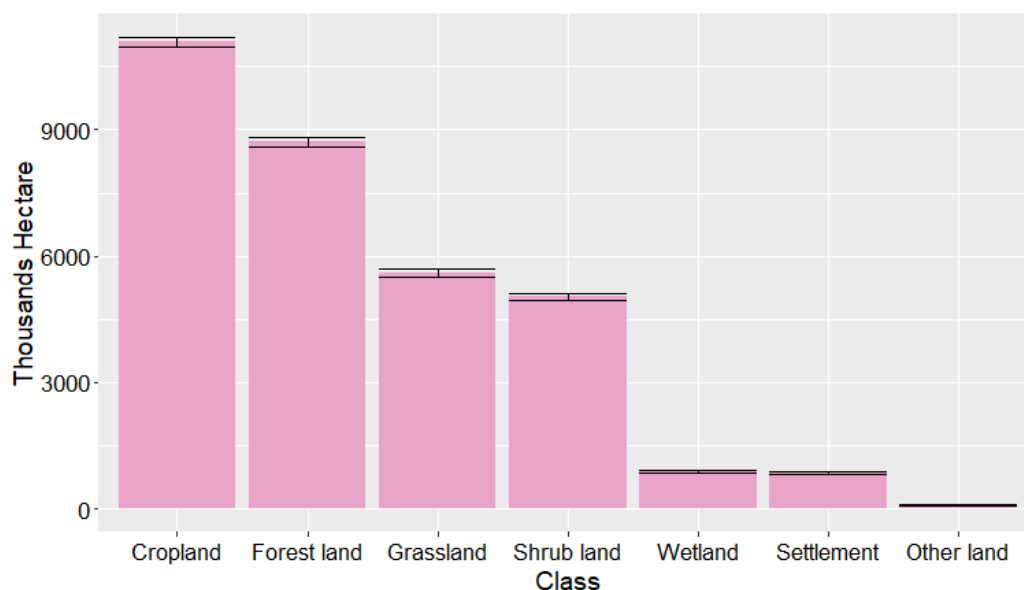


Figure 10 Area estimates for the LULC classes for the year 2017 with uncertainty estimates

Baseline emissions and removals

Emission and removals are determined for all the six subcategories and 4 pools. The ‘ISFL Guidance note on application of IPCC guidelines for subcategories and carbon pools where changes take place over a longer time period’ has been applied for relevant pools and subcategories. This includes changes in dead wood and soil organic carbon for all subcategories and changes in above- and below ground biomass in the subcategories involving conversions from other land uses to forest.

Following this note, for the Emissions Baseline it has been assumed that the average annual rate of conversion from one category to another (in ha/year) during the Baseline Period would have applied during the ISFL ERPA Phase and emissions and removals have been calculated accordingly.

ii. Emissions Baseline estimate

Table 13 Emissions Baseline estimate first monitoring period 2022-2023.

Year of reporting period	Baseline emissions (tCO ₂ e)							Total Emissions Baseline (tCO ₂ e)
	Sub category 1	Sub category 2	Sub Category 3	Sub Category 4	Sub Category 5	Sub Category 6	Sub Category 7	
	<i>Forest – Cropland</i>	<i>Forest – Grassland</i>	<i>Forest – shrub</i>	<i>Cropland – forest</i>	<i>Grassland – forest</i>	<i>Shrubland – forest</i>	SOC	

2022	7,130,570	1,601,827	916,219	(71,165)	(22,682)	(53,258)	1,100,587	10,602,098
2023	7,187,362	1,615,173	923,669	(142,331)	(45,365)	(106,516)	1,200,640	10,632,632
Total emissions during the Reporting Period								21,234,730

Table 14 Emissions Baseline estimate second monitoring period 2024.

Year of reporting period	Baseline emissions (tCO ₂ e)							
	Sub category 1	Sub category 2	Sub Category 3	Sub Category 4	Sub Category 5	Sub Category 6	Sub Category 7	Total Emissions Baseline (tCO ₂ e)
	<i>Forest – Cropland</i>	<i>Forest – Grassland</i>	<i>Forest - shrub</i>	<i>Cropland - forest</i>	<i>Grassland - forest</i>	<i>Shrubland - forest</i>	<i>SOC</i>	
2024	7,244,153	1,628,519	931,119	(213,497)	(68,048)	(159,775)	1,300,693	10,663,164
Total emissions during the Reporting Period								10,663,164

Annex 5: Resolution of Forward Action Requests

There is no forward actions requests in this ERPA phase.

Annex 6: Implementation status of the ISFL ER Program

1. Implementation status of the ISFL ER Program

The Oromia Forested Landscape Program (OFLP) is the first jurisdictional landscape pilot program in Oromia Regional State working for addressing the drivers of Agriculture Forest and Other Land Use (AFOLU) through targeted on the ground investments and enabling environment; ensuring coordination and collaboration of multi-level actors, financed projects across the region enhancing synergy, improved program outcomes and leveraging other resources and filled the financial gaps needed and achieved the Emission Reduction (ER) goals.

The Program aims to promote integrated low carbon landscape management through on ground investment and creation of enabling environment for addressing of deforestation, reducing land-use based emissions (including emission reduction from livestock), and enhancing forest carbon stocks at statewide level and sustainable forest management through Afforestation, Reforestation (A/R) and Participatory Forest Management (PFM) contributing to Ethiopia's Climate-Resilient Green Economy (CRGE) Strategy goals and its Nationally Determined Contribution (NDC).

As described in the Emission Reduction Program Document (ERPD), the activities leading to the emission reductions are a combination of interventions financed by the OFLP upfront grant provided by the Initiatives for Sustainable Forest Landscape (ISFL) but also due to other relevant investments and interventions across the region.

The Oromia Forested Landscape Program-Emission Reduction Project (OFLP-ERP), is the constitutive of OFLP aimed to contributes to the key national strategies, like the Ten-Year Prospective Development Plan; the updated Nationally Determined Contribution(NDC) of July 2021; the Ethiopian Food System; the Climate Resilient Green Economy (CRGE) Strategy and the 2015 sectoral Climate Resilience Strategies for Agriculture and Forest; the National Forest Sector Development Program; the National Reducing Emission from Deforestation, Forest Degradation, Conservation forest Carbon Stock and Enhancement of Forest Carbon Stock, Sustainable management of Forest, (REDD+) Strategy; and sector strategies for energy, water,

and agriculture with Specific goals on economic growth, poverty reduction, jobs, food and water security, forest protection and expansion, climate change adaptation and mitigation, conservation of biodiversity, and development of mechanisms for payment for ecosystems services.

In addition to the World Bank’s twin goals of ending extreme poverty and boosting shared prosperity by 2030, the OFLP-ERP directly contributes to the federal government strategies, programs, projects and initiatives through investment activities in natural resource management and in reducing vulnerability to climate shocks. The project also supports the objective of ‘Enhanced management of natural resources and climate risks’ through improved natural resources and forest management leading to preservation of critical biodiversity resources and national ecosystem assets including soil, water, important flora and fauna, genetic wealth and land resource. The project contributes to the implementation of the World Bank Forest Action Plan (2016) through promoting sustainable forestry and institutional development for measurable improvements of forest management. Furthermore, the project is in line with the implementation of the World Bank Group’s Climate Action Plan (2021–2025), in particular towards mobilizing capital and expanding access to green financing, as well as achieving improvements in climate change adaptation and resilience. The rationale for convening resources programmatically for forest landscape management in Ethiopia is to harness the potential of forest and agriculture landscapes, enhance natural wealth and ensure resilient, low carbon growth and poverty reduction. The following table provides an implementation status update of the activities.

Table 1 : Interventions addressing drivers of deforestation and forest degradation in Oromia achieved by the OFLP upfront grant and other investments (projects/programs) financed by government and Development Partners.

Interventions	Type of intervention (sector)	Status
OFLP - Forest management investment in deforestation hotspots (2017-2022) <ul style="list-style-type: none"> • Participatory Forest Management and Livelihoods 	Forestry	<u>Completed Activities</u> <ul style="list-style-type: none"> ✓ 210,592 hectares of natural forest demarcated and managed under PFM ✓ 129 PFM cooperatives established (30% female members) and managing the above 210,592 hectares of Forest using respective forest management plan (FMP)

Interventions	Type of intervention (sector)	Status
<ul style="list-style-type: none"> Afforestation / Reforestation (A/R) activities and Livelihood 	Forestry	<ul style="list-style-type: none"> ✓ AR activities completed with restoration of 9, 673.04 hectares of parcel of communal and private pooled lands converted into new forest ✓ 408 coops are organized and legalized to develop and manage the above A/R land of which 394 A/R cooperatives benefited from livelihoods activities. Overall, 514 coops (394 A/R and 120 PFM) have benefited from livelihoods activities with total beneficiaries of 50,686, of which 17, 970 are female beneficiaries. ✓ 27,478(10,327F) members of the above beneficiaries are capacitated on different livelihood intervention/Business skills
<p>REDD+ Investment in Ethiopia Phase I and II (2018 – 2026)</p> <ul style="list-style-type: none"> ✓ Assisted Natural Regeneration(ANR) ✓ Afforestation/Reforestation (A/R) 	Forestry	<p><u>Ongoing Activities</u></p> <ul style="list-style-type: none"> ✓ 278,296 hectares degraded forest land protected through ANR ✓ 23,472 hectares of land covered by forest through afforestation and reforestation
<ul style="list-style-type: none"> ✓ PFM (protection) 	Forestry	<ul style="list-style-type: none"> ✓ About 516,500 hectares of natural forest put under participatory forest management (PFM)
<p>Oromia Forest and Wild Life Enterprise (OFWE)- (2007 to now) Forest Resources Development, Conservation, and Sustainable Utilization</p> <p>Afforestation/Reforestation</p> <ul style="list-style-type: none"> ✓ PFM 	<p>Forestry</p> <p>Forestry</p>	<p><u>Ongoing Activities</u></p> <ul style="list-style-type: none"> ✓ 62,918 hectares is plantation forest (seasonal harvest and re-planting cycles depending on maturity), but OFWE’s plantations size within its concession remain the same throughout the years. ✓ 144,854 hectares PFM established using the OFLP grant project (already reported above under the OFLP grant PFM investment, i.e. (part of the 210,592 hectares). Currently, total PFM in OFWE concession area is 1,678,530 hectares of forest managed by 581 CBOs/Coops signing joint management of

Interventions	Type of intervention (sector)	Status
		forest with OFWE.
Bale Eco-region REDD+ Pilot Project Phase II		<u>Completed Activities</u>
PFM and Enrichment planting (2016-2021)	Forestry	<ul style="list-style-type: none"> • Total area under PFM is 671,397 hectares (i.e. 583,823 hectares under PFM established prior to year 2017 and 87,574 hectares newly established PFM after 2017, mostly in project's second phase operation in Guji forests). Please note, achievements of Bale Eco region project are also counted as achievement of (OFWE) as the two entities develop PFM jointly. • Total number of Community Based Organization (CBOs) established are 127 Total estimate Emission Reduction Credits (ERCs) generated by Bale Eco region REDD+ Project from 2012 to 2021 is 13.66 Million tons of Carbon dioxide equivalent (Mt CO₂eq)
National Biogas Program of Ethiopia (NBPE II-2014-2019) and (NBPE+ -2017-2020)	Energy	<u>Completed Activities</u> <ul style="list-style-type: none"> ✓ Around 4,133 biogas digesters established in Oromia; of these, 57-72% considered functional. ✓ Oromia Water and Energy bureau have been working on energy technological distributions through constituting different projects ✓ Distributed 3,716,417 Integrated Cook stoves (ICS), SHS 319,940 and 7,571 biogas digesters planted at House Hold (HH) level
Oromia Bureau of Water and Energy(OBWE 2014-2020)	Energy	<u>Completed Activities</u> <ul style="list-style-type: none"> ✓ Around 7,571 biogas digesters have been established in Oromia through the (National Biogas Program of Ethiopia, (NBPE I 2008-

Interventions	Type of intervention (sector)	Status
		<p>2013) and (NBPE II 2014-2019) of these, 57-72% is considered functional.</p> <ul style="list-style-type: none"> ✓ Oromia Water and Energy bureau has been working on energy technology distributions through different investments. ✓ Distributed 3,716,417 improved cook stoves (ICS), 319,940 small household solar system (SHS)
<p>REDD+ Joint Forest Management in South West Ethiopia – EWNRA(2017 -2025)</p>	<p>Forestry</p>	<p><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ Since 2017, 27 new PFM cooperatives have been established and registered, managing 56,631 hectares of natural forests in four woredas of South west (SW) Oromia (Becho, Ale, Didu and Halu). ✓ Before 2017, in adjacent woreda of Sele Nono, 19 PFM cooperatives were registered/legalized and established, managing close 129,590 hectares of natural forest under the PFM modality. This brings SW Ethiopia REDD+ project’s total PFM achievement to 186,221 hectares with total number of registered cooperatives managing these forests to 46 across five woredas of South West Oromia. ✓ It is noted that, though that this project’s work is a joint OFWE –at south West Ethiopia REDD+ Project undertaking. These results also reflected in OFWE’s total PFM result.

Interventions	Type of intervention (sector)	Status
FARM AFRICA, SOS Sahel Ethiopia (2017 - 2026)	Land Use Land Cover Change (LULC)	<p style="text-align: center;"><u>Ongoing activity</u></p> <ul style="list-style-type: none"> ✓ Farm Africa is the pioneer program that laid a robust foundation for sustainable forest management approach (PFM) ✓ Under Farm Africa Forest for Sustainable Development Program (FSDP) has been working on emissions reduction from Deforestation and Forest Degradation (REDD+) phase I & II projects has established the PFM on 671,397.71 hectares of natural forest and cooperate under 128 PFM Cooperatives with 63,750(14,531F) members.
Digital green foundation and Environmental and coffee forest forum (2022- 2025)	LULC	<p style="text-align: center;"><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ The project is Working on Deforestation, forest degradation and Biodiversity conservation aiming to improve the livelihood of forest dependent communities with a total budget of 39 mill for the period from
Mass Mobilization for Natural Resource Management (NRM) (2011 to now)	AFOLU ²⁶	<p style="text-align: center;"><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ Mass mobilization-based watershed development ✓ Government Green Legacy Initiatives (GLI) sustains water shade development and contributed: <ul style="list-style-type: none"> ✓ 55,032 hectares planted in 2022 season ✓ 376,141 hectares planted in 2023 season ✓ 785,949 hectares planted in 2024 season • Total: 1,217,122 hectares planted through the Green Legacy Initiative (GLI) (Source:

AFOLU: Agriculture, Forestry and Other Land Use

Interventions	Type of intervention (sector)	Status
		Oromia Bureau of Agriculture (BoA)
Sustainable Land Management Project (SLMP 2)- (20014 -2018)	AFOLU	<p><u>Completed activities</u></p> <ul style="list-style-type: none"> ✓ The project covered 26 woredas in Oromia directly benefiting 73,939 HHs of which, 9,385 were women headed HHs ✓ Area of Land covered by SLMP2 in Oromia was 196,134 hectares. ✓ No. of second Level Land holding certificates (SLLCs) issued under SLMP-2 in Oromia were 118,315, of which, 82,829 were for female holders.
Extension of SLMP 2 - Resilient Landscape and Livelihood Project (RLLP) Phase I (2014-2018) & II (2018 to 2024)	AFOLU	<p><u>Completed activities</u></p> <ul style="list-style-type: none"> ✓ 93,182 hectares of land is under sustainable landscape management practices ✓ 16.4 % increase in yield of targeted commodities (Livestock and Crop) ✓ 269,363 Project beneficiaries with improved access to key natural resources (of which 40% or 107,332 female and 26 % or 70,179 are youth) ✓ Six Rangeland Management and Investment Plans (RMIPs) under implementation ✓ 90% of Targeted clients satisfied with livestock, veterinary and agricultural extension services ✓ 385,726 Project direct beneficiaries (of which 42% or 162,387 female and 3% or 11,610 are youth)
Techno Serve Ethiopia (2021–2026)	AFOLU	<p><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ Modern coffee management (stamping old coffee trees to improve living incomes for the farmers with a total budget of above 63 Mill ETB for the period of Oct.2021- Sept. 2026
Solidaridad Ethiopia (2022 - 2025)		<p><u>Ongoing Activities</u></p> <ul style="list-style-type: none"> ✓ The project is working on transformation

Interventions	Type of intervention (sector)	Status
		dairy sectors of Oromia through promoting climate smart dairy farming practices Climate Smart dairy from sustenance to running professional for the period of 2022 up to 2025 with the total budget of 50 Mill. ETB
Climate Action Through Landscape Management (CALM) –World Bank (WB) financed (2019 - 2025)	AFOLU	<p style="text-align: center;"><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ Total number of second level land holding certificates (SLLCs) issued through CALM in Oromia up to March 2024 is 3,078,896 (out of 3,726,111 total demarcated to date) ✓ The National Rural Land Administration Information System (NRLAIS) established in 157 woredas under CALM up to March, 2024 in Oromia. ✓ 867,877 hectares of land area is under sustainable landscape management practices through CALM in Oromia ✓ 466,344 (141,134-female) community members in the Program watersheds organized as Watershed User Association (WUA), registered, and with approved Watershed Management Plan (WMP). 1,430 (WUA) organized through CALM in Oromia.
Sustainable Environment and development Action (SEDA) (2010 - 2015)	AFOLU	<p style="text-align: center;"><u>Completed activities</u></p> <ul style="list-style-type: none"> • The project is working on Improving climate change impacts through adaptation and mitigation actions with a total budget of 21.4 Mil ETB for the period of Nov, 2010 up to Nov, 2015
MELCA (Movement of Ecological Learning and Community Action) Ethiopia (2021 – 2026)	AFOLU	<p style="text-align: center;"><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ✓ The project has been working on sustainably conserving important ecosystems as well as improving the target communities' resilience to

Interventions	Type of intervention (sector)	Status
		climate change and socio economic challenges for the period of June 2021 to May 2026 with a total budget of 25.6 mill ETB.
SLLCs by Land Investment for Transformation (LIFT), government and other Development Partner (DP) (2014-2021)	Land Tenure/land Administration	<p style="text-align: center;"><u>Completed activities</u></p> <p>First round land Certificate</p> <ul style="list-style-type: none"> ➤ 294 woredas 6,478 kebele with total of 35,369,000 parcel of land certified for 22,820,000 HHs (4,244,280F) <p>2nd round'</p> <ul style="list-style-type: none"> ➤ 125 woreda, 9,774,730 parcel of land for 2,205,928 HHs ➤ In Oromia 10,026,507 parcel of land certified in the region from which 9,525,181.65 parcel of land certified for 2,381,295 HH(357,194F), 10,026.51 parcel of land under institution and 15,039.76 parcel of land under communal scheme.
Ethiopian Coffee Forest Forum (ECFF)-Certified Forest Coffee Production and Promotion Project (2009- 2025)	LUCF	<p style="text-align: center;"><u>Ongoing activities</u></p> <ul style="list-style-type: none"> ➤ The project is linked with the protection of the Yayu Coffee Forest Biosphere Reserve (YCFBR-UNESCO registered) ✓ 167,021 hectares of the YCFBR maintained and under protection and sustainable managed (buffer and transition zones through sustainable management and PFM) up to Yr. 2023 ✓ Dense forest coverage increased by 8,469 hectares from 2010 to 2023, ✓ However, size of disbursed forest and cultivated land increased by 5,233 hectares and 3,775 hectares respectively from 2010 to 2023. ✓ Rain Forest Alliance certified one coffee producing coop for Organic coffee production benefiting a total of 415 farmers (of which 68 are women) established.
Nespresso-East Africa	AFOLU	<u>Completed activities</u>

Interventions	Type of intervention (sector)	Status
Coffee Project (Nespresso, International Finance Corporation (IFC), and BioCF support) (2013- 2023)		<ul style="list-style-type: none"> ✓ During 2017-2018, training was provided to 49, 497 (34% women) farmers on various practices that enhance agricultural productivity such as rejuvenation (stumping), weeding, erosion control, shade, nutrition, IDPM, etc. ✓ In addition, through the new coffee improvement (rejuvenation) project financed by ISFL, additional 20,122 farmers were trained in coffee rejuvenation and sustainable agricultural practices during the 2022- 2023 calendar year. Of these, 6,017(43%) are female. To date, in total, 69,619 farmers have been trained. Of these, 25,000 have adopted sustainable practices on their farm.
Participatory Small-scale Irrigation Development Program II (PASIDP II) and IFAD (2017-2024)	AFOLU	<p style="text-align: center;"><u>Completed activities</u></p> <ul style="list-style-type: none"> • Covered 25 woredas and reached 15,403 beneficiaries • Climate Smart Agriculture activity conducted on 680 hectares with 1,517 beneficiaries • SWC conducted on 19,181.5 hectares • Conducted hillside communal land treatments, Area Closures, Gully and Riverbank management • Farmland Soil and Water Conservation (SWC) activities <p>Agroforestry</p> <ul style="list-style-type: none"> • Covered 1,195.9 hectares • Improved forage production conducted on 1,310 hectares <p>Soil fertility management practices</p> <ul style="list-style-type: none"> • Implementation of Vermicomposting 1,161 hectares • 1,747 Small scale alternative energy sources implemented
Agricultural Growth Program (AGP) I (2011-	Agriculture ,Irrigation	<p style="text-align: center;"><u>Completed activities</u></p> <ul style="list-style-type: none"> • To reduce forest and Natural resource

Interventions	Type of intervention (sector)	Status
2017) and II (2017-2021)	development	dependency AGP I and II has been working on adoption of improved agricultural technologies, Livelihood Enhancement and large / Small modern irrigation development in 181 woredas
Livestock and Fisheries Sector Development Project (LFSDP) (2019-2024)	Climate smart Livestock development	<p style="text-align: center;"><u>Completed activities</u></p> <ul style="list-style-type: none"> ✓ LFSDP operates in 18 zones, 23 woredas and 581 kebeles in Oromia ✓ Total beneficiaries are 115,176 people engaged in livestock production, of these 35,805 are women ✓ 2,456 common interest groups (CIG) were organized across red meat, Dairy, poultry and fishery value chains. ✓ Additionally, the CIGs collectively formed 198 marketing cooperatives and 1,350 improved breeders' cooperatives ✓ The project has also been working in improved feed development, livestock genetic improvement, animal health, etc., within 23 woredas in Oromia
Extension of SLMP 2 - Resilient Landscape and Livelihood Project (RLLP)(2018-2024)	AFOLU	<p style="text-align: center;"><u>Completed activities</u></p> <ul style="list-style-type: none"> ✓ Rural Resilient Livelihood Program I (RLLP I) and RLLP II have targeted and implemented 62 major watershed restorations and 694 micro watersheds in 62 woredas of Oromia from 2019 to the end of 2024. Total rural woredas coverage being about 24%. ✓ The RLLP program has targeted 254,358 households (HH) in Oromia with a range of land restoration activities involving communities with land holding size of more than half a hectare of rural land. 56,745 women benefited from income generation/livelihoods support in Oromia during the two RLLP phases. ✓ 723,089 Second level land holding certificates

Interventions	Type of intervention (sector)	Status
		(SLLCs) are issued to a total of 255,527 HHs, of which 177,311 women are headed HHs in Oromia during the two phases of the project period.
4B tree National Green Development Action Programme of Ethiopia	Forestry	See above Mass Mobilization for NRM section on GLI

Through the aforementioned interventions, the major drivers of emission resulted from degradation; deforestation and land use successfully addressed through improved strategic actions and enhancements to the program scope. Key results include the refinement of approaches to mitigate the drivers through interventions, leveraging jurisdictional coordination, and optimizing existing technical, institutional, and resource capacities. These efforts have contributed to aligning interventions more closely with the program's overarching goals of conserving and enhancing the forest landscape while generating emission reductions (ERs) that fortified ability and tackled the identified drivers comprehensively

9 Reference

- A Bush, K. Mankany (2016).** *Encorporating evolutionary Adaptation to Reduce projected Vulnerability to climate change.* Ecology letters 2016. Hptts//boi.10.1111/ele.12696
- Bos, A. B., De Sy, V., Duchelle, A. E., Herold, M., Martius, C., & Tsendbazar, N.-E. (2019).** *Global data and tools for local forest cover loss and REDD+ performance assessment: Accuracy, uncertainty, complementarity and impact.* International Journal of Applied Earth Observation and Geoinformation, 80, 295–311.
<https://doi.org/https://doi.org/10.1016/j.jag.2019.04.004>
- Breiman, L. (2001).** *Random Forests.* *Machine Learning* **45**, 5–32.
- Chave J, et al. (2014).** *Improved allometric models to estimate the aboveground biomass of tropical l trees.* *Global change biology.* (2014). [https//Doi.org/10.1111/gcb.12629](https://Doi.org/10.1111/gcb.12629)
- Cochran, W. G. (1977).** *Sampling techniques (3rd ed.).* New York: John Wiley & Sons.
- GFRA, (2020).** *Global Forest Resources Assessment 2020.* *FAO.*
<https://doi.org/10.4060/ca9825en>
- Friis, Ib & Demissew, Sebsebe & Breugel, Paulo. (2010).** *Atlas of the Potential Vegetation of Ethiopia.* 58. 307.
- FAO. (2019).** *World Food and Agriculture – Statistical pocketbook 2019.* Rome.
- GFOI. (2020).** *Methods and Guidance from the Global Forest Observations Initiative: Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests.*
- Healey, S. P., Cohen, W. B., Yang, Z., Kenneth Brewer, C., Brooks, E. B., Gorelick, N., Hernandez, A. J., Huang, C., Joseph Hughes, M., Kennedy, R. E., Loveland, T. R., Moisen, G. G., Schroeder, T. A., Stehman, S. V., Vogelmann, J. E., Woodcock, C. E., Yang, L., & Zhu, Z. (2018).** *Mapping forest change using stacked generalization: An ensemble approach.* *Remote Sensing of Environment*, 204(March 2017), 717–728.
<https://doi.org/10.1016/j.rse.2017.09.029>
- IPCC, (2006).** *Guidelines for national GHG inventory Volume I*
- Kozak, Marcin. (2011).** *Comparison of efficiency of geometric stratification and K-means algorithm in univariate stratification of skewed populations.* 7. 341-344.

- Lehtonen A, Tupek B, Nieminen TM, et al. (2020).** *Soil carbon stocks in Ethiopian forests and estimations of their future development under different forest use scenarios.* *Land Degrad Dev.* 2020; 31: 2763–2774. <https://doi.org/10.1002/ldr.3647>
- MEFCC, (2018).** *Ethiopia's National Forest Inventory.* Addis Ababa: MEFCC.
- MEFCC, (2018).** National Forest Sector Development program of Ethiopia, Volume II Program pillar, Action Area and target. <https://www.undp.org/ethiopia/publications/ten-year-national-forest-sector-development-programme>
- Mitchard, E.T., Saatchi, S.S., Baccini, A. et al. (2013).** *Uncertainty in the spatial distribution of tropical forest biomass: a comparison of pan-tropical maps.* *Carbon Balance Manage* 8, 10 (2013). <https://doi.org/10.1186/1750-0680-8-10>
- Mokany, K., Raison, R.J. and Prokushkin, A.S. (2006)** *Critical Analysis of Root: Shoot Ratios in Terrestrial Biomes.* *Global Change Biology*, 12, 84-96. <https://doi.org/10.1111/j.1365-2486.2005.001043.x>
- MoPD, (2021).* *Ethiopian Ten years Development plan, Pathway to prosperity.* <https://www.dpgethiopia.org/frameworks/the-10-year-development-plan/>
- Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V, Woodcock, C. E., & Wulder, M. A. (2014).** *Good practices for estimating area and assessing accuracy of land change.* *Remote Sensing of Environment*, 148, 42–57. <https://doi.org/http://dx.doi.org/10.1016/j.rse.2014.02.015>
- Tolamariam Ch. (2023).** **Forest carbon stock variation with altitude in bolale natural forest, Western Ethiopia, *Global Ecology and Conservation.*** <https://doi.org/10.1016/j.gecco.2023.e02537>
- UN-REDD, (2017).** *Ethiopia's Forest Reference Level Submission to the UNFCCC.* https://redd.unfccc.int/files/ethiopia_frel_3.2_final_modified_submission.pdf (accessed October 2023).
- Will Kenton, (2024).** *Standard Error (SE) Definition : Standard Deviation In statistics explained.*